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ORIGINAL RESEARCH

Rural versus metropolitan comparison of processes of care in the community-based management of TIA and minor stroke in Australia (an analysis from the INSIST study)

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Abstract

Objectives: To compare processes of care and clinical outcomes of community-based management of TIAs and minor strokes (TIAMS) between rural and metropolitan Australia.

Shyam Gangadharan and Shinya Tomari contributed equally to the project and share first authorship.

Christopher R. Levi and Parker Magin contributed equally to the project.

Design: Inception cohort study between 2012 and 2016 with 12-month follow-up after index event (sub-study of INSIST).

Setting: Hunter and Manning valley regions of New South Wales, within the referral territory of the John Hunter Hospital Acute Neurovascular Clinic (JHHANC).

Participants: Consecutive patients of 16 participating general practices, presenting with possible TIAMS to either primary or secondary care.

Main Outcome Measures: Processes of care (referrals, key management processes, time-based metrics) and clinical outcomes.

Results: Of 613 participants with possible TIAMS who completed the baseline interview, 298 were adjudicated as having TIAMS (119 from rural, 179 from metropolitan). Mean age was 72.3 years (SD, 10.7) and 127 (43%) were women. Rural participants were more likely to be managed solely by a general practitioner (GP) than metropolitan participants (34% v 20%) and less likely to be referred to a JHHANC specialist (13% v 38%) or have brain magnetic resonance imaging (MRI) [24% v 51%]. Those rural participants who were referred, also waited longer (both $p < 0.001$). Recurrent stroke, myocardial infarction and death at 12 months were not significantly different between rural and metropolitan participants.

Conclusions: Although TIAMS prognosis in rural settings where solely GP care is common is very good, the processes of care in such areas are inferior to metropolitan. This suggests there is further scope to support rural GPs to optimise care of TIAMS patients.

KEYWORDS

community stroke care, general practitioner, health, patient-reported outcomes, stroke-mimic

1 | INTRODUCTION

The risk of stroke following a Transient Ischaemic Attack and Minor Stroke (TIAMS) is up to 10% at 90 days.[1] The majority of these recurrent events occur within the first week after symptom onset, providing a short time-window for prevention strategies.[2] Previously, there was uncertainty about whether a hospital-based approach should be followed in all TIAMS cases.[3] However, it has since been shown that outpatient assessment post-TIAMS is an appropriate alternative, provided it can be achieved soon after the index event, via specialised clinics.[4]

In Australia, most TIA patients present to general practice, and in many regions there is a shortage of access to specialist TIAMS care.[5] Rapid-access acute neurovascular clinics (ANCs) were only available in 38% of Australian hospitals in 2015[6] compared with 98% of UK hospitals (2010).[7] Further, there is a disparity in access to specialist care after TIAMS in rural Australia.[8] Even in areas served by ANCs, access may be suboptimal.[9] Hence it is not clear whether the recommendations from guidelines for urgent assessment in a specialist clinic after TIAMS, largely

What is already known on this subject:

- TIAMS is a medical emergency, where urgent specialist care improves clinical outcomes
- In rural Australia, specialist care for TIAMS patients is often impracticable
- Data on care processes in community-based TIAMS management are limited

What this paper adds:

- Processes of care in rural community-based TIAMS management, where solely GP care is common, are inferior to metropolitan settings, though clinical outcomes are similar
- Health policy should support rural GPs in providing optimal processes of TIAMS care
- This may possibly be best achieved through digital health innovations like telehealth and GP access to MRI rather than providing specialist clinic access in larger rural towns

based on UK evidence,[1] can be applied to Australian practice, particularly in rural settings.

Specific processes of care, such as admission to specialised stroke units and early use of antithrombotic agents, correlate with better outcomes and reduced medical complications of stroke.[10,11] However, the relevant processes of care for TIAMS have not been well-characterised in community-based settings. The distribution of health services across rural Australia, with limited resources dispersed over vast geographical distances, suggests that a community-based approach would be a pragmatic and cost-effective solution to overcome these challenges.[12]

The International comparison of Systems of care and patient outcomes In minor Stroke and Tia (INSIST) study sought to provide relevant evidence for health policy by systematically documenting, for the first time, in the community-based management of TIAMS in Australia: (1) processes of care and (2) clinical outcomes, comparing rural and metropolitan settings.

