# Haemodialysis outcomes of Aboriginal and Torres Strait Islander patients of remote Kimberley region origin

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## ABSTRACT

**Objectives:** To compare the clinical outcomes and mortality rates of Aboriginal and Torres Strait Islander people of Kimberley origin receiving haemodialysis (HD) treatment with other subsets of Aboriginal and Torres Strait Islander HD patients (Northern Territory, Western Australia excluding the Kimberley region, the rest of Australia) and Australian non-Indigenous HD patients.

**Design, participants and setting:** Retrospective identification of Aboriginal and Torres Strait Islander patients of Kimberley origin and analysis of secondary data from the Australia and New Zealand Dialysis and Transplant Registry; this group was compared with other Australian patients receiving HD treatment from 1 January 2003 to 31 December 2007.

**Main outcome measures:** Clinical outcome measures; comorbid conditions; death rates per 100 patient-years, unadjusted and adjusted (for age, sex, comorbid conditions, late referral to nephrologist treatment).

**Results:** Seventy per cent of HD treatments for Aboriginal and Torres Strait Islander patients of Kimberley origin was provided in the Kimberley. They had comparable adjusted mortality rates to non-Indigenous Australian patients (adjusted mortality rate ratio, 0.80; 95% CI, 0.51–1.23).

**Conclusions:** This is the first report showing similar mortality rates for Aboriginal and Torres Strait Islander people exclusively from a remote area of Australia and non-Indigenous Australians receiving HD treatment. HD treatment delivered closer to home can be safe and effective in remote areas.


MJA 2010; 193: 516–520

As has been widely reported elsewhere, over the past 20 years, there has been an epidemic of end-stage kidney disease (ESKD) among Aboriginal and Torres Strait Islander people in remote areas of Australia.[1-5] Known risk factors include intrauterine growth retardation, various illnesses in childhood, the early onset and poor control of hypertension and diabetes, and possibly smoking.[6]

There have been limited reports on the outcomes of Aboriginal and Torres Strait Islander people on dialysis in Australia, and those that have been published have generally documented poor patient survival when compared with non-Indigenous patients in Australia.[4,5,7] From 1993 to 1996, the median survival for patients undergoing peritoneal dialysis (PD) and haemodialysis (HD) was 3.3 and 6.5 years for Aboriginal and Torres Strait Islander people, respectively.[5] When all forms of renal replacement therapy (RRT) were included, patient survival for Aboriginal and Torres Strait Islander people was less than a third that of non-Indigenous patients. During 1994 and 1995 almost 25% of the central Australian Aboriginal cohort receiving HD treatment in Alice Springs died over a 12-month period.[7] From April 2001 to mid-2005, survival on HD among Western Desert Nganampa Walytja Palyantjaku Tjutaku members was reported as being only 2.5 years.[4] Only one published study, from New South Wales, reports similar differences in mortality rates between Aboriginal and non-Indigenous patients receiving HD treatment; however, this study was unadjusted for sex, age or comorbid conditions.[2]

For some remote-living Aboriginal and Torres Strait Islander people, adherence to dialysis regimes has been difficult, and high rates of missed dialysis sessions have been reported;[7] this is associated with increased adverse outcomes.[8] Between 1993 and 2001, 50% of Aboriginal and Torres Strait Islander patients with ESKD starting dialysis lived in regions without ESKD treatment facilities. In remote areas of Australia between 1999 and 2001, more than 75% of Aboriginal and Torres Strait Islander people starting RRT needed to relocate to have access to treatment.[1] In contrast, 99.8% of non-Indigenous patients lived in regions across Australia with dialysis facilities.[6]

Aboriginal and Torres Strait Islander patients of Kimberley region origin have been managed through Royal Perth Hospital (RPH) for over 20 years with satellite dialysis services from metropolitan Perth. Satellite HD treatment has been provided in the Kimberley since the Kimberley Satellite Dialysis Centre (KSDC) opened in October 2002. RPH and KSDC have, between them, been responsible for the care of Kimberley patients requiring HD since then, with most patients receiving HD in both locations at different times. Here, we report on mortality rates and clinical outcomes for Aboriginal and Torres Strait Islander people of Kimberley region origin receiving HD treatment, and compare them with other Australian patients receiving HD treatment.

## METHODS

Because a new model of care for Kimberley patients undergoing HD started in October 2002, we investigated the outcomes for Aboriginal and Torres Strait Islander patients of Kimberley origin between 1 January 2003 and 31 December 2007.

