Are ethnic inequalities in 30-day ischaemic stroke survival emerging as treatment becomes more effective?

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ABSTRACT

AIM: Studies of ethnic differences in stroke survival have produced inconsistent findings. As treatment becomes more effective, inequalities may increase. We examine time trends in ischaemic stroke case fatality in New Zealand.

METHOD: The 30-day case fatality rate (CFR) of ischaemic stroke in New Zealand was calculated from routinely collected data for two 5-year periods (2000–2004 and 2010–2014) in Māori, Pacific, Asian and European people. A Poisson regression model tested ethnic inequalities between Europeans and people of other ethnicities in each time period.

RESULTS: From 2000–2004 to 2010–2014, the age-sex standardised CFR in Europeans fell from 13.4% (95% CI 13.0 to 13.9%) to 10.7% (10.3 to 11.1%). In Pacific and Asian people, the CFR rose between the two periods, and in Māori there was a drop from 18.2% to 16.2%; neither of these differences were statistically significant. After controlling for socio-demographic variables, service factors and comorbidities, the CFR was higher for Māori than Europeans in 2000–2004, and for all ethnic groups compared with Europeans in 2010–2014.

CFR ethnic inequality rose over that time—the change being statistically significant for Pacific (p=0.033) and Asian (p=0.010), and of borderline significance for Māori (p=0.053).

CONCLUSIONS: Ethnic inequalities in 30-day ischaemic stroke survival have increased significantly in the last 10 years. This may be due to differences in severity at presentation, or in access and utilisation of the increasingly effective acute and hyper-acute stroke interventions.

Ethnic differences in incidence and mortality from ischaemic stroke have been well documented both in New Zealand[1-4] and elsewhere.[5-7] Some of this excess can be explained by a higher prevalence of cerebrovascular risk factors, including obesity, diabetes, and hypertension.[8] There is little evidence, however, that socially-disadvantaged ethnic groups have worse stroke survival or functional outcomes.[9] In the US, case fatality rates (CFRs) for stroke in blacks are similar to those in whites.[10]

The evidence for ethnic differences in stroke survival is mixed and inconclusive for New Zealand. Results from prospective studies conducted in Auckland in 1981–82, 1991–92, 2002–03 and 2011–12 have noted that ethnic-specific 28-day stroke CFRs have declined over time in all ethnic groups.[1] A previous report from the Auckland Regional Community Stroke (ARCOS) studies found that CFRs were similar for Māori, Pacific, and European people, but noted that Māori were the only ethnic group with no significant trend in CFR reduction over time.[11] Other analyses of these studies reported higher CFRs for Māori at 28 days,[12] and at 9 months,[13] but the differences were not statistically significant.

Here we analyse routinely collected data from the whole of New Zealand to

Table 1: Ischaemic stroke mortality outcomes in New Zealand by ethnicity for 2000–2004 and 2010–2014.

	Ethnicity	Deaths	Total strokes	Crude		Age-sex-standardised	
				CFR (95% C.I.)	Rate ratio† (95% C.I.)	CFR (95% C.I.)	Rate ratio† (95% C.I.)
2000–2004	Māori	197	1,462	13.5 (11.7–15.2)	0.91 (0.80–1.04)	18.2 (15.4–21.1)	1.36 (1.13–1.63)
	Pacific	94	852	11.0 (8.9–13.1)	0.75 (0.63–0.88)	14.1 (10.9–17.2)	1.05 (0.83–1.32)
	Asian	45	571	7.9 (5.7–10.1)	0.53 (0.43–0.65)	9.5 (6.6–12.4)	0.71 (0.54–0.92)
	Other+	2,902	19,616	14.8 (14.3–15.3)	-	13.4 (13.0–13.9)	-
2010–2014	Māori	273	2,154	12.7 (11.3–14.1)	1.0 (0.89–1.12)	16.2 (14.0–18.4)	1.51 (1.28–1.79)
	Pacific	131	1,109	11.8 (9.9–13.7)	0.93 (0.79–1.09)	15.2 (12.6–17.9)	1.42 (1.15–1.75)
	Asian	109	1,020	10.7 (8.8–12.6)	0.84 (0.71–0.99)	13.5 (11.1–15.9)	1.26 (1.03–1.53)
	Other+	2,696	21,231	12.7 (12.3–13.1)	-	10.7 (10.3–11.1)	-

