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Metropolitan–rural divide for stroke outcomes: do stroke units make a difference?

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Abstract

Background: Stroke care across Australian hospitals is variable. The impact on health outcomes, in particular levels of disability for patients in rural areas, is unclear. The aim of this study was to determine whether geographic location and access to stroke units are associated with differences in health outcomes in patients with acute stroke.
Methods: Retrospective cohort study of consecutive eligible admissions from 32 hospitals (12 rural) in New South Wales between 2003 and 2007. Health status measured at discharge included level of independence (modified Rankin score: mRS) and frequency of severe complications during hospitalization. Multivariable analyses included adjustment for patient casemix and clustering.
Results: Among 2254 eligible patients, 55% were treated in metropolitan hospitals. Stroke unit treatment varied significantly (rural 3%; metropolitan 77%). Age, gender and stroke type did not differ by location (mean age 74, 50% female). After adjusting for age, gender, ethnicity, important risk factors and validated stroke prognostic variables, patients treated in rural hospitals had a greater odds of dying during hospitalization compared with those treated in metropolitan hospitals (adjusted odds ratio (aOR) 1.46, 95% confidence interval (CI) 1.03–2.05). There were no differences in mortality or frequency of severe complications between patients treated in rural and metropolitan hospitals when we adjusted for access to stroke units (aOR 1.00, 95% CI 0.62–1.61). Nevertheless, patients treated in rural hospitals were more dependent (mRS 3–5) at discharge (aOR 1.82, 95% CI 1.23–2.70) despite adjusting for stroke unit status.
Conclusion: Patients with stroke treated in rural hospitals have poorer health outcomes, especially if not managed in stroke units.

Introduction

Stroke is Australia's second largest cause of death[1] and greatest cause of adult disability.[2] The most generalizable, effective intervention for acute stroke is management in a stroke care unit (SCU). Evidence from systematic reviews indicates about a 20% improvement in survival and independence if treated in an SCUs as compared with general ward management.[3] Access to SCU remains an ongoing issue worldwide, in particular in rural locations.

There is some suggestive evidence that the geographic location of admission to hospital for stroke may influence the likelihood of survival or disability with patients treated in rural hospitals more likely to have poorer outcomes.[4] The Australian Institute of Health and Welfare report more cases of stroke mortality for persons aged less than 65 years living in rural or remote regions.[5] In Western Australia use of linked hospitalization and death records of 7784 patients showed that place of residence 'rural or remote' was important in terms of survival after stroke.[6] In the Hunter Region of New South Wales (NSW), hospitalized stroke attack rates were reported to be greater in the lower and upper Hunter rural areas as compared with metropolitan Newcastle, a finding thought to be related to sociocultural factors.[7]

A retrospective medical audit of 150 stroke patients in Queensland provided evidence of differences in stroke care practices and use of evidence-based care pathways

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between regional/smaller hospitals with metropolitan or larger hospitals.[8] Importantly, however, more detailed analyses of the outcomes (excluding mortality) of stroke patients treated in rural Australian hospitals have not been reported.

In 2001, the NSW government funded a clinician-led health system redesign that included inpatient stroke services.[9] The Greater Metropolitan Clinical Taskforce (GMCT) stroke programme was created and resulted in the establishment of 23 new SCU. An external evaluation to determine the effects on improvements in access to SCU, quality of care and health outcomes has been ongoing.[9] Pre- and post-programme analysis showed that the metropolitan focussed stroke programme had provided improvements in patient survival and level of independence (proportional odds ratio 0.73, 95% confidence interval (CI) 0.57–0.94) when adjusted for patient clustering and casemix.[9] In 2005, NSWHealth sought a review of the options for models of stroke units in rural NSW in preparation for rural SCU establishment. With awareness of the value of data to drive clinical practice and policy change, rural hospitals volunteered to use the NSW Stroke Audit tool developed by the National Stroke Research Institute.

Using the audit information obtained from both the metropolitan and rural health services, we aimed to assess whether the quality of stroke care and health outcomes were different among patients treated in metropolitan hospitals compared with hospitals in rural areas.

Materials and methods

NSW Stroke Audit programme data collected between 2003 and 2007 were used. This period reflected data collected after the GMCT stroke service enhancements had been undertaken in metropolitan, but not rural areas. Purposeful sampling ensured that audit data from rural sites was obtained before investment in the NSW Rural Stroke Project. In November 2007, the NSW government provided funding to establish specialized stroke services in rural NSW. This was achieved following a Phase I evaluation report where evidence to support stroke service enhancements proposed by Area Health Services was presented.[10] Phase II of the Rural Stroke Project encompasses the establishment of stroke services in seven sites within five designated services in rural NSW. The models of stroke service enhancements proposed in each successful submission implemented vary and include establishment of acute SCU and rural stroke care coordinators.