Patients of Kimberley origin receiving any form of RRT in any Australian location between 1 January 2003 and 31 December 2007 were identified based on an extensive search and cross-referencing of records from patient information databases at RPH, KSDC, Kimberley Aboriginal Community Controlled Health Services (ACCHSs), and the Australia and New Zealand Dialysis and Transplant Registry (ANZDATA) using postcode at entry, and supplemented by local information from service providers. There were six non-Indigenous RRT patients originating from the Kimberley region and they were not included in further analysis.

We identified patients retrospectively for inclusion in the clinical outcomes and mortality analyses if they were recorded on ANZDATA as being on maintenance HD therapy (consistent with ANZDATA annual reports) in Australia between 1 January 2003 and 31 December 2007 and had com-

**1 Annual snapshot (at 31 December each year) of the location of Aboriginal and Torres Strait Islander patients of Kimberley origin undergoing haemodialysis treatment**

| | Year | | | | |
|---|---|---|---|---|---|
| Location | 2003 | 2004 | 2005 | 2006 | 2007 |
| Kimberley* | 38 | 41 | 44 | 49 | 50 |
| Perth | 11 | 19 | 16 | 22 | 28 |
| Non-Western Australian | 0 | 1 | 1 | 1 | 2 |
| Total | 49 | 61 | 61 | 72 | 80 |

* Haemodialysis treatment in the Kimberley is provided by the Kimberley Satellite Dialysis Centre (10 chairs, up to 41 patients), Derby Aboriginal Health Service in Derby, 220 km from Broome (two chairs, up to four patients), and home haemodialysis is provided in several communities across the Kimberley (up to six patients). ◆

menced RRT after 1 January 1992 (the earliest start date on RRT for HD patients of Kimberley origin who were alive in 2003).

State or territory and Aboriginal or Torres Strait Islander identification was based on ANZDATA records.

As Aboriginal and Torres Strait Islander people from the Northern Territory have RRT incidence rates[3,9] and levels of socioeconomic disadvantage[10,11] similar to those of Kimberley Aboriginal and Torres Strait Islander people, and as other Aboriginal and Torres Strait Islander patients from Western Australia receive services from the same health system as Kimberley patients (WA Department of Health), we selected two regions (NT and the rest of WA) as the main comparison groups for patients of Kimberley origin. The other comparison groups were Aboriginal and Torres Strait Islander HD patients in the rest of the Australia and all non-Indigenous Australian HD patients.

### Kimberley dialysis treatment model

Whenever possible, patients of Kimberley origin are offered treatment at home (PD or home HD). While at least 70% of Kimberley origin patients receive PD early in treatment, during the years 2003 to 2007, most patients on PD changed to HD after complications arose (eg, peritonitis). During the study period an overall average of 70% of patients of Kimberley origin received HD treatment.

HD treatment is mainly provided by KSDC (10 chairs), with small numbers at Derby Aboriginal Health Service located 220 km from Broome (two chairs) and at home in communities across the Kimberley (four to six people). Most of the Kimberley group received treatment in both the Kimberley and Perth for varying periods during the study. As HD treatment was provided jointly by RPH and KSDC, this combined service was analysed as a whole. This approach reduces the possibility of selection bias based on location of dialysis.

### Clinical outcomes

During 1 January 2003 to 31 December 2007, ANZDATA carried out regular surveys and the last results during each survey period for urea reduction ratio (URR), and levels of haemoglobin, calcium, phosphate, and calcium × phosphate product were recorded for HD patients in Australia. During the study period, the Caring for Australasians with Renal Impairment (CARI) dialysis clinical practice guidelines[12] recommended the following levels for best practice care: URR, > 65%; haemoglobin, 110–130 g/L (currently under review); calcium, 2.1–2.4 mmol/L; phosphate, 0.8–1.6 mmol/L; and calcium × phosphate product, < 4.0 $mmol^2/L^2$. The results for patients who were alive at the end of each survey period were used in the analysis of clinical outcomes. Comorbid conditions (diabetes, chronic lung disease, coronary artery disease, peripheral vascular disease, cerebrovascular disease) that were reported to ANZDATA were used to determine comorbid conditions at start of treatment. Patients were classified as being referred late to nephrological care if they started RRT less than 3 months after their first consultation with a nephrologist.

Mortality rates are expressed as deaths per 100 patient-years of HD from 1 January 2003 to 31 December 2007. Deaths occurring less than 30 days after transferring to HD from another treatment modality were not attributed to HD, consistent with ANZDATA annual reports (as including such deaths could lead to bias). Withdrawal from treatment was counted as a death.

