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Application of Geographic Modeling Techniques to Quantify Spatial Access to Health Services Before and After an Acute Cardiac Event

The Cardiac Accessibility and Remoteness Index for Australia (ARIA) Project

Robyn A. Clark, PhD, FRCNA; Neil Coffee, BA(Hons)Geog, MA; Dorothy Turner, BSc(Geog), PhD; Kerena A. Eckert, MPH, PhD; Deborah van Gaans, BSc(Geog), MAApp Sc (Nat Res); David Wilkinson, MD, FRACGP; Simon Stewart, PhD; Andrew M. Tonkin, MD, FRACP; on behalf of the Cardiac Accessibility and Remoteness Index for Australia (Cardiac ARIA) Project Group

***Background*—**Access to cardiac services is essential for appropriate implementation of evidence-based therapies to improve outcomes. The Cardiac Accessibility and Remoteness Index for Australia (Cardiac ARIA) aimed to derive an objective, geographic measure reflecting access to cardiac services.

***Methods and Results*—**An expert panel defined an evidence-based clinical pathway. Using Geographic Information Systems (GIS), the team developed a numeric/alphabetic index at 2 points along the continuum of care. The acute category (numeric) measured the time from the emergency call to arrival at an appropriate medical facility via road ambulance. The aftercare category (alphabetic) measured access to 4 basic services (family doctor, pharmacy, cardiac rehabilitation, and pathology services) when a patient returned to his or her community. The numeric index ranged from 1 (access to principal referral center with cardiac catheterization service ≤1 hour) to 8 (no ambulance service, >3 hours to medical facility, air transport required). The alphabetic index ranged from A (all 4 services available within a 1-hour drive-time) to E (no services available within 1 hour). The panel found that 13.9 million Australians (71%) resided within Cardiac ARIA 1A locations (hospital with cardiac catheterization laboratory and all aftercare within 1 hour). Those outside Cardiac 1A were overrepresented by people >65 years of age (32%) and indigenous people (60%).

***Conclusions*—**The Cardiac ARIA index demonstrated substantial inequity in access to cardiac services in Australia. This methodology can be used to inform cardiology health service planning and could be applied to other common disease states within other regions of the world. **(*Circulation*. 2012;125:2006-2014.)**

Key Words: cardiopulmonary resuscitation ■ geography ■ health services availability ■ out-of-hospital care

In an acute cardiac event (cardiac arrest, acute coronary syndrome, acute decompensating heart failure, or life-threatening arrhythmias), the time to care is critical. For those who survive, access to basic healthcare services such as a cardiologist or a primary care physician, nursing, pharmacist, pathology services, and cardiac rehabilitation is essential for optimal prevention of a potentially fatal further event.[1] Evidence-based guidelines are available on how to appropriately manage a cardiac event,[2–13] but their implementation is often greatly influenced by the geographic location and the level of facilities available within a community and the hospital to which a patient initially presents.[14] Although therapies such as defibrillation and thrombolytic drugs are widely available, only an estimated 20% of emergency care departments in the United States[15,16] and <7% in Australia[17,18] are located in hospitals with a cardiac catheterization

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From the School of Nursing and Institute of Health and Biomedical Innovation, Queensland University of Technology, Queensland, Australia (R.A.C.); Social Epidemiology and Evaluation Research, Sansom Institute, Division of Health Sciences, Adelaide, South Australia (N.C.); GIS and Environmental Modeling School of Earth and Environmental Sciences (D.T.), Population Research and Outcomes Studies, Discipline of Medicine (K.A.E.), and Department of Geographical and Environmental Studies (D.v.G.), University of Adelaide, Adelaide, South Australia; School of Medicine, University of Queensland, Queensland, Australia (D.W.); Preventative Health, Population Health and Profiling, Baker IDI Heart and Diabetes Institute, Melbourne, Victoria (S.S.); and Cardiovascular Research Unit, Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, Australia (A.M.T.).

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Correspondence to Robyn A. Clark, PhD, FRCNA, School of Nursing and Institute of Health and Biomedical Innovation, Queensland University of Technology, Kelvin Grove, QLD, 4059, Australia. E-mail ra.clark@qut.edu.au

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laboratory, and still fewer hospitals have the capability to perform immediate percutaneous coronary intervention (PCI) or coronary artery bypass grafting.[18]

Clinical Perspective on p 2014

The continuum of care after a cardiac event does not end at hospital discharge. Healthcare services that support cardiac rehabilitation and ongoing secondary prevention are essential when a patient returns to his or her community.[11,19] Long-term cardiac outcomes will also be strongly linked to the social determinants of health within a community.[19,20] Recent data from Sweden have shown that the relative contribution of out-of-hospital deaths has increased, particularly in younger individuals, and 90% of all deaths associated with an acute coronary event occurred out of hospital.[21]

Along with significant health inequalities, inequalities exist in the access to and delivery of healthcare services in Australia.[22] This is particularly evident for specialist cardiac services in the outer urban fringes and rural and remote areas, where few cardiologists live and work, and a large proportion of the provision of health care falls on the local family physician.[23] With the trend to downgrade small-town hospitals to nursing homes and aged care centers or to close them down completely, there is an increasing need for rural and remote patients with cardiovascular disease (CVD) to travel, often long distances, to city-based specialist cardiac care centers.[23] Given that CVD patients consume more health dollars than the average Australian,[24] the added financial costs associated with transport impose a significant burden.[24]

