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Feature

Disparities in equity and access for hospitalised atherothrombotic disease

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Abstract

Objective. This study of equity and access characterises admissions for coronary, cerebrovascular and peripheral arterial disease by hospital type (rural, tertiary and non-tertiary metropolitan) in a representative Australian population.

Methods. We conducted a descriptive analysis using data linkage of all residents aged 35–84 years hospitalised in Western Australia with a primary diagnosis for an atherothrombotic event in 2007. We compared sociodemographic and clinical features by atherothrombotic territory and hospital type.

Results. There were 11 670 index admissions for atherothrombotic disease in 2007 of which 46% were in tertiary hospitals, 41% were in non-tertiary metropolitan hospitals and 13% were in rural hospitals. Coronary heart disease comprised 72% of admissions, followed by cerebrovascular disease (19%) and peripheral arterial disease (9%). Comparisons of socioeconomic disadvantage reveal that for those admitted to rural hospitals, more than one-third were in the most disadvantaged quintile, compared with one-fifth to any metropolitan hospital.

Conclusions. Significant differences in demographic characteristics were evident between Western Australian tertiary and non-tertiary hospitals for patients hospitalised for atherothrombotic disease. Notably, the differences among tertiary, non-tertiary metropolitan and rural hospitals were related to socioeconomic disadvantage. This has implications for atherothrombotic healthcare provision and the generalisation of research findings from studies conducted exclusively in the tertiary metropolitan hospitals.

What is known about the topic? Equity and access to hospital care for atherothrombotic disease in a geographically diverse population is poorly characterised. National data show that both fatal and non-fatal coronary heart disease and non-fatal stroke hospitalisations increase with remoteness. Fatal in-hospital stroke is greatest in major cities, whereas peripheral arterial disease hospitalisations are greatest in the inner and outer regional areas.

What does this paper add? This study demonstrates that around 13% of atherothrombotic events were treated in rural hospitals with in-hospital case fatality higher than in tertiary and non-tertiary metropolitan hospitals. A greater proportion of atherothrombotic disease cases treated in rural hospitals were in the most disadvantaged Socioeconomic Indices For Area group.

What are the implications for practitioners? It is important to consider differences in disadvantage when generalising results of studies generated from tertiary hospital data to non-tertiary metropolitan and rural patients.

Additional keywords: cardiovascular disease, coronary heart disease, hospital, peripheral vascular disease, stroke, Western Australia.

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Introduction

Ischaemic cardiovascular or atherothrombotic disease (ATD), involving the coronary, cerebral and peripheral arterial territories, is a leading national health priority in Australia. It is a dominant cause of death accounting for 32% of national statistics in 2010[1] and is more costly than any other single disease.[2] In 2009–10, $7.9 billion was spent on all cardiovascular disease (CVD), approximately half of which was for hospitalisations.[2] In 2007 in Western Australia's (WA's) population of 2.1 million (10% of the Australian population), 68 000 people were estimated to have CVD,[3] with the prevalence increasing with geographic remoteness.[4] This latter pattern is reflected in the age-standardised national hospitalisation and death rates for coronary heart disease (CHD), and for hospitalisations for cerebrovascular disease (CeVD) and peripheral arterial disease (PAD).[4]

Equity and access to urban versus non-urban hospitals for ATD care at a population level is poorly understood. Provision of hospital services is typically measured around presentation to large metropolitan tertiary teaching hospitals, which could limit the generalisability of the findings. Further, there is poor socio-demographic and clinical characterisation stratified by hospital services and locality of patients admitted with ischaemic CVD. The authors have not found descriptions of all ATD hospitalisations by metropolitan or rurality in other jurisdictions nationally and internationally. The objective of the present study was to characterise admissions for an atherothrombotic event in the major arterial territories among men and women aged 35–84 years to tertiary, non-tertiary metropolitan and rural hospitals in WA during 2007.

Methods

Design

This study was a descriptive analysis of a cohort identified using administrative health data linkage. The cohort consisted of all residents aged 35–84 years hospitalised in WA with a primary diagnosis for ATD identified from International Classification of Disease codes in 2007 (Table 1).

