# Inequitable provision of optimal services for patients with chronic heart failure: a national geo-mapping study

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## ABSTRACT

**Objective:** To compare the location and accessibility of current Australian chronic heart failure (CHF) management programs and general practice services with the probable distribution of the population with CHF.

**Design and setting:** Data on the prevalence and distribution of the CHF population throughout Australia, and the locations of CHF management programs and general practice services from 1 January 2004 to 31 December 2005 were analysed using geographic information systems (GIS) technology.

**Outcome measures:** Distance of populations with CHF to CHF management programs and general practice services.

**Results:** The highest prevalence of CHF (20.3–79.8 per 1000 population) occurred in areas with high concentrations of people over 65 years of age and in areas with higher proportions of Indigenous people. Five thousand CHF patients (8%) discharged from hospital in 2004–2005 were managed in one of the 62 identified CHF management programs. There were no CHF management programs in the Northern Territory or Tasmania. Only four CHF management programs were located outside major cities, with a total case load of 80 patients (0.7%). The mean distance from any Australian population centre to the nearest CHF management program was 332 km (median, 163 km; range, 0.15–3246 km). In rural areas, where the burden of CHF management falls upon general practitioners, the mean distance to general practice services was 37 km (median, 20 km; range, 0–656 km).

**Conclusion:** There is an inequity in the provision of CHF management programs to rural Australians.


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In response to the high burden of disease associated with chronic heart failure (CHF),[1] in particular the high rates of hospital admissions,[2] dedicated CHF management programs have been developed in Australia and internationally.[3,4] These multidisciplinary programs target recently hospitalised patients in an effort to optimise the continuum of care after discharge.[4]

A series of recent meta-analyses has confirmed that CHF management programs minimise readmission rates, improve quality of life, reduce costs, and prolong survival.[4-6]

The most comprehensive of the meta-analyses has shown a significant reduction in the risk of hospital readmission (relative risk [RR], 0.82; 95% CI, 0.72–0.93) and all-cause mortality (RR, 0.80; 95% CI, 0.66–0.98) associated with multidisciplinary programs of care.[4]

In a 2004–2005 survey of the location and type of CHF management programs nationally, our research team found a disproportionate concentration of services (93%) in capital and major cities.[7] The reality in Australia is that the burden of post-discharge care for the 40% of people with CHF living outside of capital cities (about 135 000 patients)[8] falls solely onto community-based general practitioners. Unfortunately, there are diminishing numbers of GPs and very few CHF management programs in rural and remote regions.[8,9]

Given the apparent mismatch between the demand for and availability of CHF management programs, we sought to accurately compare the location and accessibility of current programs and general practice services with the geographic distribution of people with CHF.

## METHODS

Our study combined geographic information systems (GIS) technology, which maps the geographic distribution and demography of the Australian population, with contemporary estimates of the prevalence and distribution of CHF,[8] the location of general practices,[10] and the known CHF management programs operating in Australia from 1 January 2004 to 31 December 2005.[7]

### Estimates of CHF in Australia

In the absence of large-scale, prospective, population-based data on the prevalence rates of CHF, we used an epidemiological projection model validated to known Australian data.[8] In this model, age- and sex-stratified CHF prevalence rates derived from international data[11-15] were used. A weighting was applied to rates among Aboriginals and Torres Strait Islanders in each region, based on CHF-related mortality data.[16]