CFR=case fatality rate, CI=confidence interval, +'Other' ethnicity is predominately European, †'Other' is the reference for rate ratio calculations

assess the magnitude and trend of ethnic inequalities in the 30-day CFR in two 5-year periods, separated by a gap of 10 years.

Methods

Data from the National Minimum Dataset (NMDS), which records all publicly-funded hospital inpatient events in New Zealand, were linked by anonymised identifier to the National Mortality Collection, which records all deaths in New Zealand. The vast majority of acute hospital inpatient events are included in the NMDS database, and although it may not be perfect, the quality of clinical coding is carefully controlled by regular internal and external audits. Patients were classified into one of four ethnicity groups: Māori; Pacific; Asian; or European/other. Patients were classified by 'prioritised ethnicity' as recorded in their hospital record. This assigns a single ethnicity to individuals who have recorded multiple ethnicities, based on a ranking specified in the national ethnicity standards.[14] Thus, those with Māori as any of their ethnicities are assigned Māori as their prioritised ethnicity. Similarly, those with any Pacific ethnicity code are classed as Pacific, unless they also have a Māori response.

Two 5-year periods were studied: 2000–2004 and 2010–2014, with eligibility based on the date of discharge. The methods for calculating CFR followed that defined by the Organisation for Economic Cooperation and Development (OECD) for the ischaemic patient-based in and out of hospital 30-day CFR.[15,16] Accordingly, the denominator comprises the number of patients in a given year with a primary discharge diagnosis ICD-10 code of I63 or I64 (ischaemic or non-specified stroke). The numerator is the number of patients that died (in hospital, or in the community) within 30 days of their first acute admission with ischaemic stroke in that calendar year. The numerator and denominator were both the sum of the numbers in each individual year in the 5-year period. Patients under 45 were excluded, and the CFRs were standardised by age and sex to the 2010 OECD stroke population, with 95% confidence limits calculated assuming a binomial distribution. Poisson regression analysis was used to examine the extent to which ethnic differences in CFR could be explained by a range of potential confounders, and whether there had been a significant change in ethnic inequalities between the two time periods. Comorbidities

Table 2: Relative risk of death within 30 days of an ischaemic stroke for Māori, Pacific, and Asian, compared with European/Other.

MODEL	Mortality relative risk (95% confidence limits)					
	2000–2004			2010–2014		
	Māori	Pacific	Asian	Māori	Pacific	Asian
Constant only	0.91 (0.80–1.04)	0.75 (0.61–0.91)	0.53 (0.40–0.71)	1.00 (0.89–1.12)	0.93 (0.79–1.10)	0.84 (0.70–1.01)
+ age and sex	1.50 (1.31–1.71)	1.14 (0.94–1.38)	0.74 (0.56–0.99)	1.76 (1.56–1.99)	1.51 (1.29–1.79)	1.20 (1.01–1.43)
+ deprivation	1.45 (1.27–1.67)	1.10 (0.91–1.34)	0.75 (0.56–0.99)	1.63 (1.44–1.84)	1.37 (1.16–1.63)	1.20 (1.00–1.43)
+ hospital, district & weekend admission	1.39 (1.21–1.60)	1.15 (0.95–1.41)	0.77 (0.58–1.02)	1.63 (1.44–1.85)	1.46 (1.23–1.74)	1.23 (1.03–1.48)
+ Elixhauser comorbidities	1.29 (1.12–1.49)	1.14 (0.94–1.39)	0.80 (0.60–1.06)	1.60 (1.41–1.81)	1.49 (1.25–1.77)	1.26 (1.05–1.51)

were controlled for using the Elixhauser comorbidity index, using coded diagnoses from the NMDS.[17] Area deprivation was controlled for using the New Zealand Deprivation Index 2006 data derived from patient domicile codes recorded in the NMDS.[18] Separate Poisson regression models were produced for each of the two periods to calculate the magnitude of ethnic inequality within each. Data from both periods was then combined in a fully parameterised Poisson regression model, controlling for the period, with an interaction term to test for statistical significance of the changes in ethnic inequalities in CFR between 2000–4 and 2010–14.