In Perth, acute health services are provided by three large public tertiary hospitals and a mix of public and private metropolitan hospitals. Hospital services in rural (inner and outer regional, remote and very remote) WA are mostly public, with a private hospital in each of the three larger regional cities of Geraldton (430 km from Perth), Bunbury (170 km from Perth) and Mandurah (70 km from Perth). The WA population is considered representative of the Australian population in terms of socioeconomic and demographic characteristics.[5] Approval for this study was obtained from the Human Research Ethics Committees at the WA Department of Health and The University of Western Australia.

Dataset

The dataset used for this study was obtained from the Hospital Morbidity Data Collection (HMDC) and death registrations. The HMDC is a collection of data from all public and private hospitals in WA managed by the WA Data Linkage System (WADLS).[6] Death registrations included only deaths registered in WA. Linkage of administrative health data was performed by the Data Linkage Branch at the Department of Health, WA using probabilistic matching with clerical review, with linkage accuracy estimated at 99.89%.[7]

Index admission was defined as the patient's first ATD hospitalisation in WA in 2007. Comparisons by arterial territory were only for the index admission. For example, a person whose index admission in 2007 was an acute myocardial infarction was only included in the CHD category, even if they had a history before 2007 of PAD, CeVD or CHD. The disease categories for index admissions were mutually exclusive.

Comorbidity was measured individually and grouped for comparative purposes. First, we considered the presence or absence of diabetes, hypertension, chronic kidney disease, atrial fibrillation, heart failure, chronic lung disease and cancer in any one of 21 diagnostic fields for any hospitalisation during the preceding 15 years of the index ATD presentation. The International Classification of Disease codes that identify these conditions are listed in Table 1. These categories were not mutually exclusive. We then used the enhanced Deyo Charlson comorbidity score,[8,9] with comorbidities identified from and of the 21 diagnostic fields during the preceding 10 years.

In-hospital case fatality was identified where the date of death was the same as the discharge date. Out-of-hospital case fatality was defined as a death occurring within 28 days from the index admission discharge date. Total case fatality was the sum of in-hospital and out-of-hospital 28-day case fatality.

Hospital types were classified as rural or tertiary according to the relevant field in the HMDC. Non-tertiary metropolitan sites included both smaller public and private metropolitan hospitals. An episode of care referred to the period from when a person first entered the hospital system until they left the hospital system. This may be an admission and discharge from the same hospital, or a contiguous set of transfers among hospitals. As transfers may occur between different hospital types, the first hospital in the sequence was used for the comparisons in this study.

Table 1. International Classification of Disease (ICD) codes used to identify atherothrombotic disease events and major comorbidity

Disease	ICD 10-AM	ICD 9/ICD 9-CM
Coronary heart disease	I20–I25	–
Cerebrovascular disease	I61, I63, I64, I65, I66, I69, G45	–
Peripheral arterial disease	I70, I73.1, I73.9, I77.1	–
Hypertension	I10–I15	401–405
Diabetes	E10–E14	250
Chronic kidney disease	N00–N08, N11, N12, N14–N16, N18, N19, N25–N28, N39.1, N39.2, Q60–63, T82.4, V56.0, V56.8, V42.0, V45.1, Z49, Z94.0, Z99.2	580, 581.0, 581.1, 581.2, 581.3, 581.89, 582, 583, 585–590, 593.0, 593.1, 593.2, 593.6, 593.81, 593.82, 593.89, 593.9, 599.7, 753.0–753.4, 996.1
Atrial fibrillation	I48	427.3
Heart failure	I50	428
Chronic lung disease	J40–J47	490–496
Cancer	C00–D48	140–239

The WADLS provides an Accessibility/Remoteness Index for Australia (ARIA+) to each admission based on distance by road to reach service centres.[10] Residence at the time of hospitalisation was categorised as: major city, inner regional, outer regional, remote or very remote. ARIA+ rating was determined from the Collection District (CD), which was the smallest geographical unit based on the 2006 Census of Population and Housing data, which included ~220 dwellings in urban areas. Where CD was not available, the Statistical Local Area (SLA), which comprised a group of CD, was the next largest unit. Local Government Area (LGA) was the largest unit, comprising several SLA. Almost 90% (n = 10 469) of the sample had CD-level ARIA+ data. Of those remaining, 587 had SLA-level data and another 21 had LGA-level ARIA+ data, giving a total sample of 11 077 (94.9%). ARIA+ determinations were missing for 593 (5%) patients spread equally across hospital type; 214 from tertiary hospitals, 184 from non-tertiary metropolitan hospitals and 195 from rural hospitals.