2 | METHODS

2.1 | Study design

International comparison of Systems of care and patient outcomes In minor Stroke and Tia was an inception cohort study in which patients of participating general practices with possible TIAMS, whether presenting to primary or secondary care, were followed up for 12 months post-index event. The study protocol has been published previously.[13] INSIST recruited all possible TIAMS patients, both TIAMS and TIAMS-mimics. INSIST has previously established the prognosis of TIAMS in Australian community practice.[14]

2.2 | Setting

Participants were recruited from the Hunter and Manning valley regions of New South Wales (NSW), within the referral territory of the John Hunter Hospital Acute Neurovascular Clinic (JHHANC), between August 2012 and August 2016.[15] Participants attended one of 16 general practices within the Hunter New England and Central Coast Primary Health Network (HNECCPHN) (Figure 1). The estimated population within the HNECCPHN region is 1 200 000, of whom 18.3% are aged over 65 years (compared to 14.4% nationally) and 18.5% have circulatory system disease (compared to a national prevalence of 17.3%).[16]

2.3 | Classification of rurality

Classification of rurality was based on patients' residential postcode, matched to the Australian Statistical Geography Standard – Remoteness Area (ASGS-RA) (2016).[17] The ASGS-RA has five categories: Major cities (hereafter, 'Metropolitan') [RA 1], Inner Regional [RA 2], Outer Regional [RA 3], Remote [RA 4] and Very Remote [RA 5]. This was dichotomised into Metropolitan [RA 1] versus others ('Rural' [RA 2–5]) for our analyses.

The great majority of INSIST study patients classified as 'rural' were from inner regional [RA 2] areas.

2.4 | Transient ischaemic attack and minor stroke

Transient ischaemic attack and minor stroke were ascertained using multiple overlapping methods, involving primary and secondary care sources.[13,15] Index and recurrent

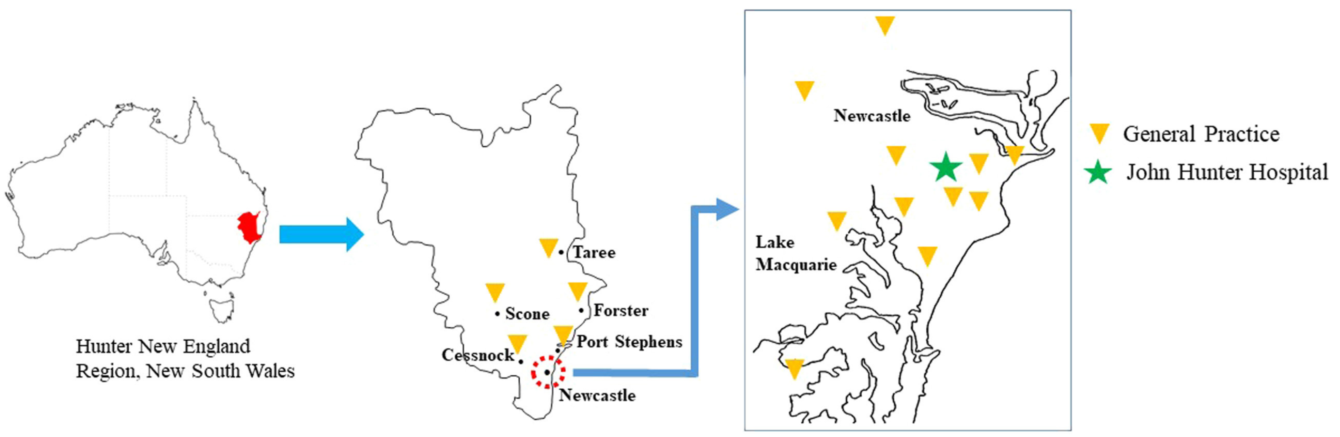


FIGURE 1 Locations of INSIST general practices in Hunter New England region

events were adjudicated as stroke, TIA or TIAMS-mimic by a panel of three medical clinicians, at least one of whom was a stroke physician and one a General Practitioner (GP).

Among TIAMS, clinical neurological events with symptoms lasting <24 h were classified as TIAs, and episodes with symptoms lasting >24 h with National Institute of Health Stroke Scale (NIHSS) score ≤5 at presentation were classified as minor strokes. Patients whose symptoms had both lasted more than 24 h and had NIHSS >5 at presentation, were excluded. All patients of the recruited practices presenting to medical care with a possible diagnosis of TIAMS were invited to participate. TIAMS-mimics referred to patients who presented with neurological symptoms of possible TIAMS but were adjudged to have a non-vascular cause, such as seizure, migraine, syncope, or functional neurological disorder.

2.5 | Data collection

Information collected at the patient's baseline interview included demographics (Socio-Economic Index for Area-Index of Relative Social Disadvantage [SEIFA-IRSD]),[18] level of education, functional status (Modified Rankin Scale [mRS]), and patient-reported outcomes (PROs),[19] including: symptoms of depression and anxiety (Hospital Anxiety and Depression Scale [HADS])[20] and fatigue (CHALDER Fatigue score).[21] Data were also obtained from general practice and hospital records. Follow-up interviews were conducted at three and 12 months post-baseline assessment, with similar data collected at these time points as at baseline. Additionally, clinical outcome data, including recurrent stroke, myocardial infarction and death, were collected from general practice and secondary care sources.

2.6 | Processes of care

Data collected on processes of care included mode of initial presentation (general practice, emergency department, etc.), whether care was solely GP-managed, and referrals to specialist, neurologist, or JHHANC-neurologist care. Key patient management process measures included whether patients received standard TIAMS care such as brain imaging, any vascular imaging, or cardiac Holter monitoring. A full basic workup was defined as comprising any brain and any vascular imaging, and some form of cardiac monitoring/recording. Also, patient management data included whether patients received early anti-thrombotic therapy (<24 h from symptom onset), anticoagulation post-event (if atrial fibrillation [AF] present), and anti-hypertensive therapy post-event. Time-based process metrics included times: from symptom onset to medical call for help, to seeing the first doctor, to receiving first brain imaging, to referral to JHHANC specialist, and to seeing JHHANC specialist.