### Distribution of CHF management programs

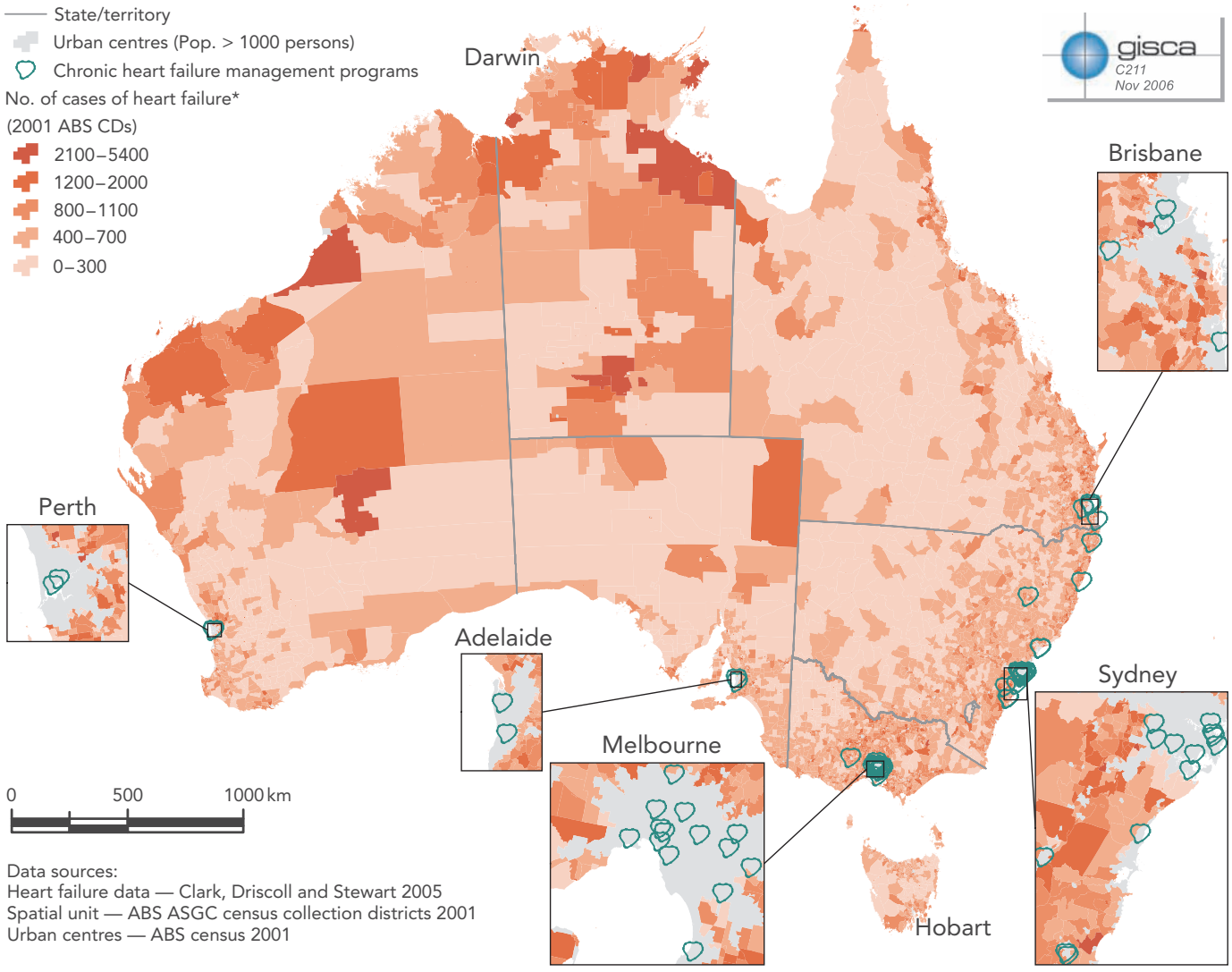
To determine the distribution of CHF management programs throughout Australia, we used the snowball sampling method. This involved contacting leading cardiologists and heart failure nurse specialists in each state and territory and asking them to identify and provide contact details for coordinators of CHF management programs and other specialist clinicians in their region. The process of contact and referral continued until no further programs were identified. Using the GIS software, we mapped the size and location of CHF management programs using exact street addresses. Each CHF management program was mapped according to size using a classification of case load from one patient to more than 200 patients.