In contrast, in recent years, the healthy aging of Australia's older population has resulted in significant retirement migration from metropolitan and nonmetropolitan areas (in the ≥65 years of age group) and a blurring of the boundaries once drawn around major cities and rural areas. Population growth in nonmetropolitan areas has been variable with growth in more accessible geographical locations such as the urban fringes and the rural areas favored by retirees while more remote areas are in decline.[25] Regrettably, services in these areas, including health services, have not kept pace with the changing face of Australia's nonmetropolitan population. Some communities situated in the fringes of major cities are located between 50 and 80 km away from the central business districts of major cities.[25]

Clear evidence suggests that inequities in health outcomes exist between the socioeconomically advantaged and disadvantaged groups.[20,22] The gap is widening, and poor CVD outcomes are not shared equally across the entire population.[22] People from socioeconomically disadvantaged groups have a poorer risk profile and are more likely to die of CVD than those from more privileged backgrounds.[22] One of the most disadvantaged groups in Australia is the Aboriginal and Torres Strait Islander people, who experience a 2.6-fold greater risk of CVD mortality and a 1.4 higher rate of overall hospitalization. Importantly, 41% of all CVD deaths and 30% of deaths occur in indigenous people living in rural and remote areas of Australia.[26]

The Cardiac Accessibility and Remoteness Index of Australia (Cardiac ARIA) was designed to measure access to cardiac care using a geographic lens. The Geographic Information Systems (GIS) software provides a tool for integrating otherwise unrelated data and allowing inferences about the relationship between these data in a spatial context.[27,28] The project was a novel application of GIS that aimed to develop an objective, comparable measure of the time and distance from any population location to evidence-based cardiac care.

Australia, like the United States, is one of the most urbanized countries in the world, with 89% of its total population living in cities. Australia is the world's smallest continent but the sixth largest country (by geographical area). The majority of the population (≈22 million) dwell along the eastern and southeastern coasts.[29] Australia has a universal healthcare system similar to that in the United Kingdom that is operated by the federal government authority, Medicare Australia.[30] Ambulance services are administered by a state-based system and include professional and volunteer emergency care providers.[30]

Methods

Design

To meet the project objectives, this study was conducted in 3 phases: an expert panel consensus process, national data acquisition and GIS modeling, and a comparison between the index categories and key Census population characteristics.

Phase 1: Expert Panel Consensus Process

An expert panel of cardiologists and other key health practitioners (see the Acknowledgments) used a consensus method to define an acute cardiac event and the context of the project (management before and after hospitalization). The context of this study did not include any acute coronary care after arrival in hospital (eg, door-to-needle or door-to-balloon time). The panel distilled current national and international guidelines relating to the management of a cardiac event[2–13] into a single patient care pathway and from this derived a master list of healthcare resources and services.

Phase 2: Defining Accessibility, Data Acquisition, and GIS Modeling

Details on the geographic methodology have been published elsewhere, and the full project report is available online at www.qut.edu.au/research/cardiac-aria.[31] The following is a summary of the GIS accessibility modeling used in this project.

Defining Accessibility

Access is an important concept in health policy and health services research, but it often is not defined or applied consistently. Accessibility can be defined as the ease of approach from 1 location to another measured in terms of distance traveled, the cost of travel, or the time taken. Remoteness can be defined as distant or far away geographically.[32] These concepts are at the heart of geographic models of access and remoteness, the underlying principle of which is the impact that distance plays in assisting or hampering access to goods and services or, in this case, access to cardiac healthcare services. We acknowledge that these definitions refer to physical rather than social accessibility, which could include class structure, income, age, education, sex, or ethnicity and the impact these factors can have in accessing services.[32]

Remoteness has been calculated in this project on the basis of accessibility to service centers based on road distances and was modeled on ARIA.[33] ARIA was designed to be simple, comprehensive, sufficiently detailed, transparent, defensible, and stable over time. Because ARIA was also designed to be an unambiguously geographical approach to defining remoteness, socioeconomic, urban/rural, and population size factors were not incorporated into the measure.[33] ARIA used Esri Spatial Analyst[34] to construct accessibility raster cost distance surfaces along and away from the road

Table 1. Cardiac Accessibility and Remoteness Index for Australia Hospital Categories

Cardiac ARIA Hospital Category	Hospital Categories
1: Principal referral with catheter laboratory	Principal referral
2: Principal referral without catheter laboratory	Principal referral
3: Large	Large hospital, major city
	Large hospital, regional and remote area
4: Medium	Medium hospital, regional and remote area
5: Other	Small acute hospitals, regional
	Small nonacute hospitals
	Small acute hospitals, remote
	Multipurpose services
	Other remote clinics