Results

Table 1 shows the crude and age-sex standardised 30-day case fatality rates for ischaemic stroke by ethnicity. A strong degree of confounding by age and sex is evident, with non-significant crude rate ratios for Māori versus European/Other becoming significant in both time periods when standardised. For Pacific, age-sex standardisation made a significantly lower CFR non-significant in 2000–2004; for the period 2010–2014, a CFR lower than for European/Other became significantly higher after standardisation.

Table 2 presents the results of Poisson regression analyses. Again, confounding by age and sex can be seen which was attenuated somewhat in Māori and Pacific after controlling for area deprivation. Controlling for service-related variables (hospital, District Health Board, and weekend admission) had only a small impact on the relative risks, despite all of these being significantly associated with CFR themselves. Although Elixhauser co-morbidity risk adjustment reduced the relative risks in each period for Māori, they remained statistically significant, and it made little difference to them for Pacific and Asian.

Ethnic inequalities have worsened in the 10 years separating the two cohorts. In 2000–2004, only Māori had a significantly higher CFR than European/Other, but by 2010–2014, all three ethnic groups had higher CFRs. Both absolute and relative inequalities have deteriorated for Māori compared with European/Other. The absolute difference in standardised CFR between Māori and European/Other increased from 4.8% in 2000–2004, to 5.5% during 2010–2014. The interaction term (ethnicity with period) in the full Poisson regression model was significant (p=0.003), and the relative risk changes were individually significant for both Pacific (p=0.033) and Asian (p=0.010), while for Māori the increase was of borderline statistical significance (p=0.053).

Discussion

This retrospective cohort study has documented a significant increase in ethnic inequalities in stroke. These findings are at odds with those recently published from the ARCOS IV study.[1] A plausible reason for this is that the published ARCOS IV 28 day CFRs do not appear to have controlled for age. As table 1 shows, age is a major confounder because it is related to both 30

day survival (younger patients tend to have better survival), and to ethnicity (Māori and Pacific suffer stroke at a younger average age).[1,19] Furthermore, in the ARCOS IV study, younger patients (15–64 years) increased from 52% to 62% of the total in Māori and Pacific between 2002/3 and 2011/12 ($p<0.05$), while the proportion of Europeans in this age group barely changed (21% to 22%, not significant). This significant increase in the proportion of younger Māori and Pacific stroke patients could have concealed the growing ethnic inequality in CFR in an analysis uncontrolled for age. Also, the figures in the ARCOS IV study combine ischaemic stroke with haemorrhagic stroke, which may dilute ethnic inequality if it exists only in the former subtype. The fact that our analysis includes stroke from across the whole of New Zealand, while the ARCOS IV study was confined to the greater Auckland region, is unlikely to explain the discrepancy since we obtained similar results when confining the analysis to Auckland and Waitemata Districts (results not shown).

How do we explain the growing ethnic inequality in ischaemic stroke survival? Two possible explanations warrant consideration: that there are (growing) differences in severity at presentation that could be due either to differences in the type of stroke, or differences in health-seeking behaviour that make non-European ethnicities less likely to present with milder strokes; or that there are ethnic differences in access to and use of the (increasingly) life-saving hospital and/or community services for acute stroke patients.