2.7 | Clinical outcomes

Key clinical outcome data comprised new events including stroke (any type including ischaemic, intracerebral or subarachnoid haemorrhage), myocardial infarction or death. Cerebrovascular and coronary interventions were also assessed.

2.8 | Statistical analysis

Demographic and hospital-based care variables were summarised for the sample by rurality (Rural versus Metropolitan). Continuous variables were summarised using mean and standard deviation or median and inter-quartile range (IQR). Categorical variables were summarised using frequency counts and percentages. Characteristics of Rural and Metropolitan patients were compared using *t*-tests for continuous variables and Chi-squared or Fisher's exact tests for categorical variables.

Variables related to processes of care were binary when indicating whether or not patients received specified investigations/modes of care and time to events when measuring the number of days between the onset event and the date of receiving care.

Associations between binary outcomes and rurality as a potential predictor were explored using logistic regression analyses with effects estimated as odds ratios (OR: Rural versus Metropolitan) with 95% confidence intervals (CI). Multivariable logistic regression was used to adjust for potential confounders such as sex, age, body mass index, smoking status, and university education.

For time-to-event analyses, patients were censored if they did not have date-time data for the event of interest. The analysed time variable was equal to time-to-event or time-to-last follow-up (death, withdrawal, or study end date 30 August 2016) if censored. The Rural versus Metropolitan associations were estimated as hazard ratios (HR) with 95% CIs using Cox regression analyses. The proportional hazards assumption was assessed using tests of the Schoenfeld residuals and log–log plots. Multivariable Cox regression was used to adjust for sex, age, body mass index, smoking status, and university education.

Potential clustering of binary and time to event responses within GP practices was assessed using mixed effects logistic regression and Cox frailty models, respectively. Due to results being very similar whether clustering was or was not accounted for, results from the standard regression models (i.e., not adjusted for clustering) are shown.

The primary analysis was confined to TIAMS participants. A sensitivity analysis for the Cox proportional hazards modelling included all participants (adjudicated TIAMS and TIAMS-mimics).

Statistical analyses were programmed using SAS 9.4 (SAS Institute). *p* values <0.05 were considered statistically significant. Due to anticipated correlation of many outcomes and the modest sample size, no adjustment for multiplicity was made to avoid elevating the type II error rate.

2.9 | Ethics approval

Ethics approval was gained from the Hunter New England Human Research Ethics Committee (Reference No. 12/04/18/4.02).

3 | RESULTS

Overall, 613/1363 possible TIAMS provided baseline data. There were 298 participants subsequently adjudicated as TIAMS patients (Table 1), 119 were from rural and 179 from metropolitan locations. The mean participant age was 72.3 years (SD = 10.7) and 127 (43%) were women. There was no difference in high-risk ABCD2 scores (greater than 4) between rural and metropolitan participants (75 (63%) vs 113 (63%), $p = 0.99$). All rural practices were located in inner regional areas [ASGS RA 2] and 98% (117) of rural participants resided in inner regional areas. For rural participants, the median (IQR) distance to the JHHANC was 155 (65–167) km, and for metropolitan participants it was 11 (6–27) km.

There was a significant difference in the socioeconomic status of rural and metropolitan participants, with 49 (42%) rural participants in the lowest SEIFA-IRSD Quartile (Quartile 1), compared to 26 (15%) of metropolitan participants ($p < 0.001$). Rural participants were also less likely to have had a university education ($n = 11$; 9.2% vs $n = 33$; 18%, $p = 0.03$).

3.1 | Processes of care

Rural participants were 2.1 times more likely to be managed solely by a GP than metropolitan patients (41 (34%)

TABLE 1 Characteristics of TIAMS-only patients

Characteristic	Class or statistic	Rural ($n = 119$)	Metro ($n = 179$)	*p*
Age (years)	mean (SD)	73.1 (10.3)	71.7 (10.9)	0.26
BMI	mean (SD)	28.3 (6.5)	27.8 (5.6)	0.46
ABCD2 risk score	mean (SD)	4.05 (1.52)	4.04 (1.62)	0.95
Sex	Female	52 (44%)	75 (42%)	0.76
University education	Yes	11 (9.2%)	33 (18%)	0.03
Current smoking status	Yes	7 (5.9%)	12 (6.7%)	0.78
SEIFA quartile	Quartile 1	49 (42%)	26 (15%)	<0.001
	Quartile 2	38 (32%)	34 (20%)	
	Quartile 3	25 (21%)	64 (37%)	
	Quartile 4	5 (4.3%)	49 (28%)	
ASGS-RA (2016)	Major city (metropolitan)	–	179 (100.0%)	N/A
	Inner regional (rural)	117 (98%)	–	
	Outer regional (rural)	2 (1.7%)	–	
ABCD2 risk score 4+	Yes	75 (63%)	113 (63%)	0.99

Note: *p*-values for continuous variables are from *t*-tests, *p*-values for categorical variables are from Chi-squared test.