ARIA indicates Accessibility and Remoteness Index for Australia. Source: Australian Institute of Health and Welfare. *Australian Hospital Statistics 2007–08*. Canberra, Australia: AIHW. Health Services Series No. 33. Catalog No. HSE 71.[18]

network to represent a distance measure for all of Australia. By combining the accessibility layers using the Esri raster calculator, we calculated a single value for each population center in Australia.[34] To develop the Cardiac ARIA model, this methodology was adapted and modified to include cardiac evidence-based time calculations and distance. The ARIA classification has been widely accepted by a variety of users since its release in 1999. As a result, the Australian Bureau of Statistics (ABS) included ARIA scores as part of the 2001 to 2006 Census data releases.[24]

Data Acquisition and Modeling

From the master list of healthcare resources and services for the management of a cardiac event, 9 key spatial and clinical data sets were used to model Cardiac ARIA. These data included road networks, population centers, ambulance stations, hospitals and remote-area clinics, primary care physicians, pharmacies, cardiac rehabilitation programs, and pathology laboratories. The road network and population centers data were sourced from Pitney Bowes Business Insight[35] and represent 2 key data sets in the model. Ambulance station location data were sourced from each state or territory jurisdiction and included metropolitan, rural, and remote services.[35] The location data of public hospitals were sourced from the Commonwealth Department of Health and Aging[18] and remote-area clinics from the National Aboriginal Community Controlled Health Organization.[36] A national classification (the Australian Institute of Health and Welfare Public Hospital Peer Groups' classification)[18] was used to categorize medical facilities/hospitals into broadly similar groups in terms of the range of admitted patient activity and their geographical location. From this classification of public hospitals, 5 categories of medical facilities/hospitals were modeled on the basis of diminishing levels of access to cardiac services and increasing remoteness (Table 1). The 44 hospitals included in the Cardiac ARIA category 1 have cardiac catheterization services; however, PCIs were not available 24 hours/7 days a week in all, and not all cardiac catheterization centers have a colocated cardiothoracic surgery service.[18] Data on the location of primary care clinics, community health clinics, pharmacies, and pathology services were sourced for the aftercare model. The National Association of Testing Authorities' data set was used to identify pathology services.[37] Cardiac rehabilitation programs were acquired from the Australian Cardiovascular Health and Rehabilitation Association.[38] To differentiate urban from nonurban areas for modeling travel speeds, ABS data on urban center locations were extracted from the ABS Census area database.[39] The GIS software applications used for this project were Esri Arc Map version 9.3.1 and Spatial Analyst (Esri 2009, Redlands, CA).[34]

The Cardiac ARIA is presented as a 2-part numeric/alphabetic categorization. The numeric category rates accessibility to services after an acute cardiac event, and the alphabetic category of the index rates accessibility to the services required for care after an acute cardiac event when the patient returns to the community. GIS measured the times to these services for each of the 20 387 population locations.

The measurements were calculated from the central point of each population area by use of the minimum bounding rectangle method; for each population location, the smallest possible rectangle is used to enclose the location and the central point identified and to estimate distance. Time classifications were based soundly on previous studies in time modeling to cardiac services[16,40–42] and on current international and national evidence-based time frames for the management of an acute cardiac event.[2–13,43] Because the majority of acute cardiac events are managed in Australia by road ambulance or mobile intensive care units,[42] Cardiac ARIA is a time-based accessibility model that measured access to the highest level of available medical assistance by road (Cardiac ARIA acute model). For management after discharge of an acute cardiac event (Cardiac ARIA aftercare model), drive time by private car was modeled along the road network.

Iterative modeling conducted before the model reported here did not appreciably change our results, and the final iteration was considered the most robust in real-world practice.[2–13] Sensitivity testing of 8 time-frame radii to services and rerouting to PCI was performed. The major difference in the models was the break points, not the speeds. The fundamental concept of the final model was the average position based on clinical guidelines and published average travel times. The outcomes of these sensitivity analyses indicated that most Australians (66%–73%) will meet the 1-hour access to PCI facilities. Although we have looked at sensitivity by 10% time variations, the situation did not change the outcomes significantly. The issue of good access decreased by $<$1% variation, and poor access remained relatively unchanged because these locations were not densely populated.[31] We decided to focus on the clinical timeline and reported average times[31] to provide an outcome that reflected a result that was a reasonable guide for policy. Clearly, travel times will differ depending on the time of day and weather, but the purpose of this modeling was to provide a view of reality that would have utility in guiding health policy and allocation of resources.

Acute Cardiac ARIA was modeled to the best available medical facility within 1 hour by road ambulance.[43] Each acute Cardiac ARIA time calculation included dispatch time (3 minutes), travel time to location (15 minutes for urban and 19 minutes for rural), time on site (15 minutes), and travel time to the nearest and best medical facility within 60 minutes. Urban road speeds were calculated at 40 km/h (25 mph), nonurban road speeds at 80 km/h (50 mph), and unsealed road speeds at 50 km/h (31 mph).[42,43] Acute Cardiac ARIA category 1 represents a population center within 1-hour access to a principal referral hospital with a cardiac catheterization laboratory; category 2, access to a principal referral hospital without a cardiac catheterization laboratory within 1 hour; and category 5, 1-hour access to a level 5 hospital/medical clinic. Category 6 represented between 1 and 3 hours to any medical facility; category 7 (30-minute transport by private car) was created to model the many remote clinics without access to an ambulance service; and category 8 represents $>$3 hours from any ambulance or medical facility (Table 1 and Figure 1).