Note that the interpretation and reporting of these data here are the responsibility of the authors and should in no way be seen as an official policy or interpretation of ANZDATA.

### Statistical analysis

Differences in baseline characteristics were compared using $\chi^2$ test for categorical data, unpaired $t$ tests for continuous normally distributed data and Mann–Whitney tests for continuous non-normally distributed data. Biochemical outcomes involved repeated measurements for each patient, and so were analysed using binomial models with log link via generalised estimating equations to compare differences in proportions between the groups. Pair-wise comparisons were performed post-hoc using model estimates. Poisson regression was used to adjust mortality for: age at the start of HD or 1 January 2003, whichever was later; sex; presence or absence of comorbid conditions; with and without adjusting for late referral. All analyses were performed using Stata, version 10 (StataCorp, College Station, Tex, USA). Point estimates were presented with 95% CIs; $P < 0.05$ was considered statistically significant.

### Ethics approval

Ethics approval was obtained from the Human Research Ethics Committee of the University of Western Australia and the Western Australian Aboriginal Health Information and Ethics Committee.

## RESULTS

During the 5 years of the study, 77 Kimberley Aboriginal and Torres Strait Islander patients commenced maintenance RRT, giving an average yearly incidence of 1249 per million (95% CI, 1000–1560 per million), similar to NT figures of 1215 per million (95% CI, 1090–1354 per million) for the same period (based on data from ANZDATA[9] using Australian Bureau of Statistics figures for population).

During 2003 to 2007, 70% (101) of Aboriginal and Torres Strait Islander RRT patients of Kimberley origin received HD, 70% of which was provided in the Kimberley. A snapshot of the location where HD patients received treatment is shown in Box 1. There were 27 414 planned HD treatment

**2 Demographic characteristics and baseline data of patients who commenced haemodialysis after 1992 recorded on the Australia and New Zealand Dialysis and Transplant Registry from 1 January 2003 to 31 December 2007**

| Characteristic | Aboriginal and Torres Strait Islander people | | | | Non-Indigenous Australians |
|---|---|---|---|---|---|
| | Kimberley | Rest of WA | NT | Rest of Australia | |
| No. of patients | 110 | 221 | 502 | 733 | 13 274 |
| Proportion who withdrew from treatment† | 1.8% | 3.2% | 5.2% | 5.8% | 10.2%* |
| Median age at start (years) | 47.6 | 47.5 | 49.8* | 51.4* | 63.5* |
| Female | 60.0% | 58.8% | 58.2% | 52.8% | 37.6%* |
| Comorbid conditions | | | | | |
| Diabetes | 70.0% | 78.3% | 75.7% | 73.5% | 33.6%* |
| Chronic lung disease | 10.0% | 17.2% | 13.6% | 17.3% | 14.9% |
| Coronary heart disease | 22.7% | 40.3%* | 34.3%* | 44.8%* | 38.8%* |
| Peripheral vascular disease | 6.4% | 9.5% | 10.4% | 13.8%* | 14.4%* |
| Cerebrovascular disease | 17.3% | 17.2% | 25.7% | 31.2%* | 24.2% |
| Late referral | 52.7% | 36.1%* | 32.5%* | 37.7%* | 24.8%* |

WA = Western Australia. NT = Northern Territory.
* Significant at $P < 0.05$ compared with the group of Aboriginal and Torres Strait Islander patients of Kimberley origin. † Treated in the analysis as deaths. ◆

sessions at KSDC, 95.7% of which were attended.

The demographic and baseline data for the HD comparison groups are shown in Box 2. Larger proportions of all Aboriginal and Torres Strait Islander HD groups compared with non-Indigenous patients had reported comorbid conditions at the start of treatment ($P < 0.0001$), but the Kimberley HD group had significantly fewer reported comorbid conditions than the other Aboriginal and Torres Strait Islander HD groups ($P < 0.05$). Overall, HD patients of Kimberley origin fulfilled the CARI guidelines[12] at least as well as other groups (Box 3).

As shown in Box 4, Aboriginal and Torres Strait Islander HD patients of Kimberley origin had significantly lower crude mortality rates than all groups outside WA. After adjusting for age, sex, and comorbid conditions, and with or without late referral, there were no significant differences in mortality rates between the Kimberley group and other groups (Box 4). Adjusted mortality rate ratios for all Aboriginal and Torres Strait Islander groups were not significantly different from those of the non-Indigenous Australian group (Box 4).

