Missing Voices: Profile and extent of acquired communication disorders in Aboriginal and non-Aboriginal adult stroke survivors in Western Australia using linked administrative records

Cover title: Acquired communication disorders in Aboriginal stroke survivors in Western Australia

Katzenellenbogen JM^a PhD

Atkins ER^{a,b} PhD

Thompson SC^a PhD

HershD^c PhD

Coffin J^{d,e} PhD

Flicker L^f PhD

Hayward C^g BEd

Ciccone N^c PhD

Woods D^e MSc

McAllister M^c BSpPath

Armstrong EM^c PhD

^aWestern Australian Centre for Rural Health, University of Western Australia, Geraldton

^bThe George Institute for Global Health, Sydney

^cSchool of Psychology & Social Science, Edith Cowan University, Perth

^dTelethon Institute for Child Health Research, University of Western Australia, Perth

^eGeraldton Regional Aboriginal Medical Service, Geraldton

^fWestern Australian Centre for Health & Ageing, Centre for Medical Research, University of Western Australia, Perth

^gKurungkurl Katitjin, Centre for Indigenous Australian Education and Research, Edith Cowan University

Corresponding author:

Assoc Prof J Katzenellenbogen, Western Australian Centre for Rural Health, University of Western Australia, 35 Stirling Highway, Crawley, GPO Box U1987, Perth, Western Australia 6009, Australia
+61-8-64881000 (T) +61-8-64881188 (F)

Judith.katzenellenbogen@uwa.edu.au

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Abstract(239)

Background: Limited data exist on the extent of specific functional sequelae, including acquired communication disorder (ACD), among Aboriginal stroke survivors, making planning of multidisciplinary services difficult.

Aims: To obtain estimates of the extent and profile of ACD in Aboriginal and non-Aboriginal adult stroke survivors in Western Australia (WA) and investigate potential disparities in receiving in-hospital speech pathology services among survivors with ACD.

Methods: Stroke cases surviving their first stroke episode during 2002-11 were identified using WA-wide person-based linked hospital and mortality data, and their 5-year comorbidity profiles determined. The mid-year prevalence of stroke cases with ACD was estimated for 2011. Regression methods were used to investigate determinants of receiving speech pathology services among ACD cases.

Results: Of 14,757 stroke survivors aged 15-79 years admitted in 2002-11, 33% had ACD (22% aphasia/dysphasia) and 777 (5.3%) were Aboriginal. Aboriginal patients were more likely to be younger, live remotely and have comorbidities. A diagnosis of aphasia was more common in Aboriginal than non-Aboriginal patients 15-44 years ($p=0.003$). A minimum of 107 Aboriginal and 2,324 non-Aboriginal stroke patients with ACD lived in WA in 2011. Aboriginal status was not associated with receiving in-hospital speech services among ACD patients in unadjusted or adjusted models.

Conclusion:

The relative youth, geographical distribution, high co-morbidity prevalence and cultural needs of Aboriginal stroke patients with ACD should inform appropriate service design for speech pathology and rehabilitation. Innovative models are required to address workforce issues, given low patient volumes.

Introduction

In Australia, the Aboriginal and Torres Strait Islander population (hereafter Aboriginal; 3% of the population) has a 3-fold higher occurrence of stroke compared with other Australians.^{1, 2} Acquired communication disorders (**ACD**), including aphasia, dysarthria, cognitive communication disorder and apraxia of speech, are common consequences of stroke^{3, 4} but little is known about the extent of ACD in Aboriginal stroke survivors in Australia.

This study aims to estimate the extent and profile of ACD in Aboriginal and non-Aboriginal adult stroke survivors in Western Australia (WA) and investigate potential disparities in receiving in-hospital speech pathology services among survivors with ACD. It forms part of a mixed methods research project⁵ which aims to determine the impact of ACD on Aboriginal Australians.

Methods

All admissions to WA hospitals 2002-2012 in people aged 15-79 years with a discharge diagnosis of stroke or hemiplegia in any diagnosis field were extracted from administrative hospital records. Using the WA data linkage system⁶, all admissions and death records for these individuals going back 20 years were accessed to form a person-linked file of events to December 2012.

The first stroke admission in 2002-2011 was considered the index admission. Follow-up hospital admissions were collected to 31st December 2012. Patients discharged alive were retained for the main analysis.

Diagnostic codes for ACD recorded on index episode of care and during follow-up were identified from ICD-10 codes while Australian Classification of Health Interventions procedure codes captured whether any speech pathology interventions (**SPIs**), including assessments and therapeutic services, were undertaken during admission (Table 1 shows codes). Procedure codes are not specific to ACD.