It was important that the data presented in this paper reflect the period of time before the government-driven service enhancements to rural stroke care were initiated. Only one of the 12 rural hospitals in this study had implemented an SCU before the Phase II government initiative to enhance rural stroke care. Data from this hospital were included because this situation reflects the reality elsewhere in Australia where hospitals have established SCUs within their own resource. The findings presented in this paper include data from both the successful and unsuccessful rural sites who applied for Phase II funding. Therefore, these data provide an unbiased contrast between rural and metropolitan settings.

Methods for the NSW Stroke Audit programme have been previously published.[10] In brief, consecutive medical records audits were conducted by trained data abstractors using a validated audit tool. Patient eligibility criteria were confirmed diagnosis of a first-ever or recurrent stroke, admission to hospital for acute management and availability of the medical record for audit. For this analysis, consecutive audits of up to 50 medical records from metropolitan sites and 100 from rural hospitals with a discharge International Classification of Diseases (ICD-10) code for stroke for each time period were used. The larger sample size for rural hospitals was to ensure sufficient patient numbers to enable reliable comparisons, as there were fewer rural hospitals eligible to participate. Patients transferred from other hospitals to participating sites were not included. This was to avoid a potential source of sampling bias for assessments of quality of care, as adherence to clinical indicators in these patients may have varied and we wanted to compare fairly homogenous groups (e.g. direct admissions).

Data included demographic characteristics (including age, gender, country of birth), and stroke outcomes included: (i) health status at discharge; (ii) dependence according to modified Rankin score (mRS);[11] and (iii) severe complications during hospitalization. Severe complications were defined as events determined to be life-threatening and/or required interventions or prolonged the hospitalization, for example falls, aspiration pneumonia, urinary tract infection and decubitus ulcers.

Hospitals were classified as either 'metropolitan' or 'rural' based on NSW Area Health service categorization and location and was verified by the State Manager for Stroke Services NSW (ML). Regional centres in Newcastle, Gosford and Wollongong were classified as 'metropolitan'.

Statistical analysis

Data were analysed using STATA software (version 10.1, Stata Corporation PL, College Station, TX, USA). Chi-squared tests were used for categorical variables, Fisher exact test for dichotomous variables and the Wilcoxon Mann–Whitney rank sum test for continuous variables.

Table 1 Selected characteristics of patients with stroke treated at rural or metropolitan hospitals

Characteristics	Rural hospital (n = 1014) n (%)	Metropolitan hospital (n = 1240) n (%)	All hospitals (n = 2254) n (%)
Age mean (SD)	74 (13)	74 (14)	74 (14)
Female	493 (49)	614 (50)	1107 (50)
Born in Australia	863 (87)*	743 (62)	1606 (73)
Living alone	278 (29)*	299 (25)	577 (26)
Hypercholesterolaemia	259 (29)*	429 (39)	688 (34)
Hypertension	608 (64)*	828 (71)	1436 (68)
Diabetes	208 (22)*	294 (26)	502 (24)
Ischaemic stroke	921 (93)	1124 (93)	2045 (93)
Previous stroke	236 (25)	265 (23)	501 (24)
Impaired speech	678 (71)	832 (69)	1510 (70)
Weak arm	749 (76)	904 (74)	1653 (75)
Able to walk on admission	337 (40)*	411 (36)	748 (37)
Incontinent <72 h of stroke	433 (45)**	488 (41)	921 (42)
Treated in a stroke unit during admission	32 (3)*	960 (77)	992 (44)

*Significant $P < 0.05$. **Borderline significance $P \leq 0.07$. SD, standard deviation.

Univariate and multivariate logistic regression models were used to predict the probability of stroke outcomes. Demographic variables found to differ between the rural and metropolitan cohort were included in multivariable models. In addition, adjustment for patient casemix was based on a validated prognostic model when comparing patient outcomes.[12] These variables included: arm deficit, speech impairment, incontinence within 72 hours and ability to walk unaided on admission. Adjustments were also made for whether the patient was treated in a stroke unit at any time during their hospitalization and also for patient clustering within hospitals. As certain types of patients may cluster within particular settings or geographical locations and are often more likely to respond in a similar manner, hence these samples cannot be assumed to act independently.[13] Therefore, statistical adjustment for patient clustering within hospitals, in addition to individual patient factors, provides a further measure against overstating differences in outcomes where location of treatment may be important. We present odds ratios, adjusted odds ratios and 95% confidence intervals.

