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Research Article

## A Comparison of Stroke Outcomes in Wellington, New Zealand, between 1997 and 2013

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### Abstract

**Background:** Stroke services in Wellington have undergone major changes in the last decade, including establishment of stroke unit care and intravenous thrombolysis. The aim of our study was to determine whether the outcomes of stroke patients have improved over this time.

**Method:** A review of 100 consecutive stroke patients admitted to Wellington Hospital between July and November 2013 was conducted. Their records were examined to determine pre-stroke function, stroke type, stroke severity, length of stay and discharge destination. A telephone interview was conducted at six to nine months after the stroke to determine their living situation and functional independence. The outcomes of the 2013 cohort were compared with a previously studied 1997 cohort.

### Results

Between 1997 and 2013, the mean total hospital length of stay was halved. The 2013 cohort had a larger proportion of mild strokes (37% compared to 20%) than the 1997 cohort. After adjustment for stroke severity, there was no significant difference between the two cohorts when comparing the discharge destination, mortality, proportion living at home, or the proportion who were functionally independent at six to nine months.

### Conclusion:

Over a 16 year period, and despite significant change to the delivery of stroke services during that time, no significant improvement in casemix-adjusted outcome at six to nine months after stroke was measured. The importance of case-mix adjustment when comparing stroke outcomes is highlighted.

**Keywords:** Stroke; Rehabilitation; Outcome

## Introduction

Quality improvement is an important component of hospital stroke care. Implementing guideline recommendations, based on high-quality evidence, should, theoretically, lead to better outcomes. However, inpatient stroke care and rehabilitation is complex. Many factors potentially influence final outcomes. These include resource constraints, such as bed capacity in acute stroke units [1] and overall hospital bed utilisation reflected in pressure to reduce hospital length of stay, decisions about transfer for inpatient rehabilitation [2] or to institutional care, and the availability of well-resourced early supported discharge teams in the community [3]. Direct measurements of outcome are necessary to be confident that outcomes from a particular stroke service are improving over time. Any rigorous measurement of stroke outcomes over time has to account for a change in stroke case-mix as stroke severity remains the most important single predictor of stroke outcome [4,5].

A prospective study conducted in the Wellington region in 1997 measured case-mix adjusted community outcomes after stroke [6]. Since that study, there have been several changes in the acute management of stroke in Wellington. These include the establishment of stroke unit care and intravenous fibrinolysis. The latter is currently administered to 15% of all people with acute ischemic stroke presenting to Wellington Hospital (median door-to-needle time 46 minutes), whereas in the 1997 cohort of patients, no patients received intravenous thrombolysis. Clear evidence shows that organised stroke unit care and intravenous fibrinolysis improve functional outcomes six months after a stroke, with numbers needed to treat (NNT) of 20 and 8 respectively [7,8]. Other secular trends in stroke care, additional to stroke unit care and thrombolysis, have also been introduced consistent with the recommendations of the New Zealand Stroke Guidelines [9]. These include early head imaging, early antiplatelet or anticoagulant treatment for all eligible patients, and calf compression devices for venous thrombosis prophylaxis for immobile patients. However, the relationship between good process of stroke care and outcomes is not straight forward [10]. In Wellington Regional Hospital, and its associated rehabilitation hospital, there has also been a strong diagnosis unrelated secular drive towards earlier discharge from both sites of care for stroke. The aim of this study was to measure outcomes in a new cohort of stroke patients in the Wellington region and compare these to those measured in 1997 to estimate the combined effect of these secular trends on case-mix adjusted outcomes.