To determine a validated measure of rurality and remoteness, each identified CHF management program was classified using the Accessibility/Remoteness Index of Australia (ARIA).[17] ARIA is a geographic index that defines remoteness by accessibility to goods and services and opportunities for social interaction across Australia, based on road distance from populated towns. ARIA measures are grouped into five categories, from Highly Accessible to Very Remote.[17]

### Location of general practices

General practice locations were identified from a project published by the National Centre for Social Applications of Geographic

**1 Estimated numbers of people living with chronic heart failure (CHF) in Australian census collection districts, and locations of CHF management programs**




*Natural Breaks (Jenks') Classification. ABS = Australian Bureau of Statistics. ASGC = Australian Standard Geographical Classification. CD = collection district. GISCA = National Centre for Social Applications of Geographic Information Systems. ◆

Information Systems (GISCA).[10] General practices were plotted to exact street addresses using the GIS software.

## GIS mapping technology

GIS are used to manage, analyse, and disseminate geographic knowledge. GIS link location to information (such as people to addresses, buildings to parcels, or streets within a network) and layer that information to give a better understanding of how it interrelates.

The GIS software applications used for this project were ESRI ArcView, version 3.3 and ESRI ArcMap, version 8.3 (ESRI, Redlands, Calif, USA).

The GIS aspects of this research involved applying our detailed estimates of CHF for the Australian population (with additional Indigenous weightings) to the smallest spatial statistical unit of the Australian Bureau of Statistics (ABS) — the census collection district.

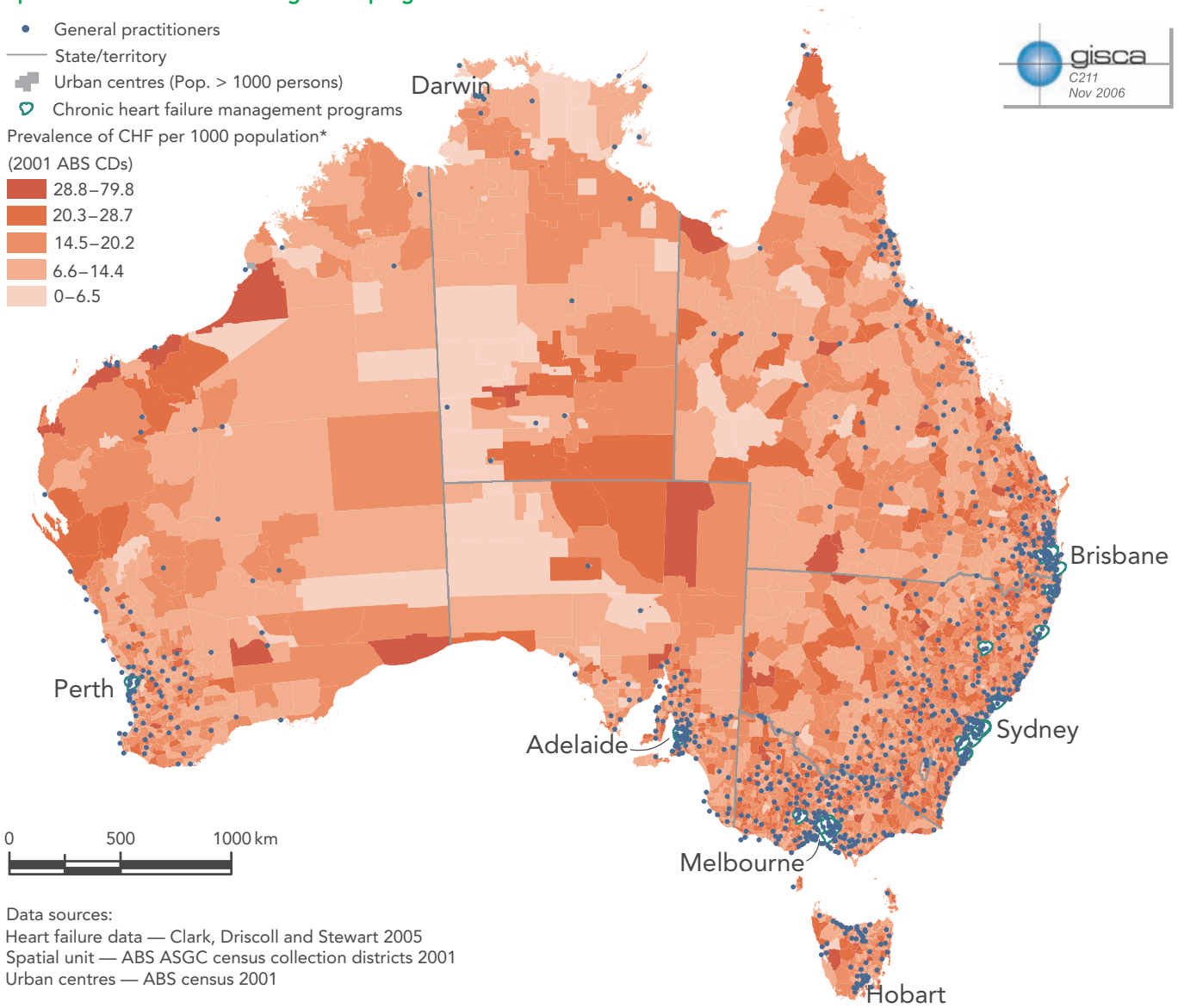
At the 2001 census, there were about 37 000 collection districts across Australia, ranging in size from 0.0022 $km^2$ to 230 000 $km^2$. Each collection district contains on average 225 households within a discrete area. Data collected included the total population of each collection district, including Indigenous population statistics.