The Cardiac ARIA (aftercare) alphabetic category measured access within a 1-hour drive from population locations along the road network to key services (Figure 1). The list of key services was based on a hierarchy developed by the cardiac rehabilitation experts from our expert panel. They were prioritized as access to medical follow-up (primary care physician), access to a pharmacy, access to a cardiac rehabilitation program, and access to pathology services.

The GIS modeling was based on research that indicated that compliance diminished as access to these services increased beyond 1-hour drive time.[44] Category A represented 1 hour access to all 4

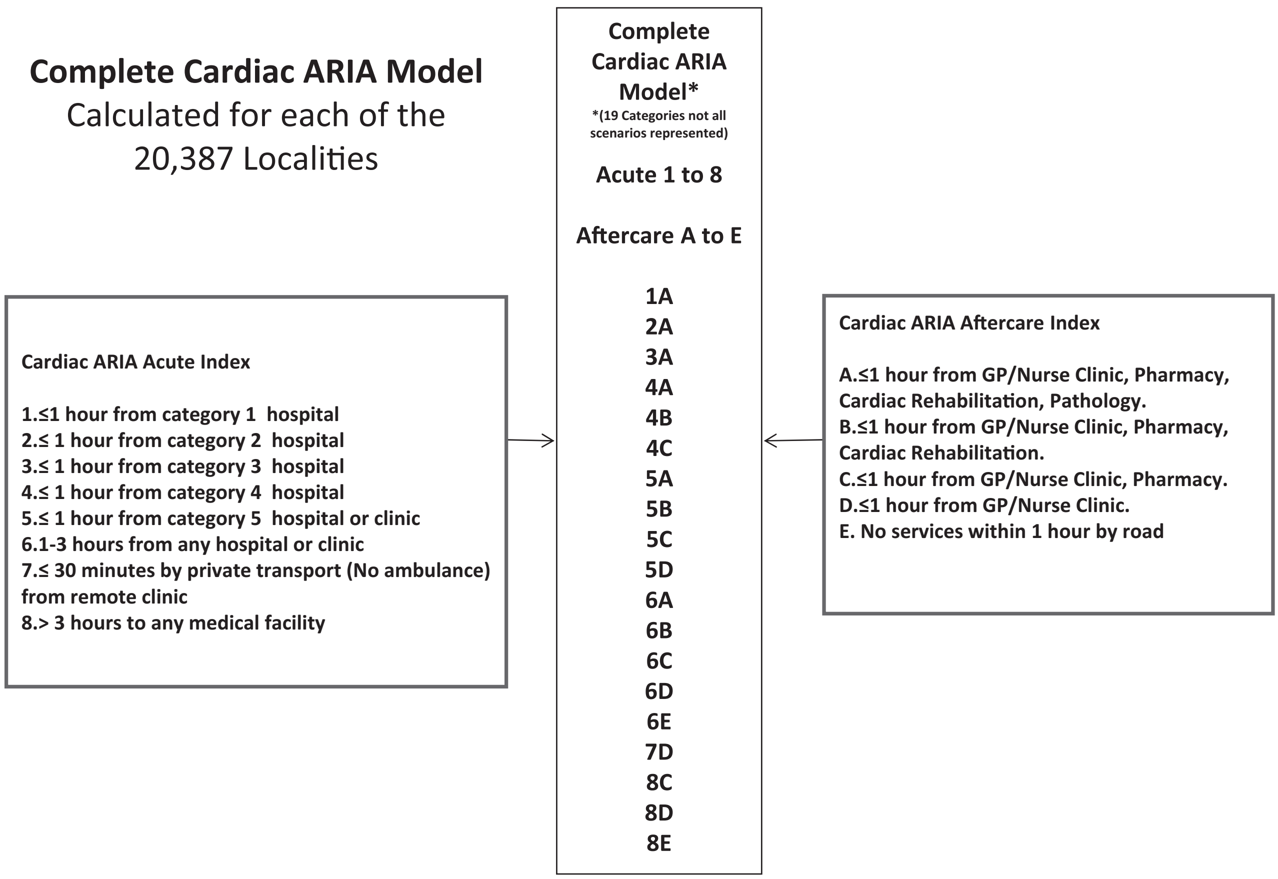


Figure 1. Flowchart for numeric and alphabetic phases of the index (acute cardiac care and aftercare). ARIA indicates Accessibility and Remoteness Index for Australia; GP, general practitioner.

services, decreasing in a hierarchy of accessibility to category E, which represents no services within 1 hour (Figure 1).

Phase 3: Comparison of Cardiac ARIA Categories and Key Census Population Characteristics

The ABS Census of Population and Housing was used to provide population data for Cardiac ARIA scores.[45] The population Census characteristics reviewed were total persons in each Cardiac ARIA category, persons >65 years of age, the proportion of persons self-identified as Aboriginal and Torres Strait Islanders, and remoteness. Microsoft Excel 2007[46] and ArcGIS[34] were used to summarize the selected population variables as numbers and percentages for each ARIA and Cardiac ARIA score. GIS was used to create a spatial link between the Cardiac ARIA score and each Census collection district similar to a Census tract in the United States.[34]

Ethics

Ethics approval for this project was provided by the Human Research Ethics Committee of the University of South Australia (approval number P136/09).

