Trends in the characteristics, service provision and outcomes of patients with stroke from 2013 to 2021 at a regional stroke centre

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The care of stroke patients has revolutionised over the last decade, facilitated by national improvement programs and Ministry of Health targets. The 30-year period ending 2012 saw a 65% reduction in stroke fatality rates in Auckland, Aotearoa New Zealand—as of 2012, 28 day stroke mortality rates were 18.8%.[1] At the service level, admission to stroke units, routine assessment for dysphagia, interdisciplinary team work, higher ratios of nursing staff to patients and stroke unit accreditation are all associated with improved outcomes.[2–7] At the individual level, a number of trials have demonstrated improved outcomes with thrombolysis, thrombectomy and early aggressive antithrombotic therapy, among others.[2,8] The Ministry of Health in New Zealand stipulate a number of quality metrics ranging from the need for medical and nursing specialists, targets for thrombolysis rates (6% of all ischaemic strokes in 2012 rising to 12% in 2021), and a requirement for 80% of all patients to be admitted under an organised stroke service.

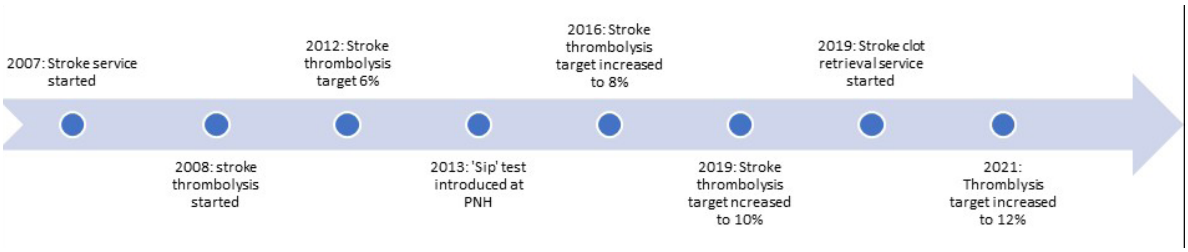
There is a paucity of data on more recent stroke outcomes in New Zealand. Here, we describe stroke admission trends at Palmerston North (PNH) Hospital from 2013 to 2021. Figure 1 illustrates the sequence of service improvements undertaken at PNH.

A number of stroke service delivery models evolved sequentially over the period. Between 2013–2018, neurologists would consult on stroke patients and provide advice, with care overseen by a number of general physicians; thrombolysed patients would remain under the care of a neurologist. From July 2018 to March 2019, patients were admitted under a stroke team led by a general physician with an interest in stroke. Finally, from April 2019 to December 2021, all stroke patients were admitted under the care of a stroke physician. PNH has a five bedded stroke unit.

Data on patient factors (e.g., demographics, ethnicity, inpatient deaths) and service level metrics (e.g., numbers admitted to the stroke service, thrombolysis rates) are routinely recorded for all stroke admissions at PNH and submitted quarterly to the Ministry of Health. These data were used to determine trends for stroke admissions and outcomes between 2013–2021 and look for associations with a focus on the medical management of stroke. There is no routinely collected data on nursing or allied health input in these reports.

Grouped variables are presented as means (±SD) for normally distributed or medians (IQR) for non-normally distributed data. Categorical variables are presented as absolute numbers and frequencies. We used Chi-squared or Fisher's exact to compare categorical data collected in 2013 and 2021, as appropriate. Since data were collected quarterly, we assessed associations using a logistic regression approach for grouped data. Only 1.6% of the data were missing (con-

Figure 1: Timeline of acute stroke service improvements at Palmerston North Hospital.



sidered missing at random); we used complete case analysis in this study. This project made use of routinely collected, deidentified patient-level data, and therefore was exempt from requiring ethical approval. All statistical analysis was performed using STATA BE/17.