Remoteness of residence was categorised using the Accessibility/Remoteness Index of Australia-Plus.⁷ The (area-level) Index of Relative Socio-economic Disadvantage⁸ was used to categorise cases into SES quintiles. The “Getting-Our-Story-Right” flag⁹ was used for defining Aboriginal status. A five-year look-back period was used to establish a history of prior (or current) admission for a range of chronic conditions and to calculate the Charlson Co-morbidity Index (**CCI**).¹⁰

Statistical methods

Patient characteristics were compared in three broad age-groups. Prevalence of stroke-related ACD and receipt of SPIs since index admission was estimated for 2011 as a proportion of stroke survivors 15-79 years still alive on 30 June 2011.

Univariate and multivariate binary logistic regression models were used to determine the characteristics influencing receipt of SPIs during the index episode in patients with an ACD diagnosis. Four additional regression analyses were run, restricted respectively to 1.incident; 2.uninsured; 3.rural; and 4.Indigenous patients.

Ethics approvals

Ethics approval was obtained from relevant Human Research Ethics Committees (WA Department of Health, Edith Cowan University, University of WA and WA Indigenous Health Ethics Committee).

Results

After excluding 2,475 deaths at index admission, 14,755 survivors (777 Indigenous, 5.3%; 69% principal stroke diagnosis) were included in the analysis (Figure 1).

Entire cohort of stroke survivors

Indigenous patients were significantly younger, more likely to be female and living in very remote and socio-economically disadvantaged areas than non-Indigenous patients (Table 1). Proportionally more Indigenous patients were admitted to regional or district hospitals and as emergency admissions. In each age-group, Indigenous patients had significantly higher mean CCI scores.

Across all ages, 43.7% of stroke survivors had SPI and 33% an ACD (22% aphasia/dysphasia) recorded. Recorded SPIs were similar for Indigenous and non-Indigenous patients aged 45-79 years, but higher in Indigenous patients 15-44 years ($p=0.013$). This appears to be driven by the significantly higher percentage of Indigenous aphasia/dysphasia recorded in this age-group (23% vs 14%; $p=0.023$). All-cause one-year readmissions and mortality were significantly higher in Indigenous patients in all age-groups (Table 2).

Comparison of Indigenous stroke survivors with and without ACD diagnosis or SPIs

Patients aged 15-44 years with speech-related codes were more likely to be male and less likely to be initially admitted to a tertiary hospital for their index admission (35% vs 54%) (Table 3). Over all ages, but particularly in older people, those with speech codes were less likely to be from very remote areas (45.9% vs 59.7%). Almost three quarters of patients 65-79 years were admitted to rural hospitals. Although numbers are small, the data suggest higher levels of discharge to residential care among those with speech-related codes and similar levels of discharges against medical advice (3.5% overall).

In the youngest age-group, a five-year history of drug and alcohol admission was significantly higher in those with a speech code. Mean length of stay was substantially longer in those with speech codes.

Prevalence estimates

Of 9,122 WA stroke patients aged 15-79 years alive at 30th June 2011, 2,432 (26.6%) people had been diagnosed with ACD. Aboriginal ACD cases (n=107; 4.4%) were substantially younger (Supplementary Figure S.1). Recorded speech-related codes were proportionally higher in non-Aboriginal prevalent cases overall and in all age-groups ≥ 45 years (Figure 2).

Determinants of having a SPI recorded among ACD patients

After adjustment, the strongest factors associated with no recorded SPIs were younger age, non-teaching metropolitan public and private hospitals, dementia and 2002-2006 period (Table 4). Having >1 ACD diagnosis, incident event, emergency admission, lack of health insurance, atrial fibrillation and hypertension were predictors of recorded SPIs. Having a subtype-specific stroke diagnosis increased the odds of having a speech procedure code more than two-fold. Aboriginal status was not a determinant of having SPI recorded.

Generally, the odds ratios from the models for restricted sub-cohorts were similar. There was no time period effect for Aboriginal patients.

Discussion

Notwithstanding variation and measurement error in administrative data, our data suggest similar levels of ACD in Aboriginal and non-Aboriginal stroke patients, with possible higher aphasia occurrence at younger ages. Very remote patients are under-represented among Aboriginal patients having speech codes. This may reflect poorer access to SP diagnostic and therapeutic options in rural hospitals with language/cultural issues challenging accurate diagnosis of ACD.