Results

The Cardiac ARIA combined the 8 categories (1–8) of acute access and the 5 aftercare categories (A–E) to form a numeric/alphabetic value (potentially 1A–8E) for each population location (Figure 1). However, when the GIS calculations were completed, only 19 of a possible 40 index combinations were needed to describe accessibility for each of the 20 387 population locations (Figure 1).

The geographic distribution and the range of the numeric/alphabetic combinations are shown in Figure 2.

Access to Acute Cardiac Services

In the event of a cardiac emergency, the majority of Australians had good access to cardiac services. Approximately 71% of all Australians (13.9 million people) and 68% of older Australians (>65 years of age) resided within 1 hour of a category 1 hospital. Ninety thousand people >65 years of age (4% of the 65-year-old population) lived >1 hour from any hospital or clinic (categories 6–8). Only 40% of Aboriginal and Torres Strait Islander people lived within 1 hour of a category 1 hospital, and 16% (74 000 persons) resided in locations with poor access to any medical assistance (categories 6–8).

Access to Cardiac Services After a Cardiac Event

Approximately 96% of Australians (19 million people) and 96% of those >65 years of age lived within 1 hour of the 4 key services to support cardiac rehabilitation and secondary prevention. Seventy-five percent of indigenous people lived within 1 hour of the 4 cardiac rehabilitation services, and 16% (73 000 persons) had poor access to the 4 key services to support cardiac rehabilitation and secondary prevention (categories D and E).

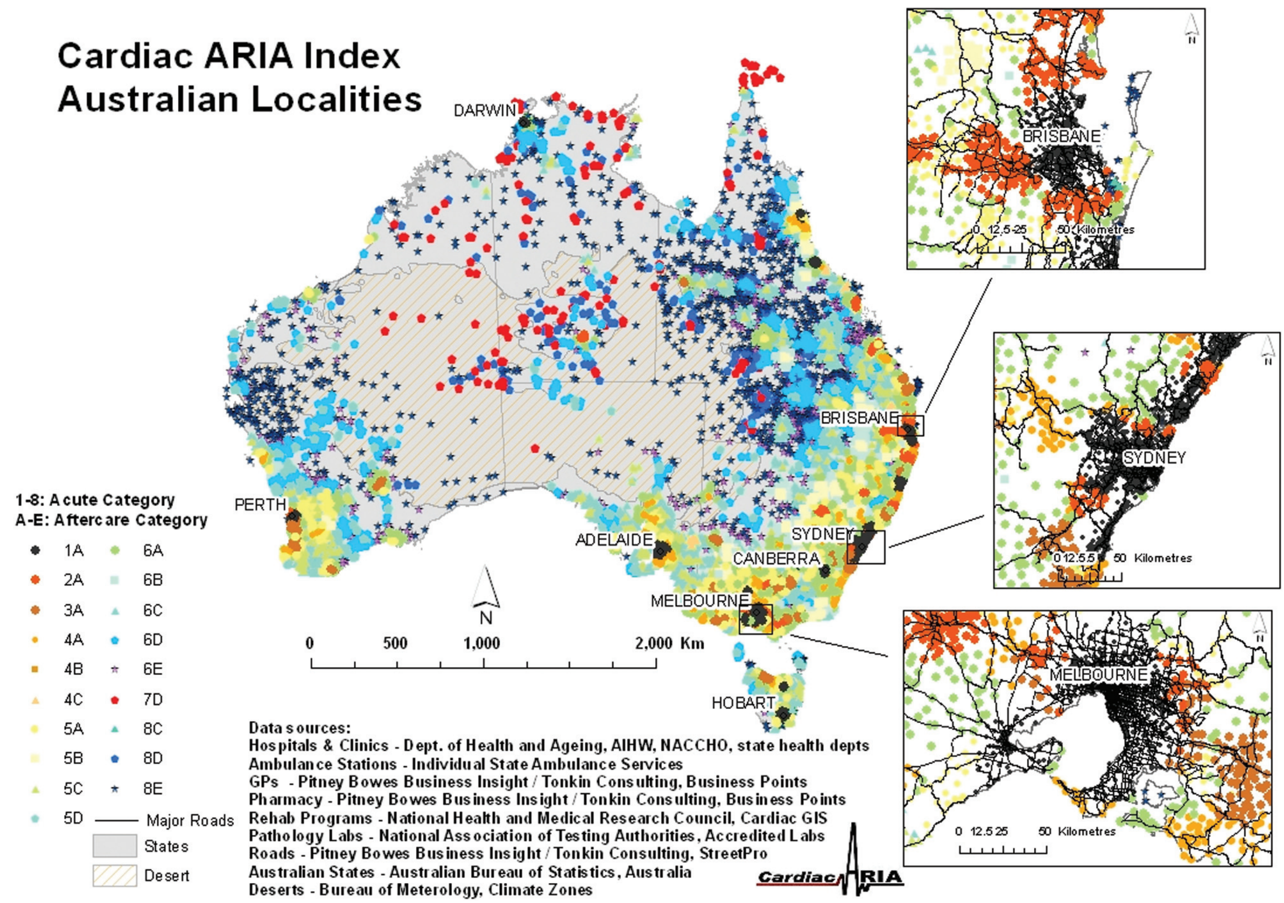
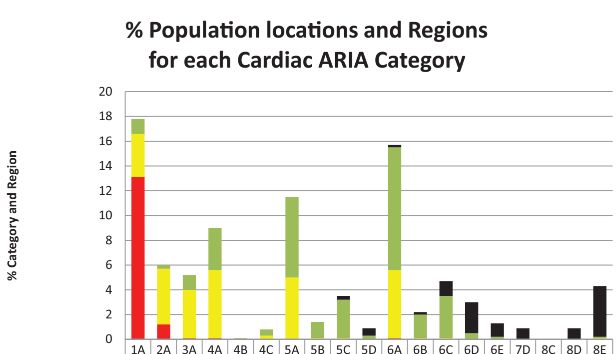