## Methods

A cohort of 100 consecutive patients admitted to Wellington Hospital with a stroke before 1 November 2013 was reviewed between six and nine months after their stroke. For the majority of these patients information was acquired prospectively through inclusion in an ongoing stroke register. Discharge

coding was used to search for any other patients aged more than 15 years, with the primary diagnosis of stroke (ICD-10 codes I61.x, I62.9, I63.x, I64) starting on 1 November 2013 and going backwards until 100 unique patients were included. The stroke register, electronic records and medical notes of each patient were used to collate information about the patients including age, sex, ethnicity, pre-stroke independence, type of stroke, Barthel Index (BI) [11] at day three, length of total hospital stay, including stay at acute and rehabilitation hospital, and discharge destination. Subsequently, a telephone interview with each patient or a 'next-of-kin' relative was conducted between six nine and months after the stroke to collect information about survival, living situation (home versus residential care), and functional independence using the modified Rankin Score (mRS) [12]. If the patient was unable to be interviewed due to communication difficulties, the next-of-kin was interviewed. To reduce the number of questions to be answered, the mRS categories 0-1 and 4-5 were not differentiated further so that possible mRS scores were 0 to 1, 2, 3, and 4 to 5. The baseline characteristics and longer term outcomes of these patients were compared to those of the 1997 cohort. The details of methods used for the 1997 cohort have been reported elsewhere [6]. As this was an observational study documenting current practice, the study was judged not to meet criteria for formal ethical review. All patients gave informed consent to be contacted 6-9 months following their stroke.

## Statistical analysis

The outcome variables were total length of hospital stay, whether discharge destination was home versus residential care or death, death between six and nine months after stroke, living at home between six and nine months after stroke, and functional independence (mRS score 0 to 2) and limited dependence or better (mRS score <4) between six and nine months after stroke. A cogent argument has been made [13] that this latter variable is a better measure of the effectiveness of inpatient stroke rehabilitation than cut-off boundaries of 0 to 2 versus 3 to 5. This argument is based on the concept that rates of independence, mRS <3, are predominantly determined by stroke severity, whereas inpatient stroke rehabilitation may make the difference between limited dependence at home but mobile, mRS of 3, and immobility, mRS of 4. Length of stay was highly skew and analyses were carried out on the logarithm transformed scale, which when back-transformed by exponentiation can be interpreted as the ratio of mean values. The outcomes were compared between the 2013 and 1997 cohorts using univariate analysis (t-test) and multivariate logistic regression analysis (ANCOVA). Multivariate analysis included adjustment for the following case-mix variables: age, sex, ethnicity (Maori and Pacific versus other), pre-stroke independence, stroke type, (categorised by the Oxfordshire Community Stroke Project classification [14] [lacunar infarct (LACI), total anterior circulation infarct (TACI), partial anterior circulation infarct (PACI), posterior circulation infarct (POCI),

primary intra-cerebral haemorrhage (PICH), and uncertain,] and stroke severity (BI at day 3). SAS version 9.3 was used for the analyses.

## Results

The 2013 stroke cohort consisted of 100 adult patients admitted to Wellington Hospital with the primary diagnosis of stroke from 27 July 2013 to 1 November 2013. The 1997 cohort consisted of 181 patients admitted to any of the three general hospitals in the Wellington region with a stroke from 1 February to end November 1997 [6]. Since 1997, two of the three hospitals have merged stroke services so that Wellington Hospital now admits approximately 70% of all acute stroke patients in the region. The baseline characteristics of the two cohorts of age, sex, ethnic distribution, and pre-stroke independence were similar, as shown in Table 1. The proportion of patients presenting with different stroke classification types was different. The 2013 cohort had a lower proportion of patients with LACI and a higher proportion with PACI. There were no patients in the 'uncertain' group in the 2013 cohort. The 2013 cohort had better activities of daily living (ADL) scores at Day 3 with a mean difference of 3.5 points on the BI compared to the 1997 cohort.