We found receipt of SPI among those with ACD diagnosis was not related to Aboriginal status, suggesting that if diagnosed, in-hospital access to some level of SP service is provided in WA hospitals irrespective of Aboriginality. However, many of the risk factors for not receiving services are more common in Aboriginal patients. Specified stroke type was strongly predictive of receiving SPI, likely reflecting the link between more intensive investigations (allowing sub-type to be identified) and referral to SP. Other studies strongly suggest disparities in speech/language assessment and services exist.^{11, 12} Audits of stroke hospitalisations identified Aboriginal patients as less likely to be assessed by speech pathologists within 48 hours than other Australians.¹² A qualitative study conducted in metropolitan WA found none of 13 Aboriginal ACD participants had received ongoing SPI after discharge from hospital.¹¹

The calculated prevalence of 107 Aboriginal people in WA with ACD in 2011 is likely to be an underestimate. However, this estimate provides a foundation for planning SP and associated services. The demographic and clinical profile of Aboriginal ACD patients, as found for heart disease¹³, needs consideration when designing SP services and indeed all stroke services for Aboriginal patients. Innovative models will be required to deal with the tyranny of distance from specialist centres, appropriate speech pathology workforce and assessment tools.

The strengths of this study include it being person- and population-based and the focus on an under-researched condition in an underserved population. However, our findings are based on un-validated administrative codes which may not accurately capture ACD and SPI, particularly across cultural and language differences. No validation studies for aphasia/ACD codes could be found in the literature; a hospital-based validation study of dysphagia¹⁴ found the codes to be relatively specific but insensitive. Despite the likely under-ascertainment of ACD cases, such codes have been used in the United States to estimate trends in incidence¹⁵ and costs associated with aphasia.¹⁶ In the current study, receipt of SPI in ACD cases also included services for dysphagia, so these estimates should be interpreted with caution.

Conclusion

Our estimates of case numbers should be considered minimum estimates of ACD in this case group. The relatively low numbers of Aboriginal stroke patients with ACD, their relative youth, higher burden of co-morbidities and more remote residency are challenges for SP/rehabilitation service design and workforce development. However, the data should inform the design of models to improve provision of appropriate SP services for Aboriginal Australians.

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Author Contributions

JMK conceptualised the study, directed the analysis and was the main contributor to the write-up. EA contributed to the design of the analysis, extracted and analysed the data, and reviewed the manuscript. All remaining authors contributed to the design of the overall study, the write-up and analysis of the results and the integration of the results into the objectives of the overall study. EMA, DH, NC and MM contributed specifically to the interpretation of data for speech pathology. JC, CH and DW additionally assisted with interpretation and integrity of the study from the Aboriginal cultural perspective. SCT and LF contributed to the quantitative integrity of the study design and analysis. All authors read and approved the final manuscript. EMA provides overall leadership of the Missing Voices project.

References

- 1.Katzenellenbogen JM, Vos T, Somerford P, et al. Burden of Stroke in Indigenous Western Australians A Study Using Data Linkage. *Stroke*. 2011;42:1515–21.
- 2.You J, Condon JR, Zhao Y, et al. Stroke incidence and case-fatality among Indigenous and non-Indigenous populations in the Northern Territory of Australia, 1999-2011. *Int J Stroke*. 2015;doi: 10.1111/ijss/ 12429.
- 3.Kauhanen ML, Korpelainen JT, Hiltunen P, et al. Aphasia, depression, and non-verbal cognitive impairment in ischaemic stroke. *Cerebrovascular Diseases*. 2006;10:455-61.
- 4.Landau J, Hissett J. Mild traumatic brain injury: Impact on identity and ambiguous loss in the in the family. *Families, Systems, & Health*. 2008;26(1):69–85.
- 5.Armstrong E, Hersh D, Katzenellenbogen JM, et al. Study Protocol: Missing Voices - Communication difficulties after stroke and traumatic brain injury in Aboriginal Australians. *Brain Impairment*. 2015;(in press).
- 6.Holman CD, Bass AJ, Rouse IL, et al. Population-based linkage of health records in Western Australia: development of a health services research linked database. *Aust NZ J Pub Health*. 1999;23(5):453-9.
- 7.Australia Institute of Health and Welfare. Rural, regional and remote health: a guide to remoteness classifications. Canberra: AIHW, 2004 AIHW Cat No PHE 53.
- 8.Australian Bureau of Statistics. Socio-Economic Indexes for Areas: Getting a Handle on Individual Diversity Within Areas Canberra: ABS, 2011 Cat. no. 1351.0.55.036.
- 9.Christensen D, Davis G, Draper G, et al. Evidence for the use of an algorithm in resolving inconsistent and missing Indigenous status in administrative data collections. *Aust J Soc Issues*. 2014;49(4):423-43.
- 10.Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care*. 2005;43(11):1130-9.
- 11.Armstrong E, Hersh D, Hayward C, et al. Communication disorders after stroke in Aboriginal Australians. *Disability & Rehabilitation*. 2014;doi:10.3109/09638288.2014.972581.
- 12.Killkenny MF, Harris DM, Ritchie EA, et al. Hospital management and outcomes of stroke in Indigenous Australians: evidence from the 2009 Acute Care National Stroke Audit. *Int J Stroke*. 2013;8(3):164-71.
- 13.Katzenellenbogen JM, Haynes E, Woods JA, et al. Information for Action: Improving the Heart Health Story for Aboriginal People in Western Australia Perth: WACRH, UWA, 2015.
- 14.Gonzalez-Fernandez M, Gardyn M, S. W, et al. Validation of ICD-9 Code 787.2 for Identification of Individuals with Dysphagia from Administrative Databases. *Dysphagia* 2009;24:398–402.
- 15.Ellisa C, Dismuke C, Edwards KK. Longitudinal trends in aphasia in the United States. *NeuroRehabil*. 2010;27: 327–33.
- 16.Ellis C, Simpson AN, Bonilha H, et al. The one-year attributable cost of poststroke aphasia. *Stroke*. 2012;43:1429-31.