Between April 2013 and December 2021, PNH had 2,448 stroke admissions of whom 324 (13%) identified as New Zealand Māori and 69 (3%) as Pacific Island ethnicity. Over the approximately nine-year period, hospital-based stroke incidence rates increased from 148/100,000 to 200/100,000 per year, a relative increase of 35% [95%CI 14%–59%]; p<0.001. 251 (10%) had a haemorrhagic stroke and a median of 12% (8–16) of all patients admitted with ischaemic stroke received thrombolysis.

Over the observed period, there were significant increases in the proportion of stroke patients admitted under the stroke service (22% [95%CI 15%–29%]; p<0.001, Figure 2) and proportion receiving thrombolysis (7% [95%CI 2%–12%]; p<0.05, Figure 3). There was a 13% [95%CI 7%–18%; p<0.001] reduction in in-hospital mortality, Figure 4. The proportion of patients aged over 65, and haemorrhagic strokes, remained stable over the period. Similarly, the proportion of patients of Māori or Pacific Island ethnicity remained stable. Summary data are displayed in Table 1.

A univariate analysis of predictors of in-hospital death (e.g., proportion admitted to a stroke unit, proportion thrombosed, etc.), identified only stroke clot retrieval (OR 0.78 [95%CI 0.68–0.89]; p<0.001) and inpatient care delivered by a stroke physician (OR 0.52 [95%CI 0.38–0.70]; p<0.001) were associated with significantly reduced mortality. There were no significant associations when these factors were used in a bivariate model. McFadden's pseudo R^2 was 0.013, suggesting that there are many other factors responsible for the reduced mortality.

Discussion

This study demonstrates significant increases in stroke admissions over the observed period, with more patients being looked after by an organised stroke service and receiving thrombolysis. A recent paper on stroke volumes in Aotearoa New Zealand projected a 40% increase between 2015 to 2028, with a 36% increase at PNH.[9] According to our data, this increase has occurred approximately four years early than anticipated. There was a significant reduction in mortality rates despite the proportion of stroke patients aged over 65 remaining stable. In the univariate model, factors associated with reduced mortality included stroke clot retrieval and inpatient care delivered by a stroke physician; however, these factors accounted for a small fraction of the overall mortality reduction. A recent meta-analysis assessing different models of organised inpatient stroke care found mobile stroke teams, defined as peripatetic teams looking after people with stroke across a range of wards, was not associated with a reduction in mortality or poor functional outcome.[10] There is an Aotearoa New Zealand strategy underway to improve access to endovascular clot retrieval.[11]

Table 1: Summary data of baseline characteristics and outcomes in 2013 and 2021.

Variable	2013 Patient cohort (%) n=235	2021 Patient cohort (%) n=355	*P* value
Ethnicity			
Māori	23 (9.8)	35 (9.9)	0.98
Pacific Island	7 (3.0)	9 (2.5)	0.8
Haemorrhagic strokes	35 (13.7)	35 (9.9)	0.06
Age >65	175 (75)	270 (76)	0.39
Stroke clot retrieval	0 (0)	11/320 (3.4)	<0.01
Thrombolysis	19/200 (9.5)	52/320 (16.3)	<0.05
In-hospital deaths	46 (18)	19 (5.4)	<0.001
Stroke service admissions	165 (65)	307 (87)	<0.001

Figure 2: Proportion of stroke patients admitted under the stroke service.

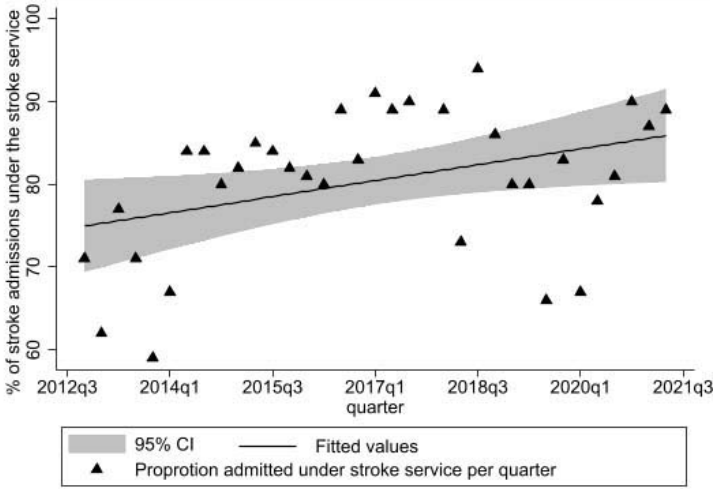


Figure 3: Proportion of all ischaemic strokes treated with thrombolysis.