SEIFA has mean 1000 and standard deviation 100. Categorised as Q4: ≥1067, Q3: 1000–1066, Q2: 933–999, Q1: <933.

Abbreviations: ABCD2, age, blood pressure, clinical features, duration of symptoms and history of diabetes; ASGS-RA, Australian Statistical Geography Standard – Remoteness Area; BMI, Body Mass Index; Metro, Metropolitan; SEIFA, Socio-Economic Index for Area.

versus 36 (20%), $p = 0.01$) (Table 2) and 3.6 times less likely to be referred to a JHHANC specialist. Rural participants were also 3.3 times less likely to receive an MRI. There was no significant difference in the frequency of any brain imaging (either MRI or CT), vascular imaging or Holter monitoring received, early anti-thrombotic or anti-hypertensive use between metropolitan and rural participants (Figure 2). There was some evidence for rural participants to receive the full basic workup less frequently (OR 0.63, $p = 0.06$).

Rural participants waited significantly longer to have a brain MRI (Hazard Ratio for time from onset to first MRI: adjusted HR = 0.40, 95% CI 0.26–0.61, $p < 0.001$), and to see a JHHANC specialist (adjusted HR = 0.40, 95% CI 0.27–0.61, $p < 0.001$) (Table 3). All other time-based comparisons were not statistically significant.

3.2 | Clinical outcomes

There were no differences between the two groups within 12 months in death or recurrent vascular event rates including recurrent TIA/stroke and myocardial infarction. Similarly, there was no significant difference in patient-reported health measures between rural and metropolitan participants either at baseline or at 12 months, including Modified Rankin Scale, HADS Depression score, HADS anxiety score and CHALDER Fatigue score (Table 4).

TABLE 2 Results from logistic regression analyses of binary 'process of care' variables in TIAMS patients ($N = 298$)

	Residential location		Unadjusted analysis (rural vs metro)		Adjusted[a] analysis (rural vs metro)	
Process of care	**Rural ($n = 119$)**	**Metro ($n = 179$)**	**Odds ratio (95% CI)**	***p*-value**	**Odds ratio (95% CI)**	***p*-value**
Referral						
GP-referred to ED	17 (14%)	19 (11%)	1.41 (0.70, 2.81)	0.34	1.33 (0.67, 2.66)	0.42
ED managed	71 (60%)	92 (51%)	1.39 (0.87, 2.23)	0.16	1.36 (0.84, 2.20)	0.21
Admitted to hospital[b]	43 (61%)	55 (62%)	0.98 (0.52, 1.87)	0.96	0.93 (0.48, 1.81)	0.84
Managed solely by GP	41 (34%)	36 (20%)	2.08 (1.23, 3.51)	0.01	2.10 (1.22, 3.61)	0.01
Referred to physician	25 (21%)	80 (45%)	0.33 (0.20, 0.57)	<0.001	0.35 (0.21, 0.61)	<0.01
Any neurologist consult	22 (18%)	74 (41%)	0.33 (0.19, 0.57)	<0.001	0.34 (0.20, 0.60)	<0.01
JHHANC neurologist consult	16 (13%)	68 (38%)	0.26 (0.14, 0.47)	<0.001	0.28 (0.15, 0.51)	<0.001
Patient management						
Received brain imaging	107 (90%)	164 (92%)	0.81 (0.37, 1.78)	0.60	0.85 (0.39, 1.87)	0.69
Received brain MRI	29 (24%)	92 (51%)	0.31 (0.19, 0.51)	<0.001	0.30 (0.18, 0.52)	<0.001
Received vascular imaging	92 (77%)	151 (84%)	0.63 (0.35, 1.14)	0.13	0.63 (0.35, 1.15)	0.13
Received Holter monitoring	24 (20%)	44 (25%)	0.78 (0.45, 1.37)	0.39	0.76 (0.43, 1.33)	0.33
Received full basic workup (brain imaging + vascular imaging + Holter monitoring)	58 (49%)	107 (60%)	0.64 (0.40, 1.02)	0.06	0.63 (0.39, 1.01)	0.06
Early antithrombotic use (new Antiplatelet/anticoagulant started <24 h of onset)	33 (28%)	62 (35%)	0.73 (0.44, 1.21)	0.22	0.79 (0.47, 1.33)	0.37
On anticoagulant post-event ([c]if AF)	16 (64%)	27 (64%)	0.98 (0.35, 2.74)	0.97	1.03 (0.36, 2.94)	0.96
On anti-hypertensive post-event	92 (77%)	137 (77%)	1.04 (0.60, 1.80)	0.89	0.89 (0.50, 1.58)	0.69