Table 1: Characteristics of stroke survivors on index admission 2002-2011, by age-group and Aboriginal status

	15-44 years Total = 1400				45-64 years Total = 4821				65-79 years Total = 8534			
	non- Aboriginal	Aboriginal	p-value		non- Aboriginal	Aboriginal	p-value		non- Aboriginal	Aboriginal	p-value	
Total	1235	165			4439	382			8304	230		
Female, n (%)	596 (48.3)	88 (53.3)	0.2207		1621 (36.5)	175 (45.8)	0.0003		3368 (40.6)	117 (50.9)	0.0017	
Age, mean (SD)	35.1 (7.5)	35.8 (6.8)	0.2129		56.3 (5.5)	54.7 (5.4)	<.0001		73.0 (4.2)	70.8 (4.1)	<.0001	
First-ever cases, n (%)	1136 (92)	142 (86.1)	0.0113		3986 (89.8)	292 (76.4)	<.0001		6645 (80)	167 (72.6)	0.0040	
Principal diagnosis												
Stroke	859 (69.6)	115 (69.7)			3340 (75.2)	246 (64.4)			5471 (65.9)	134 (58.3)		
Other CVD	63 (5.1)	10 (6.1)	0.8490		232 (5.2)	21 (5.5)	<.0001		563 (6.8)	10 (4.3)	0.0023	
Other	313 (25.3)	40 (24.2)			867 (19.5)	115 (30.1)			2270 (27.3)	86 (37.4)		
Stroke sub-type (ICD-10 code)												
Ischaemic (I63)	455 (36.8)	54 (32.7)			2094 (47.2)	120 (31.4)			3795 (45.7)	58 (25.2)		
Haemorrhagic (I60, I61)	492 (39.8)	42 (25.5)	<.0001		1038 (23.4)	53 (13.9)	<.0001		994 (12)	13 (5.7)	<.0001	
Unspecified/old stroke (I64, I69)	288 (23.3)	69 (41.8)			1307 (29.4)	209 (54.7)			3515 (42.3)	159 (69.1)		
Communication disorder indicators on index episode (ICD-10 code)												
Aphasia/dysphasia (R47.0)	175 (14.2)	38 (23)	0.0029		909 (20.5)	70 (18.3)	0.3155		1963 (23.6)	44 (19.1)	0.1117	
Dysarthria/anarthria (R47.1)	101 (8.2)	18 (10.9)	0.2374		508 (11.4)	31 (8.1)	0.0476		954 (11.5)	22 (9.6)	0.3660	
Other speech disorders (R47.8)	47 (3.8)	*	0.1963		184 (4.1)	15 (3.9)	0.8369		344 (4.1)	9 (3.9)	0.8631	
Apraxia (R47.2)	5 (0.4)	0 (0)	-		19 (0.4)	0 (0)	-		29 (0.3)	0 (0)	-	
Any ACD diagnosis (any codes above)	291 (23.6)	47 (28.5)	0.1653		1410 (31.8)	106 (27.7)	0.1048		2912 (35.1)	67 (29.1)	0.0624	
Speech procedure code**	362 (29.3)	64 (38.8)	0.0130		1885 (42.5)	152 (39.8)	0.3100		3887 (46.8)	105 (45.7)	0.7288	
ACD diagnosis or any speech procedure	449 (36.4)	75 (45.5)	0.0233		2208 (49.7)	181 (47.4)	0.3763		4596 (55.3)	125 (54.3)	0.7637	
Charlson comorbidity score, mean (SD)	0.38 (1.03)	0.89 (1.57)	<.0001		0.61 (1.37)	1.63 (2.07)	<.0001		1.18 (1.85)	1.97 (2.38)	<.0001	
Charlson category												
Score = 0	1016 (82.3)	96 (58.2)			3287 (74)	153 (40.1)			4560 (54.9)	89 (38.7)		
Score = 1 or 2	149 (12.1)	49 (29.7)	<.0001		763 (17.2)	134 (35.1)	<.0001		2216 (26.7)	65 (28.3)	<.0001	
Score = 3	38 (3.1)	8 (4.8)			174 (3.9)	28 (7.3)			630 (7.6)	22 (9.6)		
Score >3	32 (2.6)	12 (7.3)			215 (4.8)	68 (17.8)			898 (10.8)	54 (23.5)		