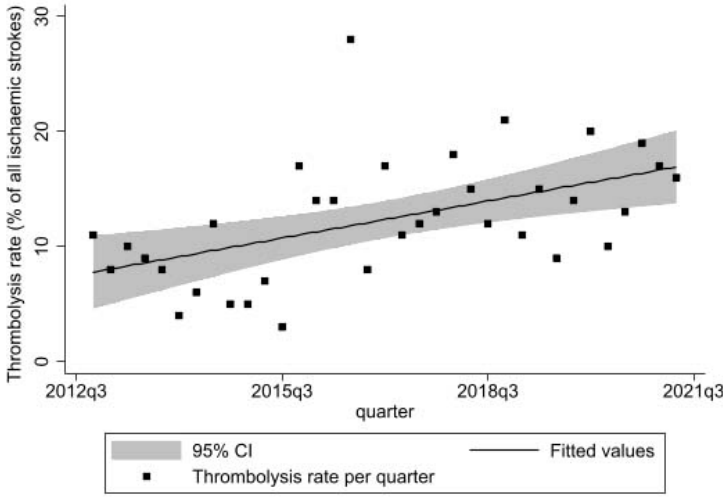
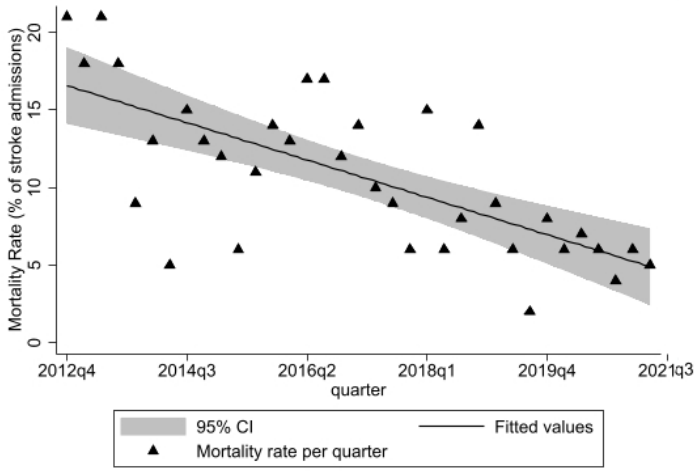


Figure 4: Time trend of in-hospital mortality rates between 2013 and 2021.



This trajectory of stroke volume will have significant implications on health and societal resources. More concerted action is needed on the addressing the causes of stroke and providing appropriate emergency care when it arises. Leadership, education and collaborative workings across services (i.e., public health services, primary care, emergency departments, radiology, and ambulance and aeromedical services) and effective interdisciplinary care in hospital are essential to meet this demand.

There are a number of limitations to this study. It is a single-centre observational study, and therefore findings may not be generalisable. A small number of stroke patients were discharged from the emergency department. There are likely to have been a number of unknown or unmeasured confounders (e.g., co-morbidities, baseline stroke severity, temporal service changes, timing of swallowing assessment, venous thromboembolism prophylaxis, timing of antiplatelets, multidisciplinary input etc.), which may bias our results. Finally, we do not have data on palliative discharges.

The strengths of this study are the measurement of hard endpoints and the use of reliable contemporaneously collected data which have been cross-checked. Further, we included all admitted patients and therefore minimised selection bias.

COMPETING INTERESTS
Nil.

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