Figure 2. Cardiac Accessibility and Remoteness Index for Australia (ARIA) categories mapped by location.

Access to Cardiac Services Before and After a Cardiac Event

Eighteen percent of Australian population locations were situated in the combined cardiac aria category 1A zones (access to a principal referral hospital with a cardiac catheterization laboratory and all aftercare services within 1 hour), indicating that 82% of population locations in Australia had >1-hour access to recommended cardiac care. Figure 3 demonstrates that there was a high proportion of localities in several categories other than 1A, including category 4A (9%; <1 hour to a medium size hospital/no PCI capability, <1 hour to all aftercare services), category 5A (12%; <1 hour to a small hospital or clinic/no PCI, <1 hour to all aftercare services), category 6A (16%; 1–3 hours to any hospital or clinic/no PCI, <1 hour to all aftercare services), and category 8E (5%; no ambulance service, >3 hours to any medical center, no aftercare services; Figure 3) From the analysis of each of the Cardiac ARIA categories, it was estimated that ≈71% of Australians (13.9 million) resided within category 1A locations (access to a principal referral hospital with a cardiac catheterization laboratory and all aftercare services within 1 hour), including 68% of older Australians (>65 years of age) and 40% of Aboriginal and Torres Strait Islander people. Conversely, 12% (56 000) of Aboriginal and Torres Strait Islander people resided in locations with poor access to a hospital or medical center and had access to only 1 (usually a doctor or clinic) or 0 of the 4 key aftercare services (categories 6D–8E; Table 2).



	1A	2A	3A	4A	4B	4C	5A	5B	5C	5D	6A	6B	6C	6D	6E	7D	8C	8D	8E
% Very Remote	0	0	0	0	0	0	0	0	0.3	0.6	0.2	0.2	1.2	2.5	1.1	0.9	0	0.9	4.1
% Outer Regional	1.2	0.3	1.2	3.4	0.1	0.5	6.5	1.3	3.1	0.3	9.9	1.9	3.4	0.5	0.2	0	0	0	0.1
% Inner Regional	3.5	4.5	3.9	5.5	0	0.3	5	0.1	0.1	0	5.5	0.1	0.1	0	0	0	0	0	0.1
% Major Cities	13.1	1.2	0.1	0.1	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0

Figure 3. Proportion of population locations and regional classification for each Cardiac Accessibility and Remoteness Index for Australia (ARIA) category.

Discussion

Cardiac ARIA, derived from an innovative model using GIS technology, describes the access to cardiac healthcare services relative to the geographic dispersion of a country's population. According to recent Census data,[39] ≈71% of Australians lived within a Cardiac ARIA index category 1A location (access by road to a principal referral hospital with a

Table 2. Population Characteristics for Each Cardiac Accessibility and Remoteness Index for Australia Category

Cardiac ARIA Category	Total Population, n (%)	Total Indigenous Population, n (%)	Total Population ≥65 Years of Age, n (%)
1A	13 983 696 (70.58)	180 210 (39.74)	1 784 081 (67.56)
2A	1 655 086 (8.30)	47 821 (10.55)	230 228 (8.72)
3A	1 100 338 (5.55)	32 252 (7.11)	172 781 (6.54)
4A	1 127 226 (5.69)	39 983 (8.82)	181 727 (6.88)
4B	7183 (0.04)	78 (0.02)	1058 (0.04)
4C	89 497 (0.45)	2718 (0.60)	14 068 (0.53)
5A	669 981 (3.38)	27 182 (5.99)	107 617 (4.08)
5B	101 629 (0.51)	8358 (1.84)	17 680 (0.67)
5C	223 851 (1.13)	23 463 (5.17)	29 924 (1.1)
5D	102 898 (0.52)	17 191 (3.79)	7827 (0.30)
6A	486 069 (2.45)	12 485 (2.75)	67 266 (2.55)
6B	44 293 (0.22)	2044 (0.45)	5445 (0.21)
6C	79 455 (0.40)	3103 (0.68)	9294 (0.35)
6D	40 411 (0.20)	10 777 (2.38)	3090 (0.12)
6E	16 139 (0.08)	975 (0.22)	1414 (0.05)
7D	40 809 (0.21)	34 219 (7.55)	1684 (0.06)
8C	2332 (0.01)	62 (0.01)	486 (0.02)
8D	3757 (0.02)	1987 (0.44)	218 (0.01)
8E	29 765 (0.15)	8225 (1.81)	2101 (0.08)
NA*	18 666 (0.09)	296 (0.07)	2678 (0.10)
Total	19 813 080	453 429	2 650 667