Metropolitan/rural residence

Highly accessible/Metropolitan	617	(50)	39	(23.6)		2342	(52.8)	77	(20.2)		4671	(56.3)	31	(13.5)	
Accessible	383	(31)	19	(11.5)		1370	(30.9)	37	(9.7)		2573	(31)	31	(13.5)	
Moderately accessible	124	(10)	27	(16.4)	<.0001	409	(9.2)	53	(13.9)	<.0001	717	(8.6)	29	(12.6)	<.0001
Remote	17	(1.4)	*			105	(2.4)	12	(3.1)		161	(1.9)	5	(2.2)	
Very remote	92	(7.4)	75	(45.5)		200	(4.5)	203	(53.1)		160	(1.9)	134	(58.3)	
Socioeconomic disadvantage (SEIFA quartiles)															
Most disadvantaged Q1	100	(8.1)	70	(42.4)		289	(6.5)	185	(48.4)		530	(6.4)	116	(50.4)	
Q2	158	(12.8)	17	(10.3)		732	(16.5)	43	(11.3)		1390	(16.7)	20	(8.7)	
Q3	182	(14.7)	25	(15.2)	<.0001	646	(14.6)	51	(13.4)	<.0001	1206	(14.5)	33	(14.3)	<.0001
Q4	307	(24.9)	27	(16.4)		1190	(26.8)	53	(13.9)		2030	(24.4)	31	(13.5)	
Least disadvantaged Q5	486	(39.4)	25	(15.2)		1569	(35.3)	50	(13.1)		3126	(37.6)	30	(13)	
Hospital category (index-admission)															
Tertiary	827	(67)	75	(45.5)		2695	(60.7)	131	(34.3)		4404	(53)	42	(18.3)	
Public Metropolitan	61	(4.9)	7	(4.2)		317	(7.1)	10	(2.6)		957	(11.5)	13	(5.7)	
Public Regional	77	(6.2)	48	(29.1)	—	345	(7.8)	78	(20.4)	—	626	(7.5)	59	(25.7)	—
Public District	123	(10)	34	(20.6)		370	(8.3)	160	(41.9)		590	(7.1)	108	(47)	
Private	147	(11.9)	*			709	(16)	*			1719	(20.7)	8	(3.5)	
Other	0	(0)	0	(0)		*	(0.1)	0	(0)		8	(0.1)	0	(0)	
Emergency admissions , n (%)	1098	(88.9)	154	(93.3)	0.0824	3913	(88.2)	352	(92.1)	0.0190	7128	(85.8)	209	(90.9)	0.0302
Patients with no private health insurance	979	(79.3)	162	(98.2)		3309	(74.5)	375	(98.2)		6012	(72.4)	227	(98.7)	
Episode length of stay, median (LQ,UQ)	10	(4,27)	12	(5,38)		11	(5,33)	13	(5,35)		14	(5,39)	12	(6,34)	

*cell size<5

** Speech procedure codes: speech rehabilitation ICD-10 Z50.5, other speech procedures 96012-00, 96014-00, 96135-00, 96137-00, 96110-00, 96113-00, 96114-00, 95550-05.

Table 2: One-year outcomes of stroke patients surviving their index admission 2002-2011, by age-group and Aboriginal status

	15-44 years					45-64 years					65-79 years				
	non-Aboriginal n=1,235		Aboriginal n=165		p-value	non-Aboriginal n=4,439		Aboriginal n=382		p-value	non-Aboriginal n=8,304		Aboriginal n=230		p-value
Total															
Readmission (any cause)	652	(52.8)	103	(62.4)	0.0198	2272	(51.2)	235	(61.5)	0.0001	4746	(57.2)	158	(68.7)	0.0005
Readmission (acute stroke)*	68	(5.5)	11	(6.7)	0.544	253	(5.7)	26	(6.8)	0.374	439	(5.3)	18	(7.8)	0.0915
New hospital ACD diagnosis	9	(0.7)	*	(1.8)	0.125	75	(1.7)	9	(2.4)	0.4316	175	(2.1)	*	(1.3)	0.3136
Repeat hospital ACD diagnosis (of total)	31	(2.5)	*	(1.8)	0.3766	156	(3.5)	14	(3.7)	0.4881	386	(4.6)	17	(7.4)	0.0039
Repeat hospital ACD diagnosis (of readmitted)	31	(4.8)	*	(2.9)		156	(6.9)	14	(6)		386	(8.1)	17	(10.8)	
Repeat speech procedure (of total)	22	(1.8)	5	(3)	0.5994	150	(3.4)	16	(4.2)	0.2655	501	(6)	16	(7)	0.4793
Repeat speech procedure (of readmitted)	22	(3.4)	5	(4.9)		150	(6.6)	16	(6.8)		501	(10.6)	16	(10.1)	
Mortality	32	(2.6)	10	(6.1)	0.0141	244	(5.5)	37	(9.7)	0.0008	951	(11.5)	41	(17.8)	0.0029