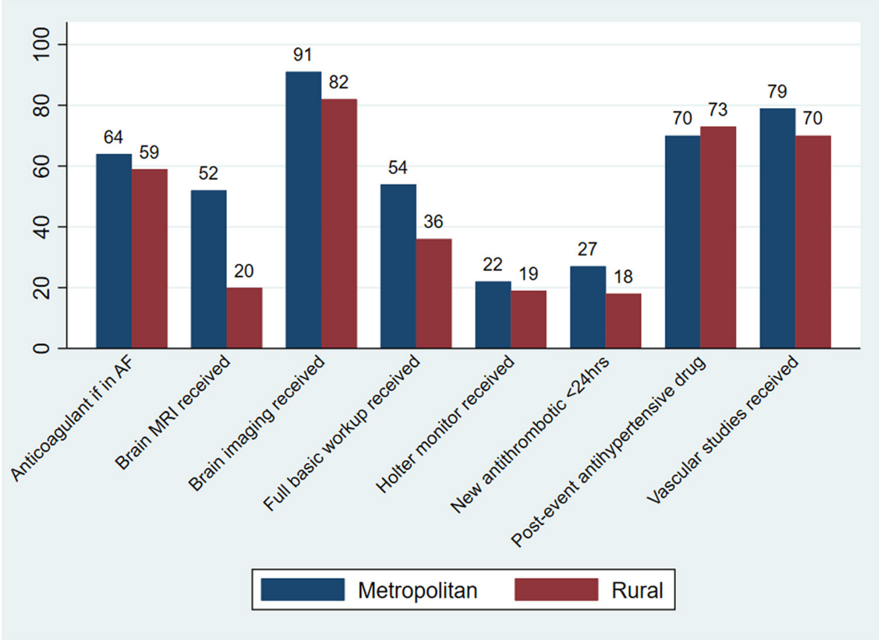
Abbreviations: CI, Confidence Interval; ED, Emergency Department; GP, General Practitioner; JHHANC, John Hunter Hospital Acute Neurovascular Clinic; MRI, Magnetic Resonance Imaging.

[a]Adjusted for patient sex, age, body mass index, smoking status, and education (university versus lower).

[b]Hospital admission outcome excludes 3 patients who were in hospital when onset event occurred.

[c]Anticoagulant outcome restricted to patients with atrial fibrillation (AF).

FIGURE 2 Key processes of care (%)



There was also no difference between the two groups in coronary stent angioplasty, carotid or vertebral procedures. There were no primary intracerebral haemorrhages or subarachnoid haemorrhages in either group over the 12-month period.

3.3 | Sensitivity analysis

The sensitivity analysis, including all participants with possible TIAMS ($n = 613$), yielded results that were similar to the primary analysis. However, rural patients received less brain imaging of any form (adjusted OR 0.46, 95% CI 0.28–0.76, $p = 0.002$) and less vascular imaging (adjusted OR 0.65, 95% CI 0.45–0.95, $p = 0.03$).

In the sensitivity analysis, the median time from symptom onset to seeing a JHHANC specialist among rural participants was 33 days (IQR 10–61) versus 17 days (IQR 8–51) for metropolitan participants.

4 | DISCUSSION

In this community-based study, we found that rural TIAMS patients were more likely to be solely GP-managed, less likely to see a JHHANC specialist, and less likely to receive a brain MRI than metropolitan patients. Moreover, rural patients waited much longer to access specialist care and receive an MRI scan. Despite these relative deficits in certain processes of care, clinical outcomes, including recurrent stroke and mortality were not significantly worse for rural patients. Similar ABCD2 risk scores in rural and metropolitan patients suggest TIAMS populations were broadly comparable in terms of recurrent event risk profiles.

Though rural TIAMS patients were less likely to receive a brain MRI, the probability of receiving any brain imaging (MRI or CT) was similar between rural and metropolitan groups. As well as lesser geographic access to MRIs in rural areas, this may reflect brain MRIs being more financially accessible in urban areas. Urban areas have, on average, higher socioeconomic status than rural areas, and TIAMS patients in urban areas are more likely to be seen by specialists (the Medicare Benefits Schedule rebate for MRIs ordered by GPs are limited to only a very few (non-TIAMS) clinical indications).[22] Brain MRI is the preferred imaging modality for TIAMS due to increased sensitivity for detecting acute ischaemic brain lesions.[23]

A notable difference in the sensitivity analysis was that metropolitan possible TIAMS patients were more likely to have any brain imaging performed. As imaging in rural areas is initiated primarily by GPs, this may imply rural GPs are ordering brain imaging in a more parsimonious fashion, being more likely to order brain imaging in patients eventually diagnosed as TIAMS rather than mimic syndromes. A higher threshold for ordering imaging in possible TIAMS, however, may not necessarily be desirable. TIAMS can be difficult to differentiate from mimic syndromes and brain imaging can assist with both diagnosis and risk prediction. While our finding may reflect clinical acumen on the part of rural GPs, it might also reflect limited access to brain imaging and resource limitations inherent in rural settings.