**Table 1.** Comparison of baseline characteristics of 2013 and 1997 cohorts.

Variable	2013 N=100 <sup>1</sup>	1997 N=181 <sup>1</sup>	Difference (95% CI) <sup>2</sup>
	<b>Mean (SD)</b>		
	<b>Median [IQR]</b>		
Age, years	73.6 (12.3) 73 [63.5 to 84]	74.4 (12.1) 76 [68 to 82]	-0.8 (-3.8 to 2.2) P=0.58
Male n, (%)	46 (46)	85 (47)	Not significant
Barthel Index at Day 3	10.7 (7.8) 11.5 [4 to 20]	7.2 (7.0) 5 [1 to 13]	3.5 (5.3 to 1.7) P<0.001
	<b>N/N (%)</b>		<b>Odds ratio (95% CI)</b>
Maori or Pacific ethnicity	14 (14)	33 (18.2)	1.37 (0.69 to 2.70) P=0.36
Pre-stroke dependence (mRS > 2)	8 (8)	22/177 (12.4)	0.61 (0.26 to 1.43) P=0.26
Stroke Type			<0.001 <sup>3</sup>
LACI	10 (10)	54 (29.8)	
PACI	42 (42)	51 (28.2)	
POCI	15 (15)	18 (9.9)	
TACI	18 (18)	33 (18.2)	
PICH	15 (15)	18 (9.9)	
Uncertain	0 (0)	7 (3.9)	

<sup>1</sup>Unless indicated. <sup>2</sup>t-test. <sup>3</sup>Overall Chi-square test 21.5 with 5 DF

LACI = lacunar infarct, PACI = partial anterior circulation infarct,

POCI = posterior circulation infarct, TACI = total anterior circulation infarct, PICH = primary intracerebral haemorrhage.

The mean (SD) total length of stay (LOS) in acute and rehabilitation hospitals was 15.7 (20.5) days in 2013, compared to 30.5 (27.2) days in 1997; with median (inter-quartile range) of 6.5 (2 to 20.5) in 2013 and 21 (8 to 47) in 1997. The analyses were performed using a logarithmic transformation of LOS. After adjustment for case-mix variables, the ratio of mean LOS in 2013 compared to 1997 was 0.46 (95% CI 0.34 to 0.61), P<0.001 so that mean LOS in 2013 was under half that in 1997.

There was no significant difference between the two cohorts when comparing the discharge destination, death at 6 to 9 months, the proportion of patients living at home at 6 to 9 months and limited dependence or better (mRS <4), in the unadjusted or adjusted analyses. The unadjusted proportion of patients who were functionally independent at 6 to 9 months (mRS <3), was significantly higher in 2013, compared to 1997 but after adjustment this difference was no longer significant. The odds ratios (OR) of the univariate analyses and multivariate analyses are shown in Table 2.

**Table 2.** Comparison of outcomes 1997 vs 2013.

Variable	1997 n/N (%)	2013 n/N (%)	Univariate OR (95% CI)	Multivariate OR (95% CI)
Discharged home versus death or residential care	110/181 (61)	70/100 (70)	0.66 (0.39 to 1.12)	0.93 (0.40 to 2.18)
Alive at 6-9 months	118/170 <sup>a</sup> (69.4)	73/100 (73)	0.91 (0.52 to 1.58)	1.77 (0.86 to 3.64)
Living at home at 6-9 months	91/170 (53.5)	62/100 (62)	0.60 (0.28 to 1.29)	1.34 (0.53 to 3.43)
Independence at 6-9 months (mRS < 3) <sup>b</sup>	55/123 (44.7)	48/73 (65.8)	0.42 (0.23 to 0.77)	0.81 (0.37 to 1.76)
Limited dependence at 6-9 months (mRS < 4)	96/123 (78.1)	62/73 (84.9)	0.63 (0.29 to 1.36)	1.83 (0.68 to 4.93)

<sup>a</sup> Survival data was only available on 170 patients. <sup>b</sup> Expressed as a proportion of patients who were alive and for whom mRS data were available. mRS = modified Rankin Score