*cell size<5

Table 3: Characteristics and comorbidity history for Aboriginal patients with and without a record of speech pathology intervention or diagnosis on index episode of care

	Aboriginal, 15-44 years					Aboriginal, 45-64 years					Aboriginal, 65-79 years				
	ACD diagnosis or speech procedure					ACD diagnosis or speech procedure					ACD diagnosis or speech procedure				
	yes <i>n</i> =75		no <i>n</i> =90		<i>p</i> -value **	yes <i>n</i> =182		no <i>n</i> =201		<i>p</i> -value **	yes <i>n</i> =126		no <i>n</i> =105		<i>p</i> -value **
Age, Mean (SD)	37.1 (5.9)		34.8 (7.4)		0.032	55.1 (5.4)		54.4 (5.4)		0.198	70.7 (4.1)		70.9 (4.2)		0.634
Male, n (%)	42 (56)		35 (38.9)		0.028	99 (54.7)		108 (53.7)		0.850	63 (50)		50 (47.6)		0.674
First-ever stroke	68 (90.7)		74 (82.2)		0.119	155 (85.6)		137 (68.2)		<.0001	96 (76.8)		71 (67.6)		0.120
Stroke sub-type															
Ischaemic	29 (38.7)		25 (27.8)		0.213	75 (41.4)		45 (22.4)		<.0001	41 (32.8)		17 (16.2)		0.014
Haemorrhagic	15 (20)		27 (30)			30 (16.6)		23 (11.4)			7 (5.6)		6 (5.7)		
Unspecified/old stroke	31 (41.3)		38 (42.2)			76 (42)		133 (66.2)			77 (61.6)		82 (78.1)		
Accessibility and remoteness															
Major Cities Australia	14 (18.7)		25 (27.8)		0.102	45 (24.9)		32 (15.9)		0.075	15 (11.9)		16 (15.2)		0.081
Inner Regional Australia	11 (14.7)		8 (8.9)			20 (11)		17 (8.5)			21 (16.7)		10 (9.5)		
Outer Regional Australia	13 (17.3)		14 (15.6)			26 (14.4)		27 (13.4)			21 (16.7)		8 (7.6)		
Remote Australia	*		0 (0)			7 (3.9)		5 (2.5)			*		*		
Very Remote Australia	32 (42.7)		43 (47.8)			83 (45.9)		120 (59.7)			66 (52.4)		68 (64.8)		
Hospital category (index admission)															
Tertiary	26 (34.7)		49 (54.4)		—	71 (39.2)		60 (29.9)		—	22 (17.5)		20 (19)		0.264
Public Metropolitan	*		*			5 (2.8)		5 (2.5)			7 (5.6)		6 (5.7)		
Public Regional	26 (34.7)		22 (24.4)			41 (22.7)		38 (18.9)			39 (31)		20 (19)		
Public District	20 (26.7)		14 (15.6)			62 (34.3)		98 (48.8)			52 (41.3)		56 (53.3)		
Private	0 (0)		*			*		0 (0)			5 (4)		*		
Emergency admissions	72 (96)		82 (91.1)		0.210	178 (98.3)		175 (87.1)		<.0001	119 (94.4)		90 (85.7)		0.013
Discharge type (index episode)															
Home, usual residence	63 (84)		78 (86.7)		—	149 (81.9)		176 (87.6)		—	94 (74.6)		89 (84.8)		—
Nursing home/aged care	5 (6.7)		*			20 (11)		6 (3)			25 (19.8)		8 (7.6)		