Several reasons could explain the putative benefits of standard-of-care processes in metropolitan patients (in particular the increased access of metropolitan patients

TABLE 3 Results from Cox regression analyses in TIAMS patients ($N = 298$)

Variable	Number censored			Survival time (days) median ($p25$, $p75$)		Rural v metro (unadjusted)		Rural v metro (adjusted[a])	
	TIAMS ($N = 298$)	Rural ($N = 119$)	Metro ($N = 179$)	Rural	Metro	Hazard ratio (95% CI)	p-value	Hazard ratio (95% CI)	p-value
Time from onset to first medical call for help	27/298 (9.1%)	12/119 (10.1%)	15/179 (8.4%)	3.0 (0.6, 24.5)	5.4 (1.0, 63.5)	1.15 (0.90, 1.47)	0.27	1.17 (0.91, 1.51)	0.21
Time from onset to first doctor seen	2/298 (0.7%)	1/119 (0.8%)	1/179 (0.6%)	5.2 (1.6, 54.2)	15.0 (3.0, 76.0)	1.22 (0.91, 1.54)	0.09	1.24 (0.98, 1.57)	0.07
Time from medical call[b] to first doctor seen	1/271 (0.4%)	0/107 (0.0%)	1/164 (0.6%)	1.3 (0.7, 6.7)	2.0 (0.8, 15.3)	1.13 (0.88, 1.45)	0.34	1.18 (0.91, 1.52)	0.20
Time from onset to JHHANC specialist seen	167/298 (56.0%)	88/119 (74.0%)	79/179 (44.1%)	NA (99.9, NA)	82.1 (13.6, NA)	0.38 (0.26, 0.57)	<0.001	0.40 (0.27, 0.61)	<0.001
Time from JHHANC Referral[c] to JHHANC specialist seen	1/114 (0.9%)	0/28 (0.0%)	1/87 (1.2%)	8.9 (3.0, 22.1)	7.0 (4.8, 25.9)	1.00 (0.65, 1.55)	0.99	1.03 (0.67, 1.59)	0.90
Time from onset to first brain imaging	27/298 (9.1%)	12/119 (10.1%)	15/179 (8.4%)	5.0 (2.0, 31.0)	10.0 (3.0, 34.0)	1.10 (0.81, 1.50)	0.55	1.14 (0.83, 1.57)	0.42
Time from onset to first MRI	177/298 (59.4%)	90/119 (75.6%)	87/179 (48.6%)	NA (NA, NA)	124.2 (6.3, NA)	0.39 (0.26, 0.60)	<0.001	0.40 (0.26, 0.61)	<0.001

Note: All other analyses include all TIAMS patients ($N = 298$). Patients with missing event data were censored. Survival time estimates from Kaplan–Meier method.

Abbreviations: JHHANC, John Hunter Hospital Acute Neurovascular Clinic; MRI, Magnetic Resonance Imaging; NA, no estimate available; TIAMS, Transient Ischaemic Attack and Minor Stroke.

[a]Adjusted for patient sex, age, body mass image, education (university versus lower).

[b]27 patients with missing datetime data for medical call to help were excluded.

[c]165 patients with missing datetime data for JHHANC referral were excluded (even if they had datetime data for JHHANC specialist seen).

to specialist care) not translating into better clinical outcomes in metropolitan compared to rural patients. Firstly, prognosis in the overall cohort was excellent with small numbers of the relevant outcome events, such that a much larger study would have been required to demonstrate a difference. Secondly, the long delays in accessing appropriate specialist care may have nullified any potential benefit from this specialist care. The risk of recurrent stroke/TIA being highest immediately after the initial event,[24] the delays found in our study may have negated any benefit of specialist management. Thirdly, even in metropolitan patients certain key time metrics, such as time to first medical assessment, time to any brain imaging, and time to MRI, were less than ideal. This is likely to have attenuated the potential benefits of metropolitan processes of care in our study. While more accurate differentiation of TIAMS from mimics due to greater access to MRI in metropolitan areas may have potentially produced a higher risk (more often 'true stroke/TIA') cohort in metropolitan areas, in practice this was very unlikely to have had an appreciable effect on outcome rates.

Our study may suggest that, at a policy level, better support for rural GP management with strategies such as telehealth, rather than addressing the current relative lack of ANCs by provision of specialist outreach clinics in larger rural towns, may best utilise resources. Our results suggest rural GPs are capable of delivering effective processes of care in TIAMS management (apart from the constraints of access to advanced imaging and specialist review), with good clinical outcomes. Further, this finding was established predominantly in inner regional areas,

TABLE 4 Clinical outcomes (TIAMS only)