ARIA indicates Accessibility and Remoteness Index for Australia.
*Persons offshore or migratory and therefore not allocated a Cardiac ARIA value.

cardiac catheterization laboratory and to all aftercare services within 1 hour). Access to appropriate rehabilitation services was higher (91%) than for acute services (71%), and older and indigenous people who carry a higher burden of disease than the general population were more disadvantaged in terms of access.

A recent study using GIS in the United States has demonstrated that nearly 80% of the adult population in the United States lived within 60 minutes of a PCI hospital in 2000. Even among those living closer to non-PCI hospitals, almost three quarters of the population would experience an additional delay of <30 minutes with direct referral to a PCI hospital, which suggested that such a strategy might be feasible for these individuals. These results indicate a greater percent of initial access to PCI than modeled for Australia in Cardiac ARIA, and a rerouting model is planned for future iterations.[16] A review of access to general cardiac services in Kentucky that reported the spatial statistical comparison of the geographical distribution with service use and travel time to hospitals showed that people living in rural areas traveled further to services and that populations residing >45 minutes from health facilities were more likely to be socially and economically marginalized.[47]

Another Australian study that used simple Google maps to measure access to PCI was consistent with our results, demonstrating that 78% of Australian cardiac catheterization laboratories were located in major cities and that a significant number of Australians could not access PCI within the time frames recommended in guidelines.[2–13,17] The findings in our study reflect the size and nature of the Australian continent, in which it appears that access to cardiac services may represent an all-or-nothing situation, with almost one third of the population (29%) outside the road distance (and time frame) for primary cardiac intervention. Figure 4 shows that there were time zones of accessibility.

These findings can directly inform strategies to improve outcomes for cardiac patients. For locations in which access is limited, there could be an agreed-on plan for mobilization and synchronization of appropriate services to optimize timely access to evidence-based care such as PCI.[48] The speed with which the system mobilizes (or response time) may be as important as distance when determining the outcomes after a cardiac event.[49,50]

Similar to the rate in the United States, the current uptake of cardiac rehabilitation and secondary prevention programs by eligible cardiac patients in Australia is between 10% and 47%.[51,52] This is despite the fact that our study showed that the majority of Australians had excellent geographic access to cardiac rehabilitation and secondary prevention programs after discharge following a cardiac event. Therefore, it appears that it is not the distance to cardiac rehabilitation that is affecting attendance.

We would recommend that population locations with limited access to cardiac services could benefit from a nationally coordinated, virtual, or electronically supported cardiac care system and the development of innovative clinical approaches to improve access to reperfusion and other therapies, point-of-care testing, and cardiac rehabilitation.[53] This requires coordination across state boundaries and health jurisdictions. The Cardiac ARIA focused on community access, and communities themselves could be proactive in lobbying for improving access to cardiac care.

Cardiac ARIA is unique in that no previous research has measured accessibility to cardiac services with a model that included essential services before hospitalization or produced an output in the form of a weighting or index. The index provides a variable that can be used in statistical modeling to measure the impact of access on cardiac outcomes and the requirements for the most rational situating of cardiac services.

Our model can be replicated easily. It used common internationally available geographic software (Esri Arc Map, version 9.3.1 and Spatial Analyst) and was modeled with data that were publically available. The methodology underlying Cardiac ARIA could be readily adapted to other emergency or chronic conditions (eg, access to specialist care for stroke, diabetes mellitus, chronic obstructive pulmonary disease, bronchial asthma, burns, cancer, and mental health care) in any country where the software and similar location and healthcare service data are available and can be accessed.

The Cardiac ARIA has some limitations. Its validity depends on the quality of the data acquired. Accessing national data sets was both a major achievement and a burden within this project. The index will be iterative as data are updated and access to key national data sets improves. A