Discharged AMA	*	5 (5.6)		7 (3.8)	8 (4)		2 (1.6)	*		
Other	4 (5.3)	6 (6.7)		5 (2.7)	11 (5.5)		4 (3.2)	6 (5.7)		
Episode LOS (LQ, UQ)	24 (8,72)	8 (4,18)		29 (8,64)	7 (3,16)		19 (7,49)	8 (4,20)		
History co-morbidities										
Atrial fibrillation	7 (9.3)	*	—	25 (13.8)	18 (9)	0.134	27 (21.4)	17 (16.2)	0.299	
Heart failure	6 (8)	7 (7.8)	0.958	22 (12.2)	31 (15.4)	0.356	20 (15.9)	28 (26.7)	0.047	
Hypertension	43 (57.3)	35 (38.9)	0.018	133 (73.5)	115 (57.2)	0.001	87 (69)	73 (69.5)	0.990	
Diabetes	27 (36)	29 (32.2)	0.610	113 (62.4)	118 (58.7)	0.457	70 (55.6)	70 (66.7)	0.099	
Kidney disease	13 (17.3)	18 (20)	0.662	46 (25.4)	49 (24.4)	0.815	22 (17.5)	27 (25.7)	0.134	
Alcohol and drug	41 (54.7)	33 (36.7)	0.021	54 (29.8)	73 (36.3)	0.179	27 (21.4)	25 (23.8)	0.690	
Mental health	13 (17.3)	13 (14.4)	0.612	17 (9.4)	23 (11.4)	0.513	10 (7.9)	17 (16.2)	0.055	
Dementia	0 (0)	0 (0)	—	*	5 (2.5)	—	21 (16.7)	19 (18.1)	0.796	
COPD	*	9 (10)	0.060	14 (7.7)	27 (13.4)	0.072	18 (14.3)	22 (21)	0.192	
Cancer	0 (0)	*	—	7 (3.9)	8 (4)	0.955	12 (9.5)	*	0.086	
Coronary heart disease	7 (9.3)	12 (13.3)	0.423	36 (19.9)	35 (17.4)	0.534	25 (19.8)	23 (21.9)	0.723	
Charlson score, mean (SD)	0.99 (1.6)	0.81 (1.6)	0.477	1.31 (1.8)	1.92 (2.2)	0.004	1.67 (2.1)	2.32 (2.6)	0.042	
Charlson category										
Score = 0	38 (50.7)	58 (64.4)		81 (44.8)	72 (35.8)		56 (44.4)	33 (31.4)		
Score = 1 or 2	28 (37.3)	21 (23.3)	—	70 (38.7)	64 (31.8)	0.003	33 (26.2)	32 (30.5)	0.211	
Score = 3	*	*		6 (3.3)	22 (10.9)		10 (7.9)	12 (11.4)		
Score >3	5 (6.7)	7 (7.8)		24 (13.3)	43 (21.4)		26 (20.6)	28 (26.7)		

*cell size<5

** Bold p-values reflect significant differences where p<0.05

Table 4: Determinants of stroke survivors with an ACD diagnosis receiving a speech procedure or intervention during their index admission

		Full cohort n=4,852 events=3,660				Incident cases only n=4,270 events=3374		Public patients only n=3,703 events=2,872		Rural hospitals only n=727 events=559		Aboriginal only n=220 events=160	
		Crude OR	(95% CI)	Adj OR	(95% CI)	Adj OR	(95% CI)	Adj OR	(95% CI)	Adj OR	(95% CI)	Adj OR	(95% CI)
Aboriginal status	Aboriginal	0.86	(0.64-1.17)	0.91	(0.6-1.3)	1.13	(0.7-1.7)	0.90	(0.6-1.3)	0.72	(0.4-1.2)	—	
	non-Aboriginal	1.00		1.00		1.00		1.00		1.00		—	
Sex	Male	1.00	(0.87-1.14)	0.97	(0.8-1.1)	1.02	(0.9-1.2)	1.01	(0.8-1.2)	1.28	(0.9-1.9)	1.03	(0.5-2.2)
	Female	1.00		1.00		1.00		1.00		1.00		1.00	
Age-group	15-44 years	0.78	(0.61-0.99)	0.55	(0.4-0.7)	0.55	(0.4-0.7)	0.58	(0.4-0.8)	0.56	(0.3-1.1)	0.80	(0.3-2.4)
	45-64 years	1.07	(0.93-1.24)	0.83	(0.7-.98)	0.84	(0.7-1.01)	0.83	(0.7-1.01)	0.74	(0.5-1.2)	0.66	(0.3-1.6)
	65-79 years	1.00		1.00		1.00		1.00		1.00		1.00	
Incident case	Incident	3.90	(3.26-4.66)	2.33	(1.9-2.9)	n/a		2.27	(1.05-1.6)	2.42	(1.4-4.1)	4.78	(1.9-12)
	Recurrent/ readmission	1.00		1.00				1.00		1.00		1.00	
Stroke sub-type	Ischaemic	3.35	(2.9-3.87)	2.33	(1.9-2.9)	2.14	(1.8-2.6)	2.70	(2.2-3.3)	2.84	(1.7-4.6)	4.96	(1.9-13.2)
	Haemorrhagic	4.11	(3.28-5.15)	2.51	(2.1-3)	2.50	(1.9-3.3)	3.16	(2.4-4.3)	4.05	(2-8.4)	4.66	(1.1-20.2)
	Unspecified/ old stroke	1.00		1.00		1.00		1.00		1.00		1.00	
Hospital type	District	0.65	(0.51-0.83)	1.15	(0.9-1.5)	0.96	(0.7-1.3)	1.21	(0.9-1.6)	1.05	(0.7-1.6)	1.35	(0.5-3.7)
	Regional	1.03	(0.78-1.36)	1.12	(0.8-1.5)	1.13	(0.8-1.6)	1.14	(0.8-1.6)	1.00		0.44	(0.2-1.2)
	Metro public	0.38	(0.32-0.45)	0.55	(0.4-0.7)	0.64	(0.5-0.8)	0.67	(0.5-0.9)	—		1.57	(0.2-13)
	Private	0.46	(0.37-0.58)	0.61	(0.5-0.8)	0.50	(0.4-0.6)	0.59	(0.5-0.8)	—		1.40	(0.1-19)
	Tertiary	1.00		1.00		1.00		1.00		—		1.00	
Admission type	Emergency	2.38	(1.37-1.83)	1.41	(1.1-1.8)	1.37	(1.04-1.8)	1.37	(0.97-1.9)	2.30	(1.1-4.8)	4.85	(1.03-23)
	Booked	1.00		1.00		1.00		1.00		1.00		1.00	
Health insurance	Public	1.58	(1.37-1.83)	1.53	(1.3-1.8)	1.49	(1.2-1.8)	n/a		1.54	(0.8-3.1)	—	
	Private	1.00		1.00		1.00		1.00		1.00		—	