Results

Thirty-two hospitals (12 rural) participated in the audit, which included 2254 admissions, 1240 (55%) from 1 January 2003 until 21 December 2007 for metropolitan hospitals and 1014 from 4 January 2003 and 19 August 2007 for rural hospitals. The median number of audits per site in metropolitan hospitals was 50 and 92 in rural hospitals.

Table 1 shows baseline demographic characteristics and level of stroke severity between patients treated at metropolitan and rural hospitals. The samples were similar for age, gender, stroke type and history of previous stroke. The mean age of the patients was 74 (standard deviation (SD) 14) and about half were men. Patients with stroke treated in metropolitan hospitals were more likely to have documented a history of high cholesterol, hypertension or diabetes as compared with patients treated in rural hospitals. However, rural patients were more likely to be born in Australia, be unable to walk on admission, and a larger number was incontinent in the first 72 hours (borderline statistical significance) as compared with patients treated in metropolitan hospitals.

Length of stay (LOS) was longer in metropolitan hospitals compared with rural hospitals, and the median LOSs were the same for all patients or just those who were discharged (metropolitan median LOS 10 days, interquartile range (IQR) 6–19 and rural LOS 7, IQR 4–13; $P < 0.001$). This finding could in part be explained by the fact that metropolitan patients have greater discharge delays reported (metropolitan 18% compared with rural 12%, $P < 0.001$).

Health outcomes

Overall, in-hospital mortality was 10% (n = 227; rural 13% and metropolitan 8%). Patients dependent (mRS grade 3–5) at time of discharge was 66% in rural and 58% for metropolitan patients. A severe complication during admission was experienced by 190 (8%) patients (rural 10%; metropolitan 7%). Figure 1 illustrates the significant difference in mRS grades at discharge or 7–10 days after stroke according to location of treating

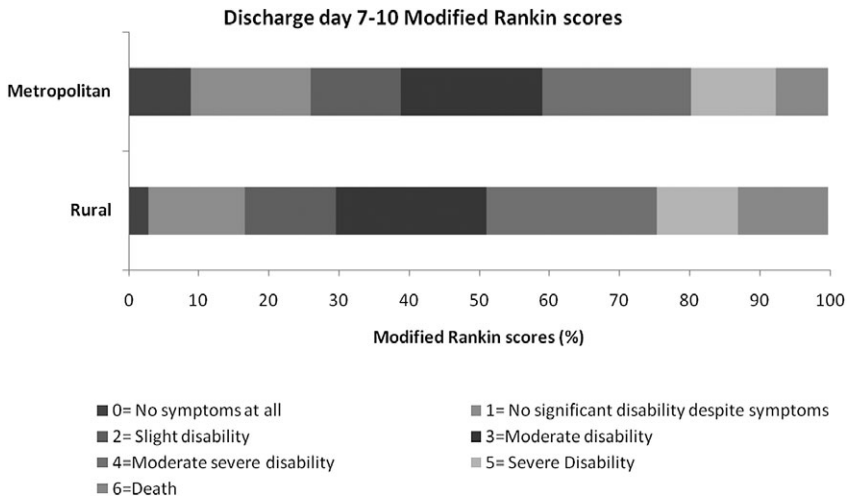

Figure 1 Modified Rankin scores at discharge by category of treating hospital.

hospital ($\chi^2 = 55.72$, $P = 0.0001$). After adjusting for age, gender, country of birth, hypertension, high cholesterol, ability to walk on admission and incontinence within 72 hours, patients treated in rural hospitals had a greater odds of death (adjusted odds ratio (aOR), 1.46; 95% CI, 1.03–2.05) compared with patients treated in metropolitan hospitals. Stroke treatment in rural hospitals was also associated with greater odds of being dependent (aOR, 1.75; 95% CI, 1.35–2.28) or having a severe complication (aOR, 1.66; 95% CI, 1.16–2.38) when adjusted for the same variables.

Stroke patients treated in an SCU

Overall, the proportion of patients treated in an SCU was 56% (rural 3% and metropolitan 77%).

Table 2 shows the results of the multivariate analyses adjusting for whether the patient was treated in an SCU and also adjusted for location category of hospital. After adjustment, there was no difference in mortality or having a severe complication between patients treated in rural and metropolitan hospital. However, those patients treated in rural hospitals continued to have a greater odds of being dependent when compared with metropolitan hospitals.

Discussion

Our data support previous findings of higher in-hospital mortality outcome for stroke sufferers in rural communities and, for the first time, provide evidence that rates of dependency are also greater at discharge in rural stroke patients. Our data provide direct evidence that in the context of overall stroke outcome, location of treating hospital and presence of an SCU are important. This suggests that ongoing investment in organized SCU care in rural NSW is needed and would be expected to reduce the occurrence of unfavourable stroke outcomes for rural residents.