Socioeconomic disadvantage was determined using the Socioeconomic Indices For Area (SEIFA) disadvantage score assigned by the WADLS at index admission. SEIFA disadvantage scores are an area-level measure based on census data relating to income, education, unemployment and motor vehicle ownership.[11] These scores are ranked and pooled into deciles, and were grouped into quintiles for this analysis. SEIFA data at the CD level were available for 89% (n = 10 392) of the study sample; of the remaining 11% (n = 1278), 664 had SLA-level data and 21 had only LGA-level data. The same 593 people who were missing ARIA+ were unable to be assigned SEIFA disadvantage data and were also excluded from comparisons of SEIFA.

Statistical methods

Three-way comparisons of the index ATD admission at tertiary, non-tertiary metropolitan and rural hospitals are presented. ANOVA was used for comparison of mean age and the non-parametric one-way test (Kruskal–Wallis Test) for episode length of stay. Chi-square tests were used for determining differences in categorical variables. Univariate and multivariate binary logistic regression models were used to determine the characteristics that influence admission to a tertiary hospital in metropolitan hospital patients. Analysis was conducted using SAS software, Version 9.3 of the SAS System for Windows.[12]

Results

There were 11 670 index admissions for ATD in 2007 of which 45.5% were in tertiary hospitals, 41.1% in non-tertiary metropolitan hospitals (of which 87% were to private hospitals) and 13.4% to rural hospitals (Table 2). Mean age on admission across all arterial territories was 66.3 (±11.5) years. Two-thirds of admissions for all ATD occurred in men. Almost 28% (n = 3252) of index admissions were same-day admissions. These made up 25% of tertiary, 33% of non-tertiary metropolitan and 22% of rural hospital index admissions. Approximately 19% of index admissions were followed by an inter-hospital transfer.

Comparisons of SEIFA rankings revealed that, for those admitted to rural hospitals, more than one-third were in the most disadvantaged quintile, compared with one-quarter admitted to tertiary hospitals and less than 16% to non-tertiary metropolitan hospitals. Conversely, far fewer admissions in the least-disadvantaged quintile occurred in rural hospitals compared with metropolitan hospitals combined (5% versus 21%).

Index admissions in males for ATD were dominated by CHD (Table 3). In women, although CHD still comprised the largest proportion of index admissions to hospital, there was a greater proportion of CeVD. A greater proportion of CeVD admissions were in rural hospitals for both men and women (28.2% and 36.1% respectively) compared with the metropolitan hospitals.

Table 2. Rural hospitals and other hospitals: sociodemographic characteristics

Characteristic	Rural hospitals n = 1558	Metropolitan hospitals		P-value[A]
		Tertiary n = 5310	Non-tertiary n = 4802	
Mean age (years)	64.2 (s.d. 12.9)	65.8 (s.d. 11.7)	67.7 (s.d. 10.7)	<0.001
Male (n)	996 (63.9%)	3459 (65.1%)	3253 (67.7%)	0.0037
Episode length of stay (median)	4 (min. 1, max. 357)	2 (min. 1, max. 267)	1 (min. 1, max. 176)	<0.001
Charlson comorbidity score (mean)	0.7 (s.d. 1.3)	0.7 (s.d. 1.4)	0.6 (s.d. 1.2)	<0.001
Accessibility and remoteness[B] (n)				
Major city	62 (4.6%)	4282 (84.0%)	3556 (77.0%)	
Inner regional	394 (28.9%)	513 (10.1%)	757 (16.4%)	
Outer regional	589 (43.2%)	194 (3.8%)	220 (4.8%)	
Remote	222 (16.3%)	69 (1.4%)	63 (1.4%)	
Very remote	96 (7.0%)	38 (0.8%)	22 (0.5%)	<0.001
Western Australian Socioeconomic Indices For Area (disadvantage)[B] (n)				
Q1 (most disadvantaged)	507 (37.2%)	1273 (25.0%)	718 (15.6%)	
Q2	371 (27.2%)	1163 (22.8%)	879 (19.0%)	
Q3	227 (16.6%)	1068 (21.0%)	912 (19.8%)	
Q4	186 (13.6%)	813 (16.0%)	877 (19.0%)	
Q5 (least disadvantaged)	72 (5.3%)	779 (15.3%)	1232 (26.7%)	<0.001