CHF prevalence data were applied to the populations of each census collection district for the whole of Australia. The data were mapped thematically to five classes using Jenks' classification.[18] This uses naturally occurring breaks in the data histogram to determine where the class breaks should go.

The GIS applications were used to calculate the average road distance from Australia's 13 763 population localities to the nearest CHF management program and general practice.

All data relating to the geographic location of individuals with CHF, CHF management programs, and general practice clinics were processed with the GIS to develop "perfusion" maps that illustrate the rela-

**2 Estimated prevalence rate of chronic heart failure (CHF) in Australian census collection districts, and locations of general practitioners and CHF management programs**

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tionship between geographic concentrations of patients with CHF and the nearest available health care service. When viewed within the program, the maps provide the opportunity to zoom into smaller areas, such as states or towns, when larger scale information is required.

## RESULTS

### Distribution of CHF management programs

At the time of the study (2004–2005), there were 62 CHF management programs in Australia. These programs varied in case loads and the type of service provided (eg, specialist clinic versus home-based programs).[7]

Sixty per cent of individuals with CHF (198 817) were estimated to reside in capital cities, 20% (64 760) in regional cities, and 20% (71 708) in rural and remote areas. Forty per cent of people with CHF (136 000) were located outside capital cities.

Using ARIA, the CHF management programs were classified into levels of accessibility to essential services. Of the 62 CHF management programs, 93% (58) were located in highly accessible areas (ie, capital cities or metropolitan areas). The remaining four CHF management programs were located in accessible areas (ie, rural towns or cities). No CHF management programs were located in remote areas, and there were no CHF management programs in the Northern Territory or Tasmania.

Using the GIS technology, we calculated that the mean distance from any Australian population centre to the nearest CHF management program was 331.7 km (median, 162.7 km; range, 0.15–3246.3 km).

### Distribution of CHF by estimated number of cases in comparison to CHF management programs

Box 1 is a spatial map of CHF patients relative to the location of CHF management programs. It illustrates the location of the estimated 335 000 people living with CHF within the community (darker shading reflects higher CHF population concentrations). This map shows many areas of high case numbers outside capital cities, compared with the locations of CHF management programs, which are predominantly in the capital cities.

### Estimated prevalence of CHF in comparison to location of GPs and CHF management programs

Box 2 shows the spatial distribution map of CHF according to its estimated prevalence per 1000 population, relative to the location of specialist CHF management programs and the location of the 24 268 general practices within Australia.[10]

Central and Western Australia had the largest areas of high prevalence of CHF (28.8–79.8 per 1000 population), reflecting concentrations of sparsely located Indigenous communities in whom rates of CHF are estimated to be particularly high.[16]

High prevalence rates (20.3–28.7 per 1000 population) were also observed in areas favoured by retirees, for example, Hervey Bay and Caloundra in Queensland, Shoalhaven, Greater Taree, Coffs Harbour and Lake Macquarie in New South Wales, and Mandurah in Western Australia.

Population centres with general practice services (represented in Box 2 by the dots) in comparison to the CHF population were relatively sparse for most rural and remote areas. We calculated that the mean distance from any Australian population centre to the nearest general practice was 37 km (median, 20 km; range, 0–656 km).

## DISCUSSION

Overall, our population and service mapping study suggests that there are many areas of high CHF prevalence (2%–8%) outside capital cities. These areas are typically populated by people over 65 years old or are large Aboriginal and Torres Strait Islander communities. Our CHF population estimates compare well with current published data such as the Cardiac Awareness Survey and Evaluation (CASE) study (13.2% of population aged > 60 years),[19] and the Canberra Heart Study (6.3% of population aged > 60 years),[20] although neither of these studies have reported on rural, Indigenous, or disadvantaged populations. Our study also suggests that, of the probable 63 000 individuals admitted to hospital with CHF during 2004–2005,[2] only 8% (5000 patients) were enrolled in a CHF management program. This indicates that most Australian CHF patients did not receive recommended evidence-based care, which includes regular access to specialist CHF management programs.[21,22]

The clear disparity between evidence and practice was accentuated in rural and remote regions, with only four CHF management programs located outside major cities. These small centres of care managed about 80 (0.7%) of the potential 16 000 rural patients with CHF discharged from hospital in that year.[2]

The 62 CHF management programs operating within Australia during the study period were tightly clustered around the capital city regions, predominantly on the eastern seaboard (Box 2). As CHF management programs are a relatively new initiative, this might be expected.

However, we also found a potential mismatch between supply and demand for long-established general practice services. For the typically old and fragile patient with CHF, even 1 km may be a challenge in reaching a GP or an outpatient clinic. The average distances to CHF management programs or, where these are not available, to GP care preclude CHF models of care such as home visiting. Alternative solutions of care, including general practice-based multidisciplinary team approaches or the use of information technology to bridge the gap between very remote communities and centres of care, should be considered.[23]

Currently, most remote health services in Australia are provided by state and territory governments, with the Commonwealth funding aspects of Indigenous services and primary health care through Medicare. Although there has been some progress in coordination of responsibility by different levels of government in the area of Indigenous health, there is still no clear responsibility and accountability for health service and health outcomes between the different levels of government. This split in Commonwealth–state funding arrangements makes the delivery of integrated care for people with chronic disease (such as CHF management programs) extremely difficult.

Our study has several limitations that require comment. Most importantly, our technique hinges on accurate population and epidemiological data. In the Australian context, we re-emphasise the need for rigorous epidemiological data that clearly describe the particular characteristics of rural and Indigenous populations, to replace our population estimates.[24] The limitation of using ABS census collection district data or any statistical method is the presence of outliers, which create extremes and distort the overall results. There were several locations on our maps that appeared to indicate high prevalence over large areas in remote regions. This phenomenon is caused by the required number of households for a collection district (225) being spread over an extensive geographic area, and is why we presented both the absolute number of cases and overall prevalence rates.

Despite these limitations, our data highlight a clear mismatch between where services are provided and where people with CHF are likely to live in the greatest concentrations. There is a need to provide equitable access to CHF management programs to the ageing population regardless of its location. The use of GIS technology in guiding service and resource allocation is scientifically grounded and free of politics and subjectivity. The concepts presented in this article are internationally unique and could have broad application for all chronic disease service research.

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## COMPETING INTERESTS

None identified.

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