The lower stroke mortality seen in metropolitan stroke care compared with care in rural settings was significantly influenced by access to SCU. Interestingly, national stroke audit data indicate a similar proportion of in-hospital stroke deaths (13% of all cases), but a

Table 2 Stroke outcomes of patients treated in rural as compared with metropolitan hospitals with adjustment for admission to stroke unit at any time or patient clustering in different hospitals

Stroke outcomes	Unadjusted odds ratio (95% CI)	Adjusted odd ratio† (95% CI)	Adjusted odd ratio‡ (95% CI)
Independent (mRS 0–2)	0.61 (0.49–0.75)	0.55 (0.37–0.81)	0.55 (0.32–0.96)
Dependent (mRS 3–5)	1.64 (1.32–2.03)	1.82 (1.23–2.70)	1.82 (1.03–3.19)
Died (mRS 6)	1.60 (1.21–2.11)	1.00 (0.62–1.61)	1.00 (0.53–1.87)
Any severe complication§	1.49 (1.11–2.02)	1.23 (0.74–2.05)	1.23 (0.61–2.49)

†Adjusted for stroke unit status, age, gender, Australian born, living alone, history of hypertension, diabetes or cholesterol, walk on admission and incontinent within 72 hours. ‡Adjusted for clustering of patients within hospitals, stroke unit status, age, gender, Australian born, living alone, history of hypertension, diabetes or cholesterol, ability to walk on admission and incontinent within 72 hours. §Included falls, aspiration pneumonia, urinary tract infection and decubitus ulcers. 95% CI, 95% confidence interval; mRS, modified Rankin score.

breakdown by geographic location or by access to SCU is unavailable.[14] The lower levels of dependency seen at discharge from metropolitan hospitals, even when adjusted for access to SCU, were interesting. This requires further investigation, but may be related to the fact that the rural SCU included in this sample (contributing only 32 SCU treated patients) was recently established and, although gains were in made for improved mortality, an impact on dependency could not be shown. Other aspects of care received in rural hospitals may also be responsible for some of these disparities in health outcomes. Overall, there was a low rate of severe complications, which probably reduced the statistical power of multivariable models resulting in wide confidence intervals.

Few investigators have assessed differences in stroke outcomes for rural and metropolitan patients. The strength of our study is the large sample size allowing sufficient power to detect differences in most health outcomes examined. Stroke patients who were treated in rural hospitals had fewer comorbidities, were more likely to be born in Australia and a larger proportion were able to walk on admission than those patients treated at metropolitan hospitals. These features in rural stroke patients would generally bias towards a better outcome.[15] It appears therefore that the poorer outcomes for rural stroke patients were not due to confounding from stroke severity or measured comorbidities. Therefore, organized stroke care is a likely factor influencing the difference in outcomes between metropolitan and rural NSW hospitals.

We have previously shown that greater adherence to important clinical processes of care is more often undertaken in metropolitan hospitals with SCU and this has an impact on survival.[10,16] Other potential influences are access to specialist clinical assessment and diagnostic testing, or access to prompt higher dependency care in the situation of clinical deterioration or serious complications of stroke, such as infection. Access to stroke thrombolysis is unlikely to have had a significant influence on our findings as implementation of the licensed thrombolytic agent, tissue plasminogen activator (tPA), remains at very low rates (3% in urban sites and 1% in rural sites),[14] and randomized evidence suggests tPA does not reduce stroke mortality.[17]

The findings from this present study are likely to be generalizable to other parts of Australia and continuing efforts need to be made to improve stroke treatment in rural areas to narrow the 'inequity of outcomes' gap between rural communities and their metropolitan counterparts. The National Stroke Foundation 2009 organizational report on stroke services in rural Australia confirmed that there are clear disparities between metropolitan and rural hospitals in adherence to important processes of care and in access to SCU (4% rural versus 96% urban).[18]

Several means for narrowing the gap in health outcomes between rural and metropolitan settings include having strategic government policies and funding, as well as clinician driven initiatives, such as adopting evidence-based clinical guidelines and protocols for management; and ensuring ongoing education of rural clinicians. These data from the NSW Stroke Audit have also been used to contribute to ongoing service enhancements. Since November 2007, the NSW government has provided funding to establish specialized stroke services in rural NSW as part of its Rural Health Plan commitments to provide services closer to home. This funding has been used to implement or enhance SCU in rural NSW and increase access to specialist staff through the appointment of stroke care coordinators.[19] We hope that initiatives in other parts of Australia will also be influenced by our findings.

Conclusion

The disparity in death and dependency between rural and metropolitan patients with stroke is greatly influenced by whether a patient has access to SCU. Initiatives to increase the equitable access to evidence-based stroke services in Australia are important if we are to reduce the burden of this disease.

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