Growing differences in severity at presentation should first be examined as a possible explanation for the increasing inequalities in stroke survival. If combined with age, severity at presentation accurately predicts survival and functional outcome from stroke.[20] Failure of Māori, Pacific, and Asian people to obtain appropriate treatment in primary care for transient ischaemic attacks of very mild stroke might increase the probability of subsequent more severe stroke. Asians, but not Māori and Pacific people, are less likely to have visited a GP in the preceding 12 months than Europeans, but this statistic does not take into account the higher health needs of Māori and Pacific.[21]

With regard to etiologic risk factors and type of stroke, ARCOS IV data have shown that the pattern of risk factors in stroke patients has changed significantly over time, but to varying extents for the different ethnicities. In 2011/12, compared with 2002/3, there was a substantial increase in the prevalence of smoking, but only among Pacific patients; hypertension prevalence rose in European and Asian patients, but not in Māori or Pacific; a history of myocardial infarction increased by about 50% in Māori, Pacific and Asian patients, but more than doubled in European; the prevalence of diabetes rose in European, Pacific and Asian patients, but fell among Māori; and atrial fibrillation increased significantly in Europeans, but not in other ethnicities. By 2011/12, Māori and Pacific patients had a much higher prevalence of smoking and diabetes, and a lower prevalence of prior myocardial infarction than European patients. There was also a higher prevalence of diabetes in Asian.

Several studies have found short-term survival (1–3 months) to be better or no different in diabetics,[22-26] while others have found it to be significantly worse.[27-30] Similarly, smoking, hypertension, and previous myocardial infarction, have not been consistently associated with either higher severity or worse survival.[23,26,30-32] Atrial fibrillation has more often been significantly associated with higher in-hospital[33] and 30-day CFR,[26,31,32] but in ARCOS IV this risk factor only increased significantly in Europeans from 2002/3 to 2011/12,[1] which would tend to reduce any ethnic disparity in CFR.

The other possibility is that improvements in care have reduced CFRs in Europeans, but not Māori and Pacific, because of differences in access and uptake of these services. Higher levels of health literacy may give Europeans advantages in attaining time-dependent services such as thrombolysis, and they may have shorter travelling times to the hospitals that provide these. Europeans may also have advantages in complying with treatments to avoid life-threatening complications from stroke (eg, fewer language barriers). Post-acute rehabilitative services may not adequately cater to cultural diversity, reducing their potential benefit to non-Europeans. There is evidence of ethnic inequalities in hospital care

generally in New Zealand,[34] although the ARCOS IV study did not identify as significant any ethnic differences in a limited range of indicators of stroke management (admission to a hospital within 28 days of stroke onset, admission to an acute stroke unit, and neuroimaging).[1] Clearly, more in-depth research would be needed to explore the possibility of ethnic disparities in the type and quality of acute stroke care.

The significant decline in CFR documented here in Europeans, but not Māori, Pacific, or Asians, is consistent with the declines reported from Denmark[35] and France.[36] Similarly, the median stroke CFR for 10 OECD countries dropped from 11.65% to 10.35% between 2004/5 and 2010/11.[37] It would seem reasonable to suggest that these declines can be attributed to improvements in quality and access to acute stroke services, such as thrombolysis, neurological imaging, dedicated stroke units, and rehabilitation. Therefore, we should not be surprised to see socioeconomic and ethnic CFR inequalities emerging in other countries where there is variation in access and uptake of these services.

The strengths of this study—a large national sample—are to some extent offset by the limitation of only including patients who were admitted to hospital. Further, we may not have fully controlled for differences in pre-existing patient comorbidity, since the Elixhauser comorbidity index relies entirely on complete hospital documentation and accurate coding.

Based on these findings, we can no longer accept that ethnic-specific CFRs are similar for Europeans, Māori, Pacific, and Asians. Whether this is due to ethnic differences in severity at presentation, the type of stroke and the distribution of prognostic risk factors, or to differences in quality and uptake acute care remains to be elucidated. If it is the latter, then we expect that socioeconomic and ethnic inequalities in ischaemic stroke CFRs will soon emerge in other countries, especially those with disparities in other health outcomes.

Competing interests:
Nil

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