Comorbidities	Atrial fibrillation	1.33	(1.12-1.59)	1.27	(1.1-1.6)	1.37	(1.1-1.7)	1.30	(1.03-1.7)	1.30	(0.8-2.2)	1.55	(0.6-4.3)
	No Atrial fibrillation	1.00		1.00		1.00		1.00		1.00		1.00	
	Hypertension	1.30	(1.14-1.49)	1.22	(1.1-1.4)	1.18	(0.99-1.4)	1.26	(1.05-1.5)	0.99	(0.6-1.5)	1.63	(0.6-4.2)
	no Hypertension	1.00		1.00		1.00		1.00		1.00		1.00	
	Diabetes	0.90	(0.77-1.04)	0.89	(0.7-1.1)	1.18	(0.99-1.4)	0.91	(0.7-1.1)	1.02	(0.6-1.6)	1.33	(0.5-3.2)
	no Diabetes	1.00		1.00		1.00		1.00		1.00		1.00	
	Dementia	0.41	(0.31-0.54)	0.65	(0.5-0.9)	0.63	(0.4-0.9)	0.55	(0.4-0.8)	0.39	(0.2-1.01)	0.61	(0.1-3.6)
Speech diagnosis	no Dementia	1.00		1.00		1.00		1.00		1.00		1.00	
	>1 ACD diagnosis	3.93	(2.9-5.31)	3.32	(2.4-4.5)	2.97	(2.1-4.2)	3.22	(2.2-4.6)	2.48	(1.2-5.3)	5.10	(0.97-27)
	Dysarthria only	1.33	(1.12-1.57)	1.17	(.97-1.4)	1.06	(0.9-1.3)	1.30	(1.05-1.6)	1.19	(0.7-2)	1.06	(0.4-2.8)
	Apraxia or other	0.42	(0.34-0.51)	0.39	(0.3-0.5)	0.37	(0.3-0.5)	0.44	(0.3-0.6)	0.43	(0.2-0.7)	0.30	(0.1-1.02)
	Dysphasia only	1.00		1.00		1.00		1.00		1.00		1.00	
Study Period	2002-2006	0.53	(0.47-0.61)	0.71	(0.6-0.8)	0.71	(0.6-0.8)	0.72	(0.6-0.9)	0.89	(0.6-1.3)	0.99	(0.5-2.2)
	2007-2011	1.00		1.00		1.00		1.00		1.00		1.00	

OR=Odds ratio; 95% CI=95% confidence interval; ACD Acquired Communication Disorder

Figure 1: Flow chart of stroke patients admitted to WA hospitals 2002-2011 with respect to acquired communication disorder and speech procedures, by Aboriginal status

Figure 2: Prevalence of acquired communication disorder (ACD) in stroke survivors alive at 30 June 2011

a) Age-specific ACD as a percentage of stroke survivors, by Aboriginal status and sex

b) Percentage of prevalent stroke cases with coded ACD diagnosis and/or speech procedure, by age and Aboriginal status

Supplementary Figure S.1: Age and sex profile of prevalent stroke survivors with acquired communication disorders in Western Australia as at 30 June 2011, by Aboriginal status