## Discussion

These results show that after adjustment for case-mix variables, particularly stroke severity, there is no evidence of a difference in outcomes for people admitted to hospital with stroke in Wellington in terms of survival, living outside institutional care and level of independence between 1997 and 2013. During that time there was a significant improvement in hospital efficiency with a roughly 50% fall in hospital length of stay, a cost saving of around US\$4,920 per patient, (calculated as 15 days at US\$328/day). This likely reflects the current practice of aggressive discharge planning and earlier decisions about transfer to residential facilities. Theoretically, too short lengths of stay may have a negative impact on outcomes, limiting expo-

sure to adequate rehabilitation especially if community rehabilitation services are not well-developed. On the other hand, a previous study involving Wellington showed that stroke patients in United States rehabilitation facilities received more hours of physiotherapy and occupational therapy and achieved better functional outcomes than New Zealand patients, despite much shorter stays [15]. Since that study, efforts have been made in Wellington to optimise rehabilitation therapy 'dose' despite shorter lengths of rehabilitation stay [16].

There was a significant difference in stroke severity between the 1997 and 2013 cohorts. The 2013 cohort included a significantly higher proportion of milder strokes and a lower proportion of severe strokes. This is likely due to patients with mild strokes being much more likely to present to a doctor and be admitted to hospital in 2013 compared to 1997, rather than a real change in population stroke severity. This may be the result of increased public awareness about the significance of stroke and the availability of interventions such as stroke units and thrombolysis. It probably also reflects a greater tendency amongst stroke physicians to admit patients for investigations aimed at determining stroke mechanism. This explanation is also supported by the observation that the monthly rate of hospital admissions for stroke in Wellington has increased from approximately 18 per month in 1997 to 33 per month in 2013, which is out of proportion to the roughly 40% increase in the region's population over the same time period.

Our relatively small sample size means that for the comparisons confidence intervals are wide so the study may be underpowered to detect important but smaller differences in case-mix adjusted outcomes. The point estimates for the case-mix adjusted outcomes favours the 1997 cohort. This suggests that the concentration on efficiency gains may have cancelled out any benefits from the combination of thrombolysis and stroke unit care. For some patients, an early decision to transfer to institutional care rather than a period of inpatient rehabilitation, or cutting short a period of inpatient rehabilitation, may have prevented a degree of functional improvement. Some patients, particularly those with large strokes take longer to improve [17] and a concentration on minimising inpatient length of stay may not allow these patients sufficient time in an appropriate environment to make the gains they need for discharge to home and independent living once they get home. Hospital stroke 'performance' can be conceptualised as the combination of efficiency and effectiveness [18]. Overall the result of the current study suggests that significant efficiency gains have been made without significant differences in effectiveness i.e. overall hospital stroke performance has improved. As suggested above, this interpretation must include the caution that effectiveness outcomes may not be as good as they should be. Careful attention to current processes – decisions about which patients are transferred for inpatient rehabilitation, decisions about which patients are discharged to institutional care, and when, and adequacy of community rehabilitation

provision – may provide avenues for intervention to optimise effectiveness outcomes without necessarily impacting hospital efficiency gains. On the other hand, our results suggest caution is required with any further efforts to reduce hospital length of stay without careful attention to other outcomes.

One important message from this study is the need to make allowance for changing case-mix over time when reporting stroke outcomes. In New Zealand, hospital managers are keen to promote 'success stories' and funders are keen to compare hospitals in 'league tables'. A superficial look at unadjusted stroke outcomes for our two cohorts of patients would strongly suggest an improvement in outcomes as well as major efficiency gains – a classic 'win-win' story. Without adequate adjustment for case-mix, comparisons at a single institution over time or comparisons across institutions have the potential to give spurious results.

### Clinical Messages

- Implementing evidence-based interventions for stroke will not necessarily translate into measureable improvements in outcome for a particular service
- Casemix adjustment for stroke outcome is important

### Author contributions:

HM, PJ, JL and VF conceived the study. PJ and LKW collected the data in 2013. HM provided the data from the 1997 cohort. MW analysed the data. PJ wrote the initial draft. All authors provided input to the final manuscript.

### Competing interests

None of the authors have any competing interests to declare.

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