[A] ANOVA was used for comparison of mean age. Kruskal–Wallis test was used for comparison of episode length of stay. Chi-square test was used for comparison of proportion of males, proportions in categories of accessibility and remoteness, and proportions in categories of disadvantage.

[B] Five hundred and ninety-three patients (195 from rural hospitals, 214 from tertiary hospitals and 184 from non-tertiary metropolitan hospitals) were missing accessibility and disadvantage data and were not included in comparisons.

Table 3. Rural hospitals and other hospitals: comparisons by vascular territory, comorbidities and deaths, stratified by sex

Atherothrombotic disease type	Rural hospitals $n = 1558$ female = 562 (36%) male = 996*n*		Metropolitan hospitals Tertiary $n = 5310$ female = 1851 (35%) male = 3459		Metropolitan hospitals Non-tertiary $n = 4802$ female = 1549 (32%) male = 3253		*P*-value[A]
	n	%	*n*	%	*n*	%	
Coronary heart disease							0.001
Females	351	62.5	1280	69.2	1045	67.5	
Males	706	70.9	2587	74.8	2392	273.5	
Cerebrovascular disease							<0.001
Females	203	36.1	458	24.7	265	17.1	
Males	281	28.2	649	18.8	389	12.0	
Peripheral arterial disease							<0.001
Females	8	1.4	113 (6.1)	6.1	239	15.4	
Males	9	0.9	223 (6.4)	6.4	472	14.5	
Comorbidities							
Hypertension							<0.001
Females	334	59.4	1261	68.1	999	64.5	
Males	551	55.3	2137	61.8	1906	158.6	
Diabetes							<0.001
Females	172	30.6	554	29.9	359	23.2	
Males	262	26.3	869	25.1	745	22.9	
Chronic kidney disease							<0.001
Females	76	13.5	234	12.6	143	9.2	
Males	112	11.2	416	12.0	326	10.0	
Atrial fibrillation							0.338
Females	94	16.7	325	17.6	251	16.2	
Males	179	18.0	530	15.3	517	15.9	
Heart failure							<0.001
Females	102	18.2	292	15.8	186	12.0	
Males	149	15.0	450	13.0	314	9.6	
Chronic lung disease							<0.001
Females	108	19.2	277	15.0	224	14.5	
Males	147	14.8	385	11.1	302	9.3	
Cancer							<0.001
Females	179	31.8	544	29.4	541	34.9	
Males	232	23.3	875	25.3	1106	34.0	
Deaths							
In-hospital case fatality							<0.001
Females	40	7.1	83	4.5	31	2.0	
Males	60	6.0	113	3.3	47	1.4	
28-day out-of-hospital case fatality[B]	11	0.7	28	0.5	22	0.5	0.498
Total case fatality	111	7.1	224	4.2	100	2.1	<0.001

[A]Chi-square test was used for all comparisons in this table.
[B]Out-of-hospital case fatality and total case fatality are not presented by sex due to the low frequency of out-of-hospital case fatality.

A higher proportion of PAD patients were admitted to non-tertiary metropolitan hospitals compared with other hospital types.