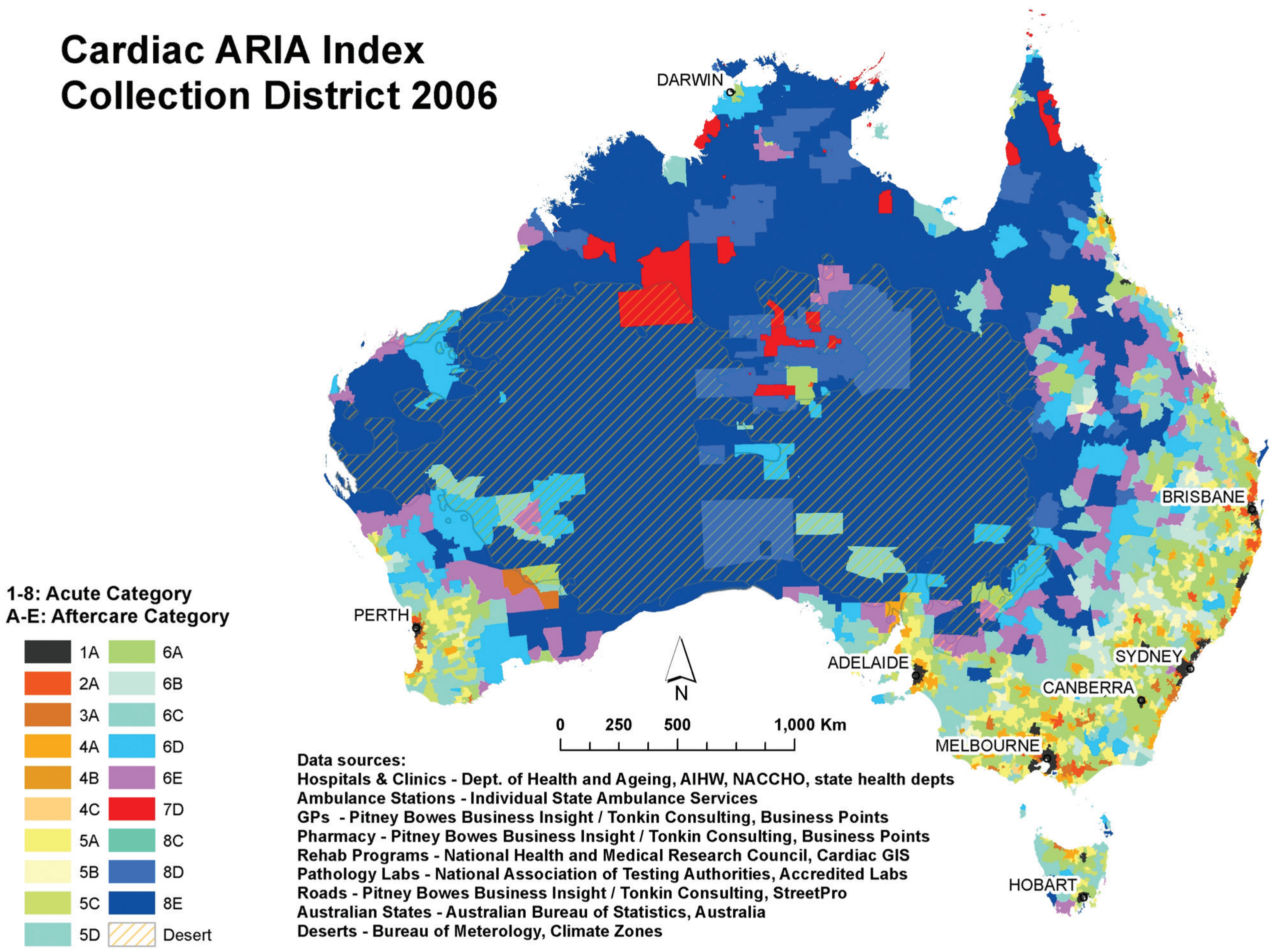


Figure 4. Cardiac Accessibility and Remoteness Index for Australia (ARIA) zones of access.

validation of the index using CVD risk factor data and disease outcomes is currently in progress.

Conclusions

The Cardiac ARIA project was underpinned by a novel partnership between clinicians and geographers. The research generated an objective geographic measure of access to health services that was independent of cultural factors, socioeconomic factors, physician judgment, or health politics. This allowed demonstration of substantial inequities in access to cardiac services for major at-risk groups within Australia. Cardiac ARIA represents a powerful tool that could be used by communities, clinicians, researchers, and healthcare funders to inform improved health strategies and to optimize cardiac outcomes.

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Disclosures

None.

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CLINICAL PERSPECTIVE

In an acute cardiac event, access to timely and definitive care through specialist centers is critical to survival and to improving longer-term outcomes. Similarly, for survivors, ready access to more routine health care, including specialist management (through a cardiologist and cardiac rehabilitation program) and community-based primary care, is essential in preventing potentially fatal secondary events. Although evidence-based guidelines provide advice on managing a cardiac event in ideal circumstance, in reality, their implementation is often limited by the geographic location of the initial acute event and the location and level of facilities available to manage that event in a timely manner. For example, only an estimated 20% of emergency departments in the United States are located in hospitals with a cardiac catheterization laboratory. Still fewer have the capability to perform immediate revascularization. These data reinforce the importance of ready access to more portable and potentially life-saving therapies such as defibrillators and thrombolytic therapy, as well as efficient cardiac triage and transportation. The Cardiac Accessibility and Remoteness Index of Australia (Cardiac ARIA) measured access to cardiac care through a geographic lens via an objective, comparable measure of the time and distance from any population location to evidence-based cardiac care. An index of access to health services that was independent of professional, socioeconomic, or political influences was generated. It highlighted substantial inequities in access to cardiac services in Australia. Cardiac ARIA represents a powerful and adaptable tool to optimize outcomes by informing more equitable distribution of cost-effective, life-saving health care in any given geographic location.