

Poor access to kidney disease management services in susceptible patient populations in rural Australia is associated with increased aeromedical retrievals for acute renal care

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Key words

chronic kidney disease, delivery of health care, emergency medicine, general medicine, rural health services.

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Abstract

Background: Inequalities in access to renal services and acute care for rural and remote populations in Australia have been described but not quantified.

Aim: To describe: the coverage of renal disease management services in rural and remote Australia; and the characteristics of patients who had an aeromedical retrieval for renal disease by Australia's Royal Flying Doctor Service (RFDS).

Methods: Data from the RFDS, the Australian Bureau of Statistics, and Health Direct were used to estimate provision of renal disease management services by geographic area. RFDS patient diagnostic data were prospectively collected from 2014 to 2018.

Results: Many rural and remote areas have limited access to regular renal disease management services. Most RFDS retrievals for renal disease are from regions without such services. The RFDS conducted 1636 aeromedical retrievals for renal disease, which represented 1.6% of all retrievals. Among retrieved patients, there was a higher proportion of men than women (54.6% vs 45.4%, $P < 0.01$), while indigenous patients ($n = 546$, 33.4%) were significantly younger than non-indigenous patients (40.9 vs 58.5, $P < 0.01$). There were significant differences in underlying diagnoses triggering retrievals between genders, with males being more likely than females to be transferred with acute renal failure, calculus of the kidney and ureter, renal colic, obstructive uropathy, and kidney failure (all $P < 0.01$). Conversely, females were more likely to have chronic kidney disease, disorders of the urinary system, acute nephritic syndrome, tubulo-interstitial nephritis, and nephrotic syndrome (all $P < 0.01$).

Conclusion: Aeromedical retrievals for acute care were from rural areas without regular access to renal disease prevention or management services.

Introduction

Similar to countries of vast expanse such as North America and China,^{1,2} Australian populations living in rural and remote regions typically have poorer health compared to those living in major cities.³ Rural and remote Australians have a higher prevalence of disease risk factors, such as smoking, overweight and obesity, and alcohol and drug misuse compared to major cities.⁴ Furthermore, there is reduced access to health care and long distances to travel to receive medical services.³ These factors, in combination, result in higher rates of chronic diseases, increased morbidity and mortality for

people living in rural and remote regions compared to those living in major cities.^{5–7}

The major discrepancies in mortality from chronic diseases between rural and remote and urban settings are 1.3 times higher mortality from coronary heart disease and 2.3 times higher death from diabetes. These diseases in turn are associated with an increased risk of chronic kidney disease (CKD).⁸ Reduction in morbidity and mortality rests firstly on prevention – the reduction of risk factors – and then on the adequacy of treatment. The risk factors for CKD are similar to those for a range of other chronic diseases: smoking, limited physical activity, obesity and hypertension. The prevalence of these risk factors is higher in rural and remote than urban populations, representing a clear opportunity for prevention.^{9–11} In addition, access to health care may be

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limited in rural and remote regions; that is, both prevention and treatment which are likely to contribute to health disparities for rural and remote populations.

Aboriginal and Torres Strait Islander (hereafter referred to as indigenous) Australians have worse health outcomes when compared to non-indigenous Australians on many metrics, and this is compounded for Indigenous Australians living in rural and remote regions. A recent study of an indigenous population in a remote area of Western Australia highlighted the leading causes of death were diabetes, renal failure and ischaemic heart disease. For diabetes and renal failure, mortality was much higher than the general Australian population (16% vs 2.9%; 12% vs 1.8%, respectively).¹²

In this article, we focus on renal diseases and access of Australians living in rural and remote areas to appropriate health services. We use data on the location of renal disease management services as a measure of access to relevant services, and the impact on aeromedical retrievals for emergent care.

The specific aims of this article are to:

- 1** map the location of renal disease management services available to people living in rural and remote areas of Australia; and
- 2** describe the characteristics of patients who underwent aeromedical retrieval (gender, indigenous status and age) for renal diseases between July 2014 and June 2018.

Methods

Setting

The Royal Flying Doctor Service (RFDS) provides essential aeromedical and primary healthcare to rural and remote populations and visitors who are unable to access traditional services, such as those involving the Medicare Benefits Schedule (MBS). As with other literature,^{13–15} the terms ‘rural’ and ‘remote’ include all areas outside Australia’s major cities, including areas classified as inner and outer regional (RA2 and RA3 respectively) and remote or very remote (RA4 and RA5 respectively) by the Australian Statistical Geography Standard (ASGS).¹⁶

Data sources

We used data from the Australian Bureau of Statistics (ABS) 2016 Census to derive geographical population estimates. We defined ‘renal disease management services’ as including renal disease management units,

dialysis and renal services/units, and Aboriginal Health Services, as registered on Health Direct. For an extensive list, please refer to Health Direct.¹⁷ We then used the Service Planning and Operational Tool (SPOT) to map coverage of renal disease management services across Australia, with a focus on rural and remote Australia. Working from a geographic distribution of ‘demand (population)’ and a set of healthcare facilities that provides cover for a range of services (in this case – renal disease management services), SPOT calculates the proportion of demand covered by those facilities within a user-specified drive time.¹⁴ Demand is represented by population levels in different categories (e.g. renal disease patients).

For the second aim, we used data on patients who had an aeromedical retrieval between July 2014 and June 2018. Data were prospectively collected on each patient’s inflight working diagnosis, and coded to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM).^{18,19} In this analysis, we included all patients with a diagnosis of renal disease, ICD-10 codes N00–N29 (diseases of the kidney). Data were collected within flight on the patient’s gender, age, and indigenous status, using either paper-based or electronic methods, according to the usual practice of the specific RFDS Section and Operation.

RFDS clinical and aeromedical databases were also accessed to provide patient flight information, including the number of patient flight legs. Multiple transfer legs were removed from the analysis and reduced to a single episode of care.

This project was deemed a low-risk quality assurance project by the RFDS Clinical and Health Services Research Committee (CHSRC), on 18 March 2019. As this project involved routinely collected data, specific patient consent forms were not required.

Statistical analysis

A combination of descriptive statistics and Chi-squared analysis was used in data analysis, with significance determined at $P < 0.01$. All analyses were performed using Microsoft Excel and the statistical software package R version 3.5.1.

Results

Mapping of the registered renal disease management services indicate that there are many rural and remote areas that do not have permanent clinical provision, such as the rural and remote regions of Whyalla (26 460 people without access), Norseman (14 761 people

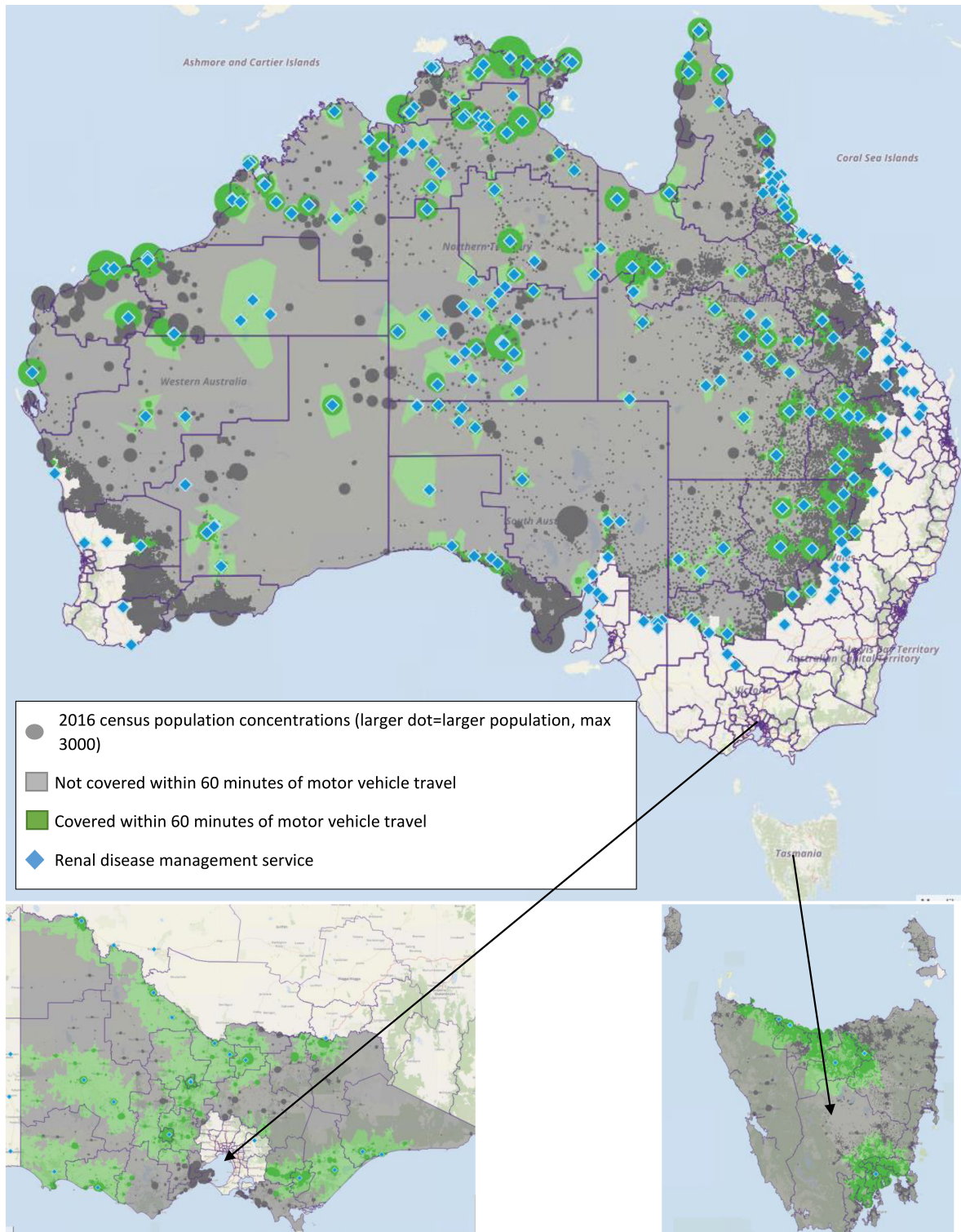


Figure 1 Rural and remote renal disease management service locations and corresponding population concentrations. This figure estimates the rural and remote provision of renal disease management services, and excludes metropolitan areas, using HealthDirect (renal disease management services, including dialysis unit and Aboriginal Medical Services), RFDS and ABS data sources. The dots indicate population concentrations, with larger dots equalling more people (max 3000). Green dots indicate population concentrations that are able to access services within a 60 min drive time; grey dots indicate population concentrations that are not able to access services within a 60 min drive time.

Table 1 Study characteristics and yearly trends

	2014/15	2015/16	2016/17	2017/18	Total
Total renal disease diagnosis: ICD-10 codes N00-N29 (% of total retrievals)	238 (2.0)	241 (0.8)	543 (1.85)	614 (1.8)	1636 (1.6)
Mean age (SD) (years)	51.9 (23.4)	53.1 (22.8)	52.1 (21.3)	52.9 (21.7)	52.7 (22.2)
Male (%)	133 (55.9)	125 (51.9)	303 (55.8)	332 (54.1)	893 (54.6)
Indigenous (%)	87 (36.5)	83 (34.4)	180 (33.1)	196 (31.9)	546 (33.4)
Total retrievals	11 760	30 151	29 319	33 917	105 147

without access), and Merridin (6752 people without access). Figure 1 provides a graphical representation of the locations of the current renal disease management service providers, and the ABS population concentrations.

The RFDS conducted 1636 aeromedical retrievals (1.6% of the total aeromedical retrievals) for patients with renal disease, during the 2014 to 2018 financial years, as detailed in Table 1. Most of the transfers were from rural and remote areas to inner-regional or

metropolitan centres (Fig. 2). Data on the kilometres flown by each patient were collected on 1022 (62.5%) of the patients; the average flight distance was 377.5 km (SD = 254.7). The majority ($n = 965$; 94.4%) of the aeromedical retrieval locations were more than 100 km, with many ($n = 481$; 47.1%) being over 300 km, from the nearest chronic disease management service, as detailed in Figure 3.

Among retrieved patients, there was a higher proportion of men than women ($P < 0.01$). Indigenous patients

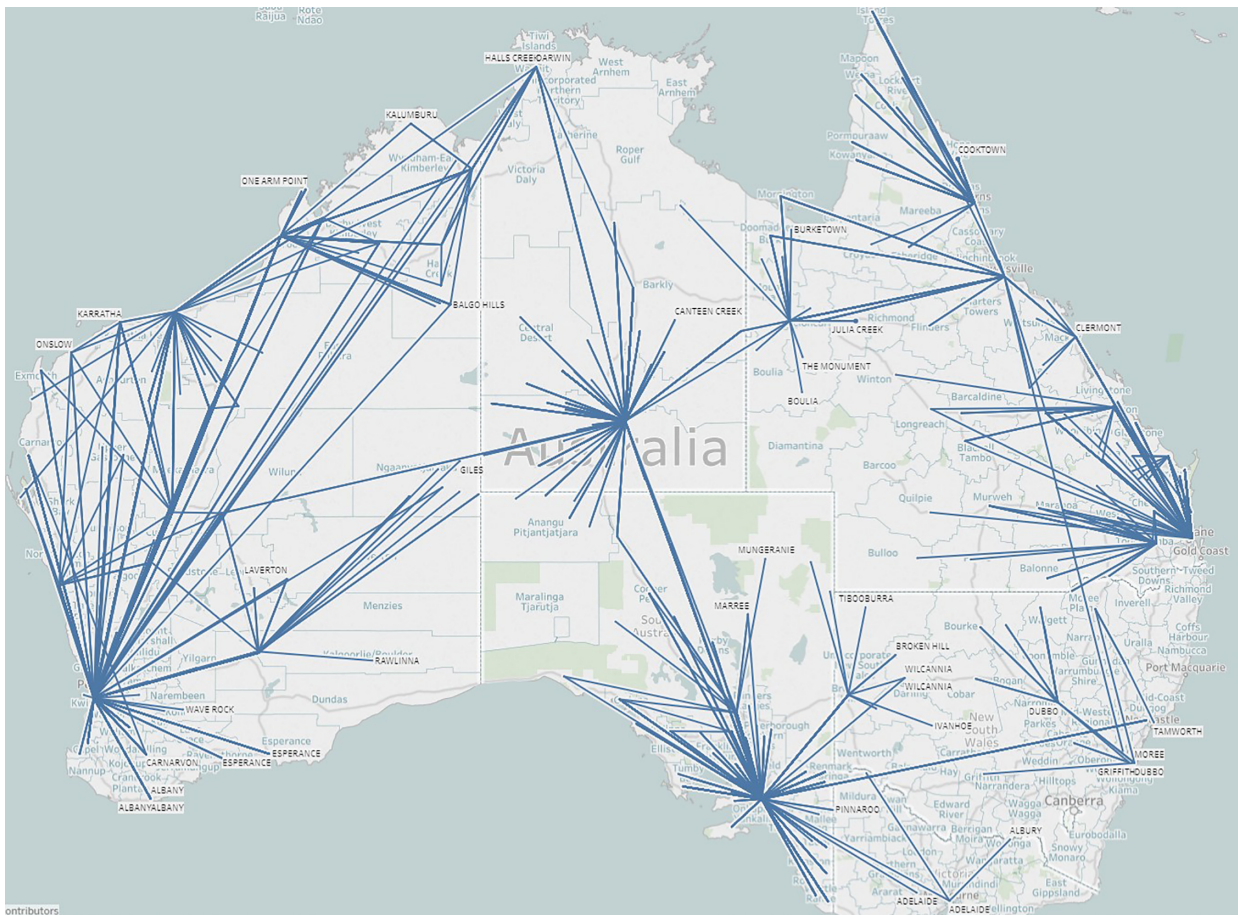


Figure 2 Chronic kidney disease aeromedical retrieval and transfer locations.

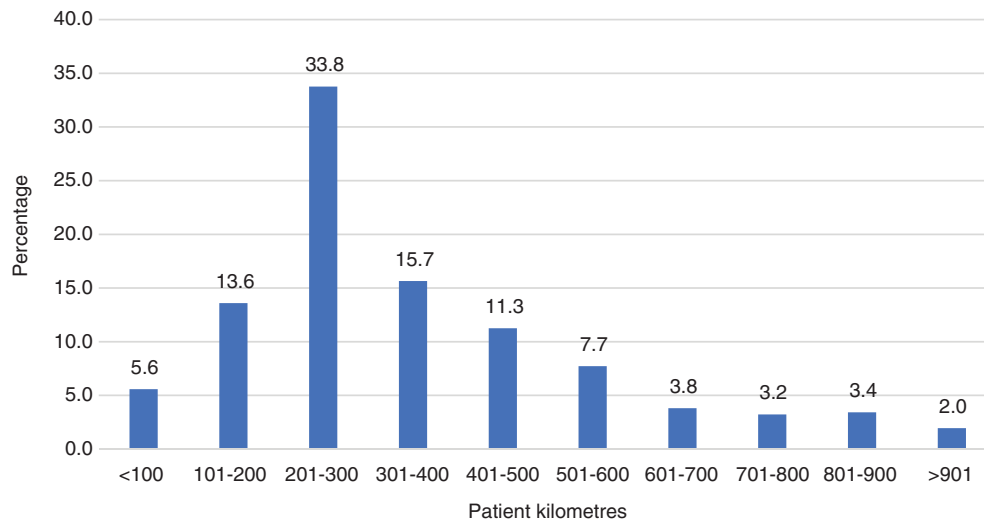


Figure 3 Patient aeromedical retrieval location and the distance to an appropriate treatment facility.

comprised over one-third of all retrievals (see Table 2). The average age of indigenous patients was 40.9 (SD = 20.6) years which was significantly ($P < 0.01$) younger than that of the non-indigenous patients (average age of 58.5 (SD = 19.1) years). Age is described by diagnosis in Table 2.

Among retrieved patients, there were significant differences in diagnoses between genders, as shown in Table 2. Males were more likely (all $P < 0.01$) than females to have a diagnosis of acute renal failure (acute kidney injury), calculus of the kidney and ureter, renal colic, obstructive uropathy, kidney failure, unspecified nephritic syndrome, calculus of the lower urinary tract, and recurrent and persistent haematuria. Conversely, females were more likely (all $P < 0.01$) to have a diagnosis of chronic kidney disease, other disorders of kidney and ureter, acute nephritic syndrome, tubulo-interstitial nephritis, acute tubulo-interstitial nephritis, other renal tubulo-interstitial diseases, nephrotic syndrome, disorders resulting from impaired renal tubular function, and other disorders of kidney and ureter in diseases not classified elsewhere.

Indigenous patients were over-represented (all $P < 0.01$) as compared to non-indigenous patients in relation to transfers with diagnoses of chronic kidney disease, acute nephritic syndrome, tubulo-interstitial nephritis, and unspecified nephritic syndrome (refer to Table 2 for the full breakdown). Of concern, indigenous Australians who were retrieved for acute renal failure (acute kidney injury), chronic kidney disease, and kidney failure were significantly (all $P < 0.01$) younger, aged 50.5 (SD = 13.4), than non-indigenous Australians, aged 66.4 (SD = 15.2), retrieved for the same conditions.

Discussion

Our findings show that there are large populations living in rural and remote regions of Australia who do not have access to specific renal disease management services within a reasonable driving distance, that is 60 min. This lack of access is supported by the more common use of aeromedical retrieval services by people living in these rural and remote regions. Of particular concern is the high proportion of indigenous patients requiring an aeromedical retrieval for renal disease, and the younger age of indigenous versus non-indigenous patients.

General practitioners manage the majority of chronic conditions in Australia; however rural and remote areas have primary healthcare shortages,²⁰ with large communities without reasonable access.²¹ Mapping demonstrated that the majority of the rural and remote population may not have regular access to specific renal disease management services, including dialysis services, with the majority of the population required to travel hundreds of kilometres. This is consistent with recently published literature on other health outcomes, which indicated shortages of mental health and primary healthcare services in rural and remote areas.^{14,22}

The primary management for end-stage kidney disease is haemodialysis. Haemodialysis is physically and socially demanding with patients often requiring dialysis three times a week, while also adhering to medication regimens and dietary recommendations.²³ Consistent with our findings, it has been reported that 50% of indigenous patients with end-stage kidney disease starting dialysis lived in regions without dialysis treatment facilities,²⁴ with 75% of remote indigenous patients

Table 2 Characteristics of patients who had a RFDS medical retrieval between 2014 and 2018

ICD-10 code description	Male, % (n)	Female, % (n)	Total, % (n)	Indigenous, % (n)	Indigenous, males, % (n)	Non-indigenous patients, mean age (SD)	Indigenous patients, mean age (SD)
N17 Acute renal failure (acute kidney injury)	25.9 (231)	20.1 (149)	23.2 (380)	33.4 (127)	47.2 (60)	66.0 (15.7)	48.9 (14.6)
N20 Calculus of kidney and ureter	24.2 (216)	17.2 (128)	21.0 (344)	6.1 (21)	38.1 (8)	56.4 (16.6)	39.6 (13.1)
N18 Chronic kidney disease	13.2 (118)	19.2 (143)	16.0 (261)	70.1 (183)	38.8 (71)	69.1 (14.4)	51.8 (10.7)
N23 Renal colic	7.6 (68)	4.8 (36)	6.4 (104)	13.5 (14)	21.4 (3)	49.0 (14.4)	41.3 (16.9)
N13 Obstructive and reflux uropathy	6.0 (54)	4.4 (33)	5.3 (87)	14.9 (13)	23.1 (3)	62.0 (17.3)	54.0 (5.7)
N28 Other disorders of kidney and ureter, not elsewhere classified	3.7 (33)	5.5 (41)	4.5 (74)	16.2 (12)	25.0 (3)	56.5 (23.5)	49.8 (21.3)
N00 Acute nephritic syndrome	2.9 (26)	4.7 (35)	3.7 (61)	75.4 (46)	41.3 (19)	45.7 (25.6)	9.6 (13.4)
N19 Kidney failure	4.1 (37)	2.8 (21)	3.5 (58)	41.4 (24)	41.7 (10)	64.3 (12.3)	49.4 (22.3)
N12 Tubulo-interstitial nephritis, not specified as acute or chronic	1.1 (10)	5.5 (41)	3.1 (51)	52.9 (27)	3.7 (1)	49.1 (20.7)	36.4 (13.3)
N10 Acute tubulo-interstitial nephritis	1.0 (9)	4.2 (31)	2.4 (40)	42.5 (17)	5.9 (1)	50.0 (5.7)	29.0 (8.5)
N15 Other renal tubulo-interstitial diseases	1.6 (14)	3.4 (25)	2.4 (39)	48.7 (19)	15.8 (3)	47.6 (22.2)	38.1 (23.7)
N05 Unspecified nephritic syndrome	2.0 (18)	1.6 (12)	1.8 (30)	60.0 (18)	61.1 (11)	47.0 (19.8)	9.0 (3.5)
N04 Nephrotic syndrome	1.7 (15)	1.9 (14)	1.8 (29)	37.9 (11)	27.3 (3)	31.8 (31.2)	21.0 (18.1)
N25 Disorders resulting from impaired renal tubular function	1.2 (11)	1.6 (12)	1.4 (23)	26.1 (6)	33.3 (2)	53.3 (17.5)	31.3 (19.4)
N29 Other disorders of kidney and ureter in diseases classified elsewhere	1.1 (10)	1.6 (12)	1.3 (22)	22.7 (5)	20.0 (1)	59.5 (27.4)	50.5 (27.6)
N21 Calculus of lower urinary tract	1.2 (11)	0.9 (7)	1.1 (18)	11.1 (2)	0.0 (0)	70.6 (12.5)	60.0 (0.0)
N02 Recurrent and persistent haematuria	1.3 (12)	0.4 (3)	0.9 (15)	6.7 (1)	0.0 (0)	69.3 (34.9)	50.0 (n/a)
Total	54.6 (893)	45.4 (743)	100 (1636)	33.4 (546)	36.5 (199)	58.5 (19.1)	40.9 (20.6)

All gender comparisons were significant, at $P = <0.01$.

required to relocate to access treatment. Conversely, 99.8% of non-indigenous patients requiring treatment live in regions with dialysis services.²⁵ As such, it should be of little surprise that the survival rates of rural and remote indigenous patients are significantly lower than those in non-indigenous metropolitan populations.⁴ If cost-effective and culturally appropriate services, compared to the cost of an aeromedical retrieval (estimated to be AU\$8500.0), are provided to areas without renal treatment units, patient outcomes may be improved which could potentially reduce the need for organisations, such as the RFDS, to undertake emergency aeromedical retrievals for patients at crisis point.

This is the first study to consider the characteristics of patients who underwent an aeromedical retrieval for

renal disease. A key finding is that Indigenous Australians make up a high proportion of the aeromedical retrievals for these conditions. This may not be surprising as the National Rural Health Alliance reports that the prevalence of end-stage kidney disease is much higher in rural and remote Australia, at 81.1 and 35.7 in very remote and remote areas respectively, compared to 19.9 per 100 000 in major Australian cities.²⁶ Furthermore, the Second Australian Atlas of Healthcare Variation (second Atlas), showed that kidney and urinary tract infections are more prevalent in Indigenous Australians, and that rural and remote populations generally have a higher prevalence than metropolitan areas.²⁷ The literature also indicates that Indigenous Australians have eight times the rate of end-stage kidney

disease compared with non-indigenous Australians,²⁸ with many having an earlier onset of disease.²⁹ Indigenous Australians are more likely to live in rural and remote regions.³⁰ While the RFDS is a rural and remote service provider, it was expected that many of the aeromedical transfers would be for indigenous patients. However, this study highlights several concerning factors in rural and remote areas: the earlier age of onset of acute and chronic renal disease, the lack of access to renal services as well as to dialysis facilities, likely culminating in many patients either leaving their communities to receive treatment or foregoing treatment until crisis point, via aeromedical retrieval services.²⁹

It has been reported that travelling satellite dialysis units provide similar medical outcomes, and perceived patient benefits, as compared to major hospital units.³¹ The RFDS, like Purple House, is ideally placed to provide road-based travelling dialysis treatment via its current primary healthcare services. As per other recently established non-traditional interventions for dental and hearing services,^{22,32} the RFDS could target areas without current renal treatment options using a travelling service integrated into current chronic disease care, leveraging telemedicine capabilities. This would allow rural and remote patients to stay within their communities to access regular treatment, which is believed would then improve outcomes for patients with renal disease living in rural and remote areas.

This study was limited to RFDS patient data and as such did not include other rural and remote healthcare providers. While all diagnoses were collected, a limitation was that we were unable to code all the working diagnoses to the more detailed second ICD-10-AM level; only the patient's primary working diagnosis was recorded. Consequently, this study may under-represent the burden of illness and complexity of case retrieval by the RFDS. This study may also have under-represented renal disease management service provision, in that this study only included services registered on HealthDirect. Nevertheless, HealthDirect was the most robust national dataset available at the time of publication. By including Aboriginal Medical Services that conduct renal disease management, such as Purple House,³³ some of this limitation may have been ameliorated.

Future research will be aimed at determining how many patients returned to their communities following retrieval, and their associated patient journey. We also hope to determine patient outcomes while in hospital, which should also help determine the reasons for some patients not returning to their community. Understanding the social impacts of removing patients

from their communities will be of considerable importance.

Ideally, all Australians should have access to appropriate health services to ensure good health. The 'adequate' provision of renal services depends on the size as well as the age, sex and indigenous status of the population, in addition to the prevalence of renal disease. In reality, provision of services is constrained by competing priorities within limited funding. Better understanding factors such as the social, economic, and personal impact of aeromedical retrievals in rural and remote populations provides additional information to this consideration of competing priorities.

Conclusion

This study aimed to estimate the provision of dedicated renal disease management services, and the characteristics of patients who received an aeromedical retrieval for renal disease within rural and remote Australia. The majority of retrievals were from areas without regular access to renal disease management services, with many rural and remote patients required to travel extensive distances to access services. The majority of patients retrieved were male, with significant aeromedical diagnostic differences between genders. Indigenous Australians were significantly younger than the wider population, with a significant over-representation of patients with chronic kidney disease, acute nephritic syndrome, tubulointerstitial nephritis, cystitis and unspecified nephritic syndrome.

To reduce acute cases requiring aeromedical retrieval, policy inventions need to be established to encourage increased service provision of renal disease management and dialysis services. The RFDS, alongside its current primary healthcare travelling clinics, could provide road-based travelling satellite dialysis units, which have been found to provide similar medical benefits to units provided in major hospitals. These proposed travelling units would target areas without current service provision, with high population prevalence of renal disease and its associated comorbidities, such as diabetes and hypertension. A RFDS travelling satellite dialysis unit could also reduce retrievals for renal emergencies through early intervention.

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