		Residential location		
Outcome	**Class**	**Rural ($n = 119$)**	**Metro ($n = 179$)**	***p***
ABCD2 risk score	Mean (SD)	4.05 (1.52)	4.04 (1.62)	0.95
Modified Rankin Scale (mRS) - baseline	Mean (SD)	1.01 (1.10)	0.93 (1.10)	0.56
Modified Rankin Scale (mRS) - 12 months	Mean (SD)	1.15 (1.11)	1.05 (1.21)	0.47
Patient-reported outcomes				
HADS depression score – baseline	Mean (SD)	3.14 (2.45)	2.84 (2.90)	0.37
HADS depression score - 12 months	Mean (SD)	2.73 (3.09)	2.35 (2.59)	0.27
HADS anxiety score - baseline	Mean (SD)	3.67 (3.36)	3.50 (3.93)	0.71
HADS anxiety score - 12 months	Mean (SD)	2.71 (3.34)	2.77 (3.08)	0.89
Fatigue score - baseline	Mean (SD)	14.54 (3.52)	13.82 (2.96)	0.06
Fatigue score - 12 months	Mean (SD)	13.72 (3.05)	13.34 (3.11)	0.32
Patient outcomes within study period				
Myocardial infarction	No	117 (98%)	179 (100.0%)	0.16
	Yes	2 (1.7%)		
Coronary stent angioplasty	No	117 (98%)	177 (99%)	1.00
	Yes	2 (1.7%)	2 (1.1%)	
Carotid or vertebral procedure	No	115 (97%)	172 (96%)	1.00
	Yes	4 (3.4%)	7 (3.9%)	
Intracerebral haemorrhage	No	119 (100.0%)	179 (100.0%)	
Subarachnoid haemorrhage	No	119 (100.0%)	179 (100.0%)	
Death	No	117 (98%)	178 (99.4%)	0.57
	Yes	2 (1.7%)	1 (0.6%)	
Recurrent TIA/stroke	No	109 (92%)	155 (87%)	0.20
	Yes	10 (8.4%)	24 (13%)	
Recurrent stroke	No	117 (98%)	172 (96%)	0.32
	Yes	2 (1.7%)	7 (3.9%)	
Recurrent TIA	No	111 (93%)	162 (91%)	0.52
	Yes	8 (6.7%)	17 (9.5%)	

Note: *p*-value is from *t*-test for means or Fisher's exact test for categorical variables.

Abbreviation: HADS, Hospital Anxiety and Depression Scale.

which is where expansion of rural outreach ANC clinics would occur.

A response may be timely access to specialist opinion for rural GPs via telehealth rather than dedicated ANC outreach clinics. This might entail GP-stroke physician collaboration through specialist clinical and imaging review, mediated by telehealth. We envisage that there would be investment in upgraded radiology and telehealth infrastructure (and MRI access for GPs) in inner regional areas to achieve this, rather than further alternative investment in setting up resource-intensive ANCs in these areas. Telehealth has previously been shown to be a successful model of acute stroke care in regional Australia,[25] as well as for patients with TIA in the UK.[26]

4.1 | Limitations

The great majority of our rural participants resided in inner regional areas, limiting the generalisability of findings to other rural and more remote areas. The focus of our study on one geographic classification, however, also has advantages. Inner regional areas are where the majority (63%) of rural Australians live.[27] There is currently a particular need for policy refinement around TIAMS-related service provision in these areas.

One further caution is the high rate of censored patients in the time-to-event analyses for some time metrics.

5 | CONCLUSION

We have provided novel insights on the community-based management of TIAMS in Australia. TIAMS prognosis in inner regional areas where solely GP management is common was very good, reflecting low event rates overall. However, our findings suggest a degree of inequity in processes of care for rural patients compared to metropolitan patients. A potential implication is that rural GPs could be supported to manage TIAMS using digital health innovations such as telehealth, augmented by access (both geographical and financial) to appropriate imaging.

AUTHOR CONTRIBUTIONS

SG and ST contributed equally to the study and share first authorship. Study design: CRL, DL, JMV, PAB, DAC, PM. Data collection: HZ, CGE, AD, NN, MS. Statistical analysis: NW, EH. Interpreted the data: SG, ST, CRL, PM. Drafted or revised the manuscript: SG, ST, CRL, JMV, HMD, PAB, NJS, VLF, PMR, BB, PM. Critical review, commentary or revision: all authors.

CONFLICT OF INTEREST

No relevant disclosures.

ETHICAL APPROVAL

Ethics approval was gained from the Hunter New England Human Research Ethics Committee (Reference No. 12/04/18/4.02).