Differences in the history of major comorbidity and affected arterial territory by sex and hospital type are shown in Table 3. Hypertension was the most frequent comorbidity followed by cancer and diabetes. In each hospital type the percentage with hypertension, cancer and diabetes was higher in women. This held true across all comorbidities considered except for chronic kidney disease at metropolitan hospitals and atrial fibrillation at rural hospitals, where the percentage was higher in men.

Clear differences existed in total case fatality, driven by the 374 (86%) in-hospital cases, being highest in rural and least in non-tertiary metropolitan sites ($P < 0.001$; Table 3). Out-of-hospital case fatality ($n = 61$) was not significantly different between rural, tertiary and non-tertiary metropolitan hospitals. Approximately 70% of all deaths had a cardiovascular cause recorded, consistent across hospital type (data not shown).

Approximately 62% of all admissions for ATD were emergency admissions, with the highest proportions in tertiary and rural hospitals. The proportions of elective admissions for both CHD and PAD exceeded 50% for non-tertiary metropolitan hospitals (Table 4). Same-day admissions made up just over half of the elective admissions and 14% of the emergency admissions (data not shown).

All patients admitted to a metropolitan hospital on their index admission were included in the analysis to determine the likelihood of being admitted to a tertiary versus other metropolitan hospital, according to place of residence (Table 5). Multivariate models included age, Charlson comorbidity score, sex, admission type, SEIFA disadvantage and ARIA+. A statistically significant interaction between SEIFA disadvantage and ARIA+ necessitated stratifying the model by ARIA+, simplified to major city and rural resident. Other variables significantly associated with patients being admitted to a tertiary versus other metropolitan hospital were increasing age, Charlson comorbidity score and emergency admission type for both major city and rural residents. Compared with the most disadvantaged quintile, decreasing disadvantage was associated with a corresponding decrease in the odds of index admission to a tertiary hospital. After adjustment for the other variables there was no difference between males and females in the odds of index admission to a tertiary hospital.

Discussion

This study demonstrates that patients admitted to rural, tertiary and non-tertiary metropolitan hospitals for ATD differ significantly in their demographics, socioeconomic disadvantage, clinically and early case-fatality. Although the differences in age, sex and length of stay were small, the differences in SEIFA disadvantage scores and case fatality measures were more important. A greater proportion of patients admitted to rural hospitals died and overall these patients were more disadvantaged compared with their tertiary and metropolitan counterparts.

The larger proportion of case fatalities in rural hospitals is consistent with their access to healthcare and treatment options for acute atherothrombotic events. In WA, the distance involved often necessitates pharmacological over arterial interventions. Rural areas in Australia are known to experience higher age-standardised cardiovascular death rates than their metropolitan counterparts,[4] and this trend has been noted in other parts of the world.[13] This could possibly be related to the complexity of ATD through to poorer cardiovascular risk profile and management in rural areas and reduced regularity of general practice visits, the latter two known to increase the risk of atherothrombotic events.[14,15]

The majority of patients with ATD were treated in metropolitan hospitals, which is consistent with where over 70% of the WA population resides. It is also where specialist emergency

Table 4. Rural hospitals and other hospitals: emergency admissions by vascular territory

Disease	Rural hospitals $n=1448$		Metropolitan hospitals Tertiary $n=3819$		Metropolitan hospitals Non-tertiary $n=1993$		*P*-value[A]
	n	%	*n*	%	*n*	%	
Coronary heart disease	996	68.8	2700	70.7	1473	73.9	<0.001
Cerebrovascular disease	442	30.5	1020	26.7	484	24.3	<0.001
Peripheral arterial disease	10	0.7	99	2.6	36	1.8	<0.001

[A]Chi-square test was used for all comparisons in this table.

Table 5. Binary logistic regression models of the odds of index admission to a tertiary hospital among metropolitan hospital patients by Accessibility/Remoteness Index for Australia classification

CI, confidence interval; OR, odds ratio; SEIFA, Socioeconomic Indices For Area; *$P<0.05$; **$P<0.01$

Variable	Major city Univariate		Major city Multivariate		Rural (regional or remote) Univariate		Rural (regional or remote) Multivariate	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age (change of 5 years in age)	0.95**	0.93, 0.97	0.94**	0.92, 0.96	0.86**	0.83, 0.90	0.84**	0.80, 0.88
Charlson comorbidity score	1.07**	1.04, 1.11	1.06*	1.02, 1.09	1.05	0.97, 1.14	1.09*	1.00, 1.18
Sex								
Male	1		1		1		1	
Female	1.14**	1.04, 1.25	1.02	0.92, 1.13	1.11	0.91, 1.35	1.01	0.82, 1.24
Admission type								
Elective	1		1		1		1	
Emergency	4.18**	3.80, 4.60	4.03**	3.65, 4.44	1.91**	1.58, 2.30	1.97**	1.62, 2.39
SEIFA disadvantage[A]								
Q1 (most disadvantaged)	1		1		1		1	
Q2	0.79**	0.67, 0.93	0.82**	0.69, 0.96	0.64**	0.49, 0.84	0.64**	0.48, 0.84
Q3	0.66**	0.56, 0.76	0.68**	0.58, 0.80	0.56**	0.43, 0.73	0.56**	0.42, 0.73
Q4	0.52**	0.45, 0.62	0.56**	0.47, 0.66	0.57**	0.43, 0.75	0.54**	0.41, 0.72
Q5 (least disadvantaged)	0.31**	0.27, 0.36	0.34**	0.29, 0.40	0.46**	0.32, 0.67	0.40**	0.27, 0.59

[A]Overall *P*-value for SEIFA disadvantage is <0.01; 398 patients (214 from tertiary hospitals and 184 from non-tertiary metropolitan hospitals) were missing accessibility and disadvantage data and were not included in the models.

and elective procedural care is available, exclusively so in the case of arterial interventions such as coronary angiograms and invasive vascular procedures.[16] Thus, the statistical differences in death, demographics, SEIFA disadvantage and emergency admissions from ATD by hospital type likely reflect the populations they serve, disease complexity, provision of care and available health resources.

When we consider the regression models we get a clear picture of the services tertiary hospitals provide as compared with the other metropolitan hospitals. The probability of being admitted to a tertiary hospital as an emergency case was higher for major city residents than for rural residents. This is what we would expect to see, as those in proximity to the tertiary hospitals are taken there for high-quality emergency care, although it may highlight the different and longer referral path that rural residents may take before tertiary hospital admission. Encouragingly, higher levels of disadvantage did not preclude admission to tertiary hospitals for those rural residents transferred to the metropolitan area. However, the high proportion of the most disadvantaged patients admitted to rural hospitals remains a major concern and highlights the need for further investigation of this patient group in terms of disease prevention and care.

The strengths and limitations of this study lie in its use of routinely collected and audited administrative health data. This methodology is cost and time efficient in comparison to population surveys and recruitment of participants; however, it limits analysis to information that is contained within these datasets and the variables requested. Rural public and private hospitals were pooled into one hospital category because of the small number of private rural hospitals in WA, and to ensure site anonymity. SEIFA disadvantage scores were based on the residential address at hospital admission, which could be transitory, and not the individual's education, occupation or income. This could potentially over- or under-estimate the level of disadvantage of a person if they were outside of the norm for the area. The use of all diagnostic fields over 15 years of hospitalisations to determine hypertension, diabetes and chronic kidney disease has been used previously, and is likely to have captured the cardiovascular complexity of cases admitted.[17] The strength of using linked data is the ability to study all hospitalisations for ATD for the entire population of WA residents aged 35–84 years in 2007 without recall bias or non-response to surveys.

Conclusions

Significant differences in demographic characteristics, clinical presentation and early case-fatality were evident among WA rural, tertiary and non-tertiary hospitals for patients with a given atherothrombotic event. The most important of these differences among hospital type was related to socioeconomic disadvantage and case fatality. A greater proportion of ATD cases treated in rural hospitals were in the most disadvantaged SEIFA group. Differences in disadvantage are important considerations for equitable distribution of resources and for the interpretation of comparative outcomes data.

Competing interests

The authors declare there are no competing interests.

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