## DISCUSSION

We have shown that the overall results for Aboriginal and Torres Strait Islander people from the remote Kimberley region who receive HD treatment are as good as elsewhere in the country.

Several factors may contribute to the outcomes of dialysis, and hence need to be considered when looking at reasons for variations in mortality among patients on HD. These include whether people commencing HD are selected differently in different centres, and what care these patients actually receive, including both dialysis and care unrelated to dialysis.

Detailed studies of who is selected for RRT and the treatment modality selected have not been reported for WA. However, based on discussions with the clinicians involved, it appears that the vast majority of Kimberley people with ESKD are offered dialysis, and few refuse. This is at least anecdotally similar across WA. Transplants have been relatively uncommon for Kimberley patients (one between 2003 and 2007). The reasons for Aboriginal patients being less likely to receive transplants are not

**3 Proportions of patients who commenced haemodialysis after 1992, recorded on the Australia and New Zealand Dialysis and Transplant Registry (ANZDATA) from 1 January 2003 to 31 December 2007, and adhering to Caring for Australasians with Renal Impairment (CARI) dialysis clinical practice guidelines[12]***

| | Aboriginal and Torres Strait Islander people | | | | Non-Indigenous Australians |
|---|---|---|---|---|---|
| | Kimberley | Rest of WA | NT | Rest of Australia | |
| No. of patients† | 100 | 203 | 460 | 650 | 11 388 |
| Proportion of patients with urea reduction ratio > 65% | 86.2% | 86.0% | 87.4% | 81.9%‡ | 85.8%‡ |
| Proportion of patients with concentrations of: | | | | | |
| Haemoglobin 110–130 g/L | 47.5% | 49.4% | 41.6%‡ | 48.3% | 52.7% |
| Calcium 2.1–2.4 mmol/L | 45.3% | 49.8% | 57.0%‡ | 55.2%‡ | 52.0% |
| Phosphate 0.8–1.6 mmol/L | 45.5% | 41.2% | 45.7% | 39.4%‡ | 46.0%‡ |
| Calcium × phosphate product < 4 $mol^2/L^2$ | 58.9% | 52.0% | 67.0% | 55.1% | 57.1%‡ |

WA = Western Australia. NT = Northern Territory.
* During the study period, CARI recommended the following levels for best practice care: URR, > 65%; haemoglobin, 110–130 g/L (currently under review); calcium, 2.1–2.4 mmol/L; phosphate, 0.8–1.6 mmol/L; and calcium × phosphate product, < 4.0 $mmol^2/L^2$.
† Includes measurements from patients who were alive and undergoing haemodialysis at the end of each survey period (consistent with ANZDATA annual reports). ANZDATA records the last measurement taken during each survey period. For patients who died, this would be the last recorded measurement before death, which could lead to bias if they were included in the analysis. ‡ Significant at $P < 0.05$ compared with the group of Aboriginal and Torres Strait Islander patients of Kimberley origin after adjusting for age, sex, comorbid conditions and late referral. Biochemical outcomes involved repeated measures for each patient, and so were analysed using a binomial model through generalised estimating equations to estimate differences in proportions between the groups. ◆

**4 Mortality rates per 100 patient-years and mortality rate ratios for patients who commenced haemodialysis after 1992, recorded on the Australia and New Zealand Dialysis and Transplant Registry from 1 January 2003 to 31 December 2007**

| Group | No. of patients | Deaths | Patient-years | Crude rates (95% CI) | | Rates (95% CI) adjusted for age, sex, comorbid conditions* | | Rates (95% CI) adjusted for age, sex, comorbid conditions, late referral* | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Rate per 100 patient-years | MRR† | Rate per 100 patient-years | MRR† | Rate per 100 patient-years | MRR† |
| Aboriginal and Torres Strait Islander people | | | | | | | | | |
| Kimberley | 110 | 24 | 286 | 8.4 (5.6–12.9) | 0.53 (0.35–0.80)§ | 11.2 (7.3–17.1) | 0.87 (0.57–1.33) | 10.2 (6.6–15.7) | 0.80 (0.51–1.23) |
| Rest of WA | 221 | 58 | 492 | 11.8 (9.1–15.3) | 0.75 (0.58–0.98)§ | 14.1 (10.8–18.4) | 1.10 (0.84–1.44) | 13.6 (10.4–17.9) | 1.08 (0.81–1.40) |
| NT | 502 | 151 | 1114 | 13.6 (11.5–16.0)‡ | 0.86 (0.73–1.02) | 15.0 (12.6–17.8) | 1.17 (0.98–1.39) | 14.6 (12.3–17.3) | 1.14 (0.96–1.37) |
| Rest of Australia | 733 | 218 | 1627 | 13.4 (11.8–15.3)‡ | 0.85 (0.74–0.97)§ | 13.9 (12.1–15.9) | 1.08 (0.94–1.25) | 13.4 (11.7–15.4) | 1.05 (0.91–1.21) |
| Non-Indigenous Australians | | | | | | | | | |
| | 13 274 | 4004 | 25 439 | 15.7 (15.3–16.2)‡ | 1.00 | 12.8 (12.3–13.3) | 1.00 | 12.8 (12.3–13.3) | 1.00 |