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REFERENCES

1. Rothwell PM, Giles MF, Chandratheva A, Marquardt L, Geraghty O, Redgrave JNE, et al. Effect of urgent treatment of transient ischaemic attack and minor stroke on early recurrent stroke (EXPRESS study): a prospective population-based sequential comparison. Lancet. 2007;370:1432–42.
2. Yakhkind A, McTaggart RA, Jayaraman MV, Siket MS, Silver B, Yaghi S. Minor stroke and transient ischemic attack: research and practice. Front Neurol. 2016;7:86. doi:10.3389/fneur.2016.00086
3. Sanders LM, Srikanth VK, Jolley DJ, Sundarajan V, Psihogios H, Wong K, et al. Monash transient ischemic attack triaging treatment: safety of a transient ischemic attack mechanism-based outpatient model of care. Stroke. 2012;43:2936–41.
4. Prabhakaran S, Joshi JK, Ouyang B. Should TIA patients be hospitalized or referred to a same-day clinic? A decision analysis. Neurology. 2011;77:2082–8.
5. Davey AR, Lasserson DS, Levi CR, Magin PJ. Managing transient ischaemic attacks in Australia: a qualitative study. Fam Pract. 2017;34(5):606–11.
6. National Stroke Foundation. National Stroke Audit – acute services report 2015. Melbourne, Australia: National Stroke Foundation; 2015. Available from: https://www.strokefoundation.com.au
7. Royal College of Physicians of London. National Sentinal Stroke Audit 2010. Wales and Norther Ireland: Public report for England; 2010.
8. Cadilhac DA, Purvis T, Reyneke M, Dalli L, Kim J, Kilkenny MF. Evaluation of the National Stroke Audit Program: 20-year report; 2019. pp. 1–109.
9. Magin P, Lasserson D, Parsons M, Spratt N, Evans M, Russell M, et al. Referral and triage of patients with transient ischemic attacks to an acute access clinic: risk stratification in an Australian setting. Int J Stroke. 2013;8(Suppl A100):81–9.
10. Cadilhac D, Kim J, Lannin N, Levi C, Andrew N, Kilkenny M, et al. The quality of care provided to patients hospitalised with a transient ischemic attack. Int J Stroke. 2015;10(S3):27.
11. Ingeman A, Andersen G, Hundborg HH, Svendsen ML, Johnsen SP. Processes of care and medical complications in patients with stroke. Stroke. 2011;42:167–72.
12. Rosen A, Gurr R, Fanning P. The future of community-centred health services in Australia: lessons from the mental health sector. Aust Health Rev. 2010;34(1):106–15.

13. Levi CR, Lasserson D, Quain D, Valderas J, Dewey HM, Barber P, et al. The International comparison of systems of care and patient outcomes In minor stroke and Tia (InSIST) study: a community-based cohort study. Int J Stroke. 2019;14:186–90.
14. Tomari S, Levi CR, Holliday E, Lasserson D, Valderas JM, Dewey HM, et al. One-year risk of stroke after transient ischemic attack or minor stroke in hunter New England, Australia (INSIST study). Front Neurol. 2021;12:791193. doi:10.3389/fneur.2021.791193
15. Tomari S, Magin P, Lasserson D, Quain D, Valderas JM, Levi CR, et al. The characteristics of patients with possible transient ischemic attack and minor stroke in the hunter and Manning Valley regions, Australia (the INSIST study). Front Neurol. 2020;11:383. doi:10.3389/fneur.2020.00383
16. Hunter New England and Central Coast PHN Health Profile. 2015. Available from: http://www.hneccphn.com.au/media/1372/hnecc-2-page-infographic.pdf
17. Australian Statistical Geography Standard – Remoteness Area (ASGS-RA). Australian Bureau of Statistics (ABS). 2016. Available from: https://www.abs.gov.au/ausstats/abs@.nsf/mf/1270.0.55.001
18. Socio-Economic Index for Area-Index of Relative Social Disadvantage [SEIFA-IRSD]. Available from: https://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa
19. Valderas JM, Alonso J. Patient reported outcome measures: a model-based classification system for research and clinical practice. Qual Life Res. 2008;17(9):1125–35.
20. Turner A, Hambridge J, White J, Carter G, Clover K, Nelson L, et al. Depression screening in stroke: a comparison of alternative measures with the structured diagnostic interview for the diagnostic and statistical manual of mental disorders, fourth edition (major depressive episode) as criterion standard. Stroke. 2012;43:1000–5.
21. Winward C, Sackley C, Metha Z, Rothwell PM. A population-based study of fatigue after transient ischemic attack ad minor stroke. Stroke. 2009;40:757–61.
22. RACGP. Clinical guidance for MRI referral. Available from: Guidance-for-MRI-referral.pdf.aspx(racgp.org.au)
23. Chaturvedi S, Ofner S, Baye F, Myers LJ, Phipps M, Sico JJ, et al. Have clinicians adopted the use of brain MRI for patients with TIA and minor stroke? Neurology. 2017;88:237–44.
24. Arsava EM, Kim GM, Oliveira-Filho J, Gungor L, Noh HJ, de Jesus Lordelo M, et al. Prediction of early recurrence after acute ischemic stroke. JAMA Neurol. 2016;73(4):396–401.
25. Bladin CF, Kim J, Bagot KL, Vu M, Moloczij N, Denisenko S, et al. Improving acute stroke care in regional hospitals: clinical evaluation of the Victorian stroke telemedicine program. MJA. 2020;212:371–7. doi:10.5694/mja2.50570
26. D'Anna L, Ellis N, Bentley P, Brown Z, Halse O, Jamil S, et al. Delivering telemedicine consultations for patients with transient ischaemic attack during the COVID-19 pandemic in a comprehensive tertiary stroke Centre in the United Kingdom. Eur J Neurol. 2021;28:3456–60.
27. https://www.bitre.gov.au/sites/default/files/An-introduction-to-where-Australians-live-BITRE-Information-Sheet-96.pdf.

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