 doi:10.20944/preprints202110.0398.v1

**Article Title**

# Disparities in Care and Outcome of Stroke Patients from Culturally and Linguistically Diverse Communities in Metropolitan Australia


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**Funding Sources:**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.


**Conflict of Interest Disclosures:**

None of the authors has any conflict of interest to disclose.

 doi:10.20944/preprints202110.0398.v1

**Abstract**

**BACKGROUND:** Acute stroke is a time-critical emergency where diagnosis and acute management are highly dependent upon accuracy of patient's history. We hypothesised that language barrier is associated with delayed onset time to thrombolysis and poor clinical outcomes. **AIM:** To evaluate the effect of language barriers on time to thrombolysis and clinical outcomes in acute ischemic stroke. **METHODS:** This is a retrospective study of all patients admitted to a metropolitan stroke unit (Melbourne, Victoria, Australia) with an acute ischemic stroke treated with tissue plasminogen activator between 1/2013 and 9/2017. Baseline characteristics, thrombolysis time intervals, length of stay, discharge destination, and in-hospital mortality were compared between patients with and without a language barrier using multivariate analysis after adjustment for age, sex, stroke severity, premorbid modified Rankin Scale (mRS) and Charlson Comorbidity Index (CCI). Language barriers were defined as a primary language other than English. **RESULTS:** A total of 374 patients were included. Of this, 76 patients (20.3%) had a language barrier. Mean age was 5 years older for patients with language barriers (76.7 vs 71.8 years, P=0.004). Less non-English speaking patients had pre-morbid mRS score of zero (P=0.002) and more had pre-morbid mRS score of one or two (P=0.04). There was no statistically significant difference between two groups in terms of stroke severity on presentation (P=0.06). The onset to needle time was significantly longer in patients with a language barrier (188 min vs 173 min, P=0.04). Onset to arrival and door to imaging times were surprisingly similar between the two groups. However, imaging to needle time was 9 minutes delayed in non-English speaking patients with a marginal P value (65 vs 56 min, P=0.06). patients with language barriers stayed longer in stroke unit stay (6 vs 4 days, P=0.02) and had higher rates of discharge to residential aged care facilities in those admitted from home (9.2% vs 2.3%, P=0.02). In-hospital mortality was not different between two groups (P=0.8) **CONCLUSION:** In this study language barriers were associated with almost 14 min delay in thrombolysis. The delay was mostly attributable to imaging to needle time. Language barriers were also associated with poorer clinical outcomes.

Keywprds: stroke, thrombolysis, Culturally linguistically diverse communities (CALD)

## Introduction

Stroke is a leading cause of death and substantial disability globally (1). Approximately 80% of incident strokes are ischemic (2) where time-critical acute care is heavily dependent upon an accurate history and examination.

Rising global migration has led to cultural and linguistic diversification of communities and introduced new challenges to healthcare system in Australia along with other immigration nations. 2016 census in Australia showed that 26% of population was born overseas with 1% increase from last census in 2011, while more than one-fifth (21%) speak a language other than English at home (3). The Australian Stroke Clinical Registry (AuSCR) also reported that more than 7% of stroke patients in Australia speak a language other than English (4). Little is known about the influence of language barriers on stroke care in terms of time-to-thrombolysis in particular (5) and clinical outcomes such as mortality, discharge destinations and quality of life in general (6).

The aim of this study was to determine the influence of language barriers on relevant thrombolysis timing intervals and clinical outcomes (mortality, discharge destination and length of stay) within a consecutive series of stroke patients who received tissue plasminogen activator (tPA). We tested the hypothesis that presence of a language barrier would be independently associated with delayed thrombolysis and disparity in clinical outcomes.

## Methods

This was a retrospective observational study of a cohort of patients who admitted to a metropolitan stroke unit of Western Health, Melbourne, Victoria, Australia with an acute ischemic stroke and treated with tPA between January 2013 and September 2017.

Relevant time intervals, pre-morbid modified Rankin Scale (mRS), National Institutes of Health Stroke Scale (NIHSS), demographic variables and recruitment to clinical trials for thrombolysed patients are prospectively collected in our unit by a stroke nurse consultant for the purpose of quality improvement. These datasheets together with electronic medical records were retrospectively reviewed for all eligible patients.

Language barriers were defined as primary language other than English as recorded in our health network administration database. This data is collected and documented by a hospital clerk at the time of admission.

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The time of code stroke call was used as arrival time for in-patient strokes.
Charlson comorbidity index was calculated as described by Goldstein et al (7). The stroke and hemiplegia secondary to the incident stroke were not included.
Ethical approval was granted by the ethics committee at Western Health.

**Statistical Analysis**

Continuous variables were expressed as means (standard deviations) or medians (interquartile ranges). Baseline characteristics were compared between English and Non-English patients using Chi-squared test for categorical variables, Fisher exact test for binary variables, and Mann-Whitney U test for all continuous variables aside from age, which was compared using a t test. Absolute difference in time intervals and length of stay were determined using univariate linear regression. To determine the independent effect of a language barrier on relevant time intervals and length of stay, multi-variable regression models were used adjusted for age, sex, initial stroke severity, premorbid modified Rankin Scale (for thrombolysis times) and Charlson comorbidity index (for length of stay).
Logistic regression models adjusted for age, sex, initial stroke severity and Charlson comorbidity index were also built to examine the effect of Non-English status on in-hospital mortality and discharge destination from stroke ward.
GraphPad Prism version 7.03 was applied to analyse the baseline characteristics and regressions were modelled using Stata version 14. $P<0.05$ was considered statistically significant. P-values of regression models were calculated with bootstrap with 5000 replications.

**Results**

A total of 374 patients were included after exclusion of 22 patients due to stroke mimics (n=18) and incomplete medical records (n=13). English was documented as primary language in 298 patients while 76 patients reported a primary language other than English (79.7% vs 20.3%). The baseline characteristics of patients are listed in Table 1. Mean age was 5 years older for patients with language barriers (76.7 vs 71.8 years, P=0.003). There were similar proportion of males in two groups (57.7% vs 52.6%, P=0.43). Less non-English speaking patients had pre-morbid mRS score of zero (46.6% vs 65.7%, P=0.002) and more had pre-morbid mRS score of one or two (18.6% vs 9.7%, P=0.04; 16% vs 7.3%, P=0.04 respectively) while comparable

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numbers had mRS>2. Stroke severity on presentation (median initial NIHSS) was slightly higher in non-English speaking cohort however this was not statistically significant (9 vs 8, P=0.06). Most common comorbidities (hypertension and hyperlipidaemia) appeared to be more common in patients with a language barrier however this difference did not reach statistical significance (P=0.16 and P= 0.06 respectively). CCI and other baseline comorbidities including history of previous stroke/TIA were not significantly different. Recruitment to clinical trials were comparable between the two group of patients.

Table 1: Study population baseline characteristics

| | English (N = 298) | Non-English (N = 76) | P-value |
|---|---|---|---|
| Age, years, mean (SD) | 71.85 (13.58) | 76.68 (10.25) | 0.003 * |
| Male (%) | 172 (57.72) | 40 (52.63) | 0.43 |
| Initial NIHSS, median (IQR) | 8 (5-15) | 9 (6-16) | 0.06 |
| In-patient stroke (%) | 16 (5) | 3 (4) | 0.5 |
| Recruitment to clinical trials (%)[a] | 25/115 (21.74) | 5/28 (17.86) | 0.79 |
| Charlson Comorbidity Index (CCI) (%) | | | |
| 0 | 99 (33.3) | 22 (28.9) | 0.58 |
| 1 | 66 (22.2) | 18 (23.7) | 0.76 |
| ≥2 | 133 (44.5) | 36 (47.4) | 0.69 |
| Pre-morbid modified Rankin Scale (%) | | | |
| 0 | 196 (65.77) | 35 (46.67) | 0.002 * |
| 1 | 29 (9.73) | 14 (18.67) | 0.04 * |
| 2 | 22 (7.38) | 12 (16) | 0.04 * |
| 3 | 33 (11.07) | 10 (13.33) | 0.68 |
| ≥4[b] | 18 (6.04) | 4 (5.33) | 0.58 |
| Comorbidities (%) | | | |
| Hypertension | 201 (67.45) | 58 (76.32) | 0.16 |
| Hyperlipidaemia | 124 (41.61) | 41 (53.95) | 0.06 |
| Diabetes mellitus | 87 (29.19) | 24 (31.58) | 0.67 |
| Ever smoker | 79 (26.51) | 18 (23.68) | 0.66 |
| Ischemic heart disease | 81 (27.18) | 21 (27.63) | >0.99 |
| Peripheral vascular disease | 9 (3.02) | 3 (3.95) | 0.71 |
| Previous stroke/TIA | 56 (18.79) | 17 (22.37) | 0.51 |
| Atrial fibrillation | 73 (24.5) | 23 (30.26) | 0.30 |
| Renal impairment | 30 (10.07) | 4 (5.26) | 0.26 |
| History of malignancy | 45 (15.1) | 8 (10.53) | 0.36 |
| Cognitive impairment | 26 (8.72) | 7 (9.21) | 0.82 |
| Depression/Anxiety | 40 (13.42) | 12 (15.79) | 0.58 |

[a] Only applicable to 2016 and 2017; [b] Only 1 patient from English group had pre-morbid mRS of 5; * P<0.05.
Abbreviations: NIHSS, National Institutes of Health Stroke Scale; CCI, Charlson comorbidity index; TIA, Transient Ischemic attack.

The onset to needle time was significantly longer in patients with language barriers (Adjusted difference 13.7 min, 95% CI 0.12-27.4, P=0.04) (Table 2). Onset to arrival and door to imaging times were similar between English and Non-English speaking (P=0.81 and P=0.99 respectively). However, imaging to needle time was 8.9 min delayed in patients with language barriers with a marginal P value (95% CI -0.57-18.5, P=0.06) (Table 2).

In-hospital mortality rate was similar between the two groups (P=0.8) (Table 3). Equal proportion of patients from each group were discharged to home or rehabilitation unit from stroke ward (P=0.9 and P=0.63 respectively). Clot retrieval rate was also comparable (P=0.83). However, patients with a language barrier had longer median length of stay under stroke unit (3 days longer, 95% CI 0.35–5.8; P=0.02) and higher rates of discharge to residential aged care facility (RACF) in those admitted from home (9.2% vs 2.3%, adjusted OR 3.6, 95% CI 1.1-11.4, P=0.02) (Table 3).

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Table 2: Relevant time intervals by language

| | English | Non- English | Unadjusted Difference [95%CI][a] | Unadjusted P-value | Adjusted difference [95% CI][b] | Adjusted P-value |
|---|---|---|---|---|---|---|
| Time intervals, minutes, mean (median, IQR) | | | | | | |
| Onset to arrival | 85.7 (73.5, 55-104) | 87.6 (75, 60-105.5) | 1.9 [-8.8-12.8] | 0.71 | 1.3 [-10-12.9] | 0.81 |
| Onset to needle | 173.4 (167.5, 135-209) | 188.5 (180, 155-213) | 15.1 [1.3-28.8] | 0.03* | 13.7 [0.12-27.4] | 0.04 * |
| Door to imaging | 35.8 (27, 16-47) | 36.4 (30, 17-50) | 0.6 [-5.7-6.9] | 0.99 | -0.009 [-6.5-6.4] | 0.99 |
| Imaging to needle | 56.7 (52, 36-73.5) | 65.7 (60, 41-77.5) | 9 [-0.44-18.4] | 0.06 | 8.9 [-0.57-18.5] | 0.06 |
| Door to needle | 91.9 (87.5, 65-110) | 100.9 (91.5, 73-121.5) | 9 [-1.4-19.6] | 0.09 | 8.2 [-2.1-18.5] | 0.11 |

[a] Univariable Analysis; [b] Multivariable Analysis- for time intervals: adjusted for age, sex, mRS, NIHSS; *P<0.05; P-values calculated with bootstrap with 5000 replications.
Abbreviations: CI, confidence interval; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale

Table 3: Clinical outcomes by language

| | English | Non- English | Unadjusted OR [95%CI][a] | Unadjusted P-value | Adjusted OR [95% CI][b] | Adjusted P-value |
|---|---|---|---|---|---|---|
| Mortality (%) | | | | | | |
| In-hospital mortality | 34 (11.4) | 10 (13.1) | 1.1 [0.55-2.5] | 0.67 | 0.89 [0.37-2.1] | 0.8 |
| Discharge destination from stroke ward (%)[c] | | | | | | |
| Home | 139 (46.6) | 29 (38.1) | 0.7 [0.42-1.1] | 0.18 | 1 [0.56-1.8] | 0.9 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| Clot retrieval | 21 (7) | 4 (5.2) | 1.1 [0.43-2.9] | 0.79 | 1.1 [0.37-3.3] | 0.83 |
| Rehabilitation unit | 80 (26.8) | 20 (26.3) | 0.97 [0.54-1.7] | 0.92 | 0.86 [0.47-1.56] | 0.63 |
| Admitted from home discharged to RACF | 7 (2.3) | 7 (9.2) | 4.2 [1.4-12.4] | 0.009 * | 3.6 [1.1-11.4] | 0.02 * |
| Length of stay[d] | | | | | | |
| LOS under stroke unit, days, median (IQR) | 4 (3-8) | 6 (3-13) | 3.8 § [0.84-6.9] | 0.01* | 3 § [0.35-5.8] | 0.02 * |

[a] Univariable Analysis; [b] Multivariable Analysis- for clinical outcomes: adjusted for age, sex, CCI, NIHSS; [c] Data not shown for patients who were admitted form RACF and discharged to RACF (n=10) or transferred to another hospital for reasons other than clot retrieval (n= 13); [d] Patients who died or transferred to other hospitals on day zero were excluded.

§ Absolute difference with 95% confidence interval; * P<0.05

Abbreviations: OR, Odds Ratio; CI, confidence interval; RACF, Residential Aged Care Facility; LOS, Length of stay; CCI, Charlson comorbidity index; NIHSS, National Institutes of Health Stroke Scale.

**Discussion**

Presence of a language barrier was associated with approximately 14 minutes delay in onset to needle time after adjusting for baseline characteristics. The observed delay was mainly attributable to longer imaging to needle time although this did not reach statistical significance, possibly due to small sample size.

We also found that non-English speaking patients had longer stay in stroke unit and were more likely to be discharged to residential aged care facilities independent of age, sex, stroke severity and comorbidity index. However, other discharge outcomes (in-hospital mortality and discharged to home/rehabilitation) were similar to English speaking patients.

To our knowledge, this is the first report of significant delay in thrombolysis in patients with language barriers. Rostanski et al failed to demonstrate an association between language discordance between patient and physician and thrombolysis times (5) . It is important to note that this study was conducted in an American centre with a large proportion of Spanish-speaking patients where in-person Spanish interpreters were available 24 hours per day. While in our network telephone interpreting services are available, access to in-person interpreter in an Emergency setting is limited and requires prior bookings. The use of interpreter services was not determined in our cohort.

Shah et al in a large retrospective study using registry of the Canadian Stroke Network showed that patients with language barriers had similar thrombolysis rate and door to needle time but surprisingly less mortality and better quality of care in general compared to those without language barriers (6). These findings persisted after adjustments for many potential confounders. The authors suggested that reduced mortality in patients with language barriers could be explained by their desire for aggressive care as shown by longer length of stay and higher rates of moderate-to- severe residual neurological deficit at discharge (6).

Kilkenny et al in the only Australian study that investigated the impact of language barriers on stroke care, reported longer onset to arrival time (173 min vs 155 min; P=0.06) in patients who required interpreters while thrombolysis time interval differences were not reported (8). Similar to our finding there was a 2-day longer length of stay and higher rates of living with support associated with language barriers (8). Use of interpreter as an indicator of language barriers expectedly underestimated the true number of patients with language barriers; i.e. language barriers were shown to exist in >7% of strokes in Australia (4) compared to 4.2% who required interpreter in Kilkenny et al report (8).

Our study has the expected limitations of a retrospective study based on medical records. This was a single-centre study that makes the generalisability of the findings uncertain. However, our centre represents an area with a high proportion of migrants in Melbourne which provides an excellent opportunity for studies into language barriers (9); i.e. 20% of study population had a primary language other than English compared to >7% reported nationally (4). While we conducted an adjusted analysis to a range of potential confounding variables, other potential confounders such as ethnicity and socioeconomic status were not collected. Another limitation is the fact that language disturbance as a result of stroke (aphasia) was not accounted for. Similar to other retrospective research into language barriers, definition of a language barrier used in the study is unlikely to fully capture the patient capacity to communicate effectively and could be a source of over/underestimation.

**Conclusion**

Understanding the impact of linguistic disparities on healthcare in countries such as Australia with ever-growing cultural and linguistic diversity is important. Despite this, only scarce research has been conducted into the impact of language barriers on stroke care and outcome. Thrombolysis is a time-sensitive therapy where the benefit diminishes with delay (10). A 15-minute delay in thrombolysis is associated with loss of one-month disability-free life (11). Presence of language barrier in our study was associated with an almost 15 min delay in thrombolysis and poorer clinical outcomes after adjustment to a number of potential confounders. More research is required to investigate the underlying reasons for this disparity and to establish methods to improve current practice.

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