MRR = mortality rate ratio. WA = Western Australia. NT = Northern Territory.
* Means for the covariates: age 63 years; 60.2% male; 38.0% with diabetes; 14.5% with chronic lung disease; 38.7% with coronary heart disease; 24.1% with peripheral vascular disease; 13.6% with cerebrovascular disease; and 25.3% late referral. † MRR compared with the non-Indigenous Australians group. In the final model the characteristics significantly associated with mortality (at $P < 0.001$) are: age (MRR, 1.03 [95% CI, 1.029–1.035] per year); male (MRR, 0.86 [95% CI, 0.81–0.91]); diabetes (MRR, 1.20 [95% CI, 1.12–1.28]); chronic lung disease (MRR, 1.29 [95% CI, 1.20–1.39]); coronary heart disease (MRR, 1.31 [95% CI, 1.22–1.40]); peripheral vascular disease (MRR, 1.23 [95% CI, 1.15–1.32]); cerebrovascular disease (MRR, 1.20 [95% CI, 1.11–1.30]); and late referral (MRR, 1.31 [95% CI, 1.22–1.40]). ‡ Significant at $P < 0.05$ compared with the group of Aboriginal and Torres Strait Islander patients of Kimberley origin. § Significant at $P < 0.05$ compared with the group of non-Indigenous Australian patients. ◆

entirely related to medical suitability.[13] Patients who are suitable for transplantation are relatively healthy and are likely to have better survival. It is probable that the Kimberley HD group included patients who were medically suitable for transplantation. Therefore fewer transplants in these medically suitable patients could have increased HD survival in this population. Conceivably, lower rates of withdrawal from treatment might also contribute to the relatively low mortality among Kimberley HD patients.

The high rate of late referrals among Kimberley Aboriginal and Torres Strait Islander patients is of concern, as late referral is documented to contribute to less planning, including less use of arteriovenous fistulae for first access, and has been associated with early deaths.[14] Using a central venous catheter for first access is also associated with higher mortality.[15] The extent to which late referral is a proxy for socioeconomic factors and access to services more generally, and how much it is a direct effect of the consequences of late referral in terms of treatment is not clear.[16] Hence we have presented figures with and without adjustment for late referral.

Rural satellite dialysis units have been found to provide similar reported patient-specific quality-of-life outcomes, and higher patient satisfaction with the environment and atmosphere of the unit and communication with staff, compared with major hospital units.[17] Adherence to treatment regimens is dependent on patient satisfaction with care.[18] Effective communication has been shown to correlate with improved outcomes.[19] Adherence to a dialysis prescription,[8] meeting multiple clinical targets,[20] and enrolment in disease-state management programs[21] are all associated with significant decreases in hospitalisation and better survival. It has been suggested that holistic disease management of dialysis patients, which focuses on better management of comorbid conditions, patient satisfaction and quality of life, and preventive care can further improve outcomes.[22]

At KSDC, patients' adherence to care (dialysis prescription adherence and meeting clinical targets) has been excellent and comparable to that in non-Indigenous dialysis services. KSDC is the first satellite unit in Australia run by an ACCHS. While there is no empirical evidence for this, the sense of ownership the patients have for the organisation, the extensive use of Aboriginal staff, including Aboriginal health workers delivering dialysis care and Aboriginal drivers to collect patients, as well as the support provided by a regional renal social worker all contribute to a unit that welcomes patients and provides culturally appropriate care. Primary care from one general practitioner with renal training is also central to good outcomes. Supportive relationships with the local hospital and excellent relationships with RPH are also integral to the unit's success. The unit is funded on a price per treatment (PPT) basis, as are other non-government units in WA, and the somewhat higher PPT is to allow for the increased cost of staff in remote areas, not to provide increased services. Most HD treatments for patients of Kimberley origin have been provided by KSDC since 2003; a small proportion were provided at home, and the remainder in urban settings.

Aboriginal community control of delivery of HD treatment in a remote location in partnership with good tertiary care can result in health outcomes similar to those of non-Indigenous patients and improve quality of life. While waiting for improved prevention to reduce the numbers of patients requiring dialysis, good quality care in culturally appropriate settings is essential. The continued creative expansion of culturally safe dialysis services in rural and remote areas of Australia needs to be a central part of providing equitable care to the growing number of Aboriginal and Torres Strait Islander people with ESKD.

## ACKNOWLEDGEMENTS

We thank the staff at Kimberley Satellite Dialysis Centre, Kimberley Aboriginal Health Service and Royal Perth Hospital for providing data for this study.

## COMPETING INTERESTS

Julia Marley received sponsorship from Amgen Australia to attend an International Society for Quality in Health Care conference in Copenhagen in October 2008 to present the findings from this study.

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## REFERENCES

1 Cass A, Cunningham J, Wang Z, Hoy W. Regional variation in the incidence of end-stage renal disease in Indigenous Australians. *Med J Aust* 2001; 175: 24-27.
2 Cass A, Gillin AG, Horvath JS. End-stage renal disease in Aboriginals in New South Wales: a very different picture to the Northern Territory. *Med J Aust* 1999; 171: 407-410.
3 Kneipp E, Murray R, Warr K, et al. Bring me home: renal dialysis in the Kimberley. *Nephrology* 2004; 9 Suppl 4: S121-S125.
4 Rivalland P. Western Desert Nganampa Walytja Palyantjaku Tjutaku: "Making all our families well". Casuarina, NT: Western Desert Nganampa Walytja Palyantjaku Tjutaku Aboriginal Corporation and Cooperative Research Centre for Aboriginal Health, 2006.
5 Spencer JL, Silva DT, Snelling P, et al. An epidemic of renal failure among Australian Aboriginals. *Med J Aust* 1998; 168: 537-541.
6 Cass A, Cunningham J, Snelling P, et al. Exploring the pathways leading from disadvantage to end-stage renal disease for indigenous Australians. *Soc Sci Med* 2004; 58: 767-785.
7 Devitt J, McMasters A. "They don't last long": Aboriginal patient experience of end-stage renal disease in Central Australia. *Nephrology* 1998; 4: S111-S117.
8 Denhaerynck K, Manhaeve D, Dobbels F, et al. Prevalence and consequences of nonadherence to hemodialysis regimens. *Am J Crit Care* 2007; 16: 222-235; quiz 236.
9 Jose M, Livingston B, McDonald S, et al. End-stage kidney disease among indigenous peoples of Australia and NZ. In: McDonald S, Excell L, Livingston B, editors. ANZDATA registry report, 2008. Adelaide: Australia New Zealand Dialysis Transplant Registry; 2008.
10 Biddle N. Ranking regions: revisiting an index of relative Indigenous socioeconomic outcomes. Working Paper No. 50/2009. Canberra: Centre for Aboriginal Economic Policy Research, Australian National University, 2009. http://caepr.anu.edu.au/Publications/WP/2009WP50.php (accessed Sep 2010).
11 Taylor J. The relative socioeconomic status of Indigenous people in the Kimberley. A report to the Kimberley Land Council. Canberra: Centre for Aboriginal Economic Policy Research, Australian National University, 2009.
12 CARI. Caring for Australasians with Renal Impairment. CARI guidelines. http://www.cari.org.au/guidelines.php (accessed Sep 2010).
13 Devitt J, Cass A, Cunningham J, et al. Study protocol — Improving Access to Kidney Transplants (IMPAKT): a detailed account of a qualitative study investigating barriers to transplant for Australian Indigenous people with end-stage kidney disease. *BMC Health Serv Res* 2008; 8: 31.
14 Ravani P, Brunori G, Mandolfo S, et al. Cardiovascular comorbidity and late referral impact arteriovenous fistula survival: a prospective multicenter study. *J Am Soc Nephrol* 2004; 15: 204-209.
15 Polkinghorne KR, McDonald SP, Atkins RC, et al. Vascular access and all-cause mortality: a propensity score analysis. *J Am Soc Nephrol* 2004; 15: 477-486.
16 Winkelmayer WC, Owen WF Jr, Levin R, et al. A propensity analysis of late versus early nephrologist referral and mortality on dialysis. *J Am Soc Nephrol* 2003; 14: 486-492.
17 Roderick P, Armitage A, Nicholson T, et al. A clinical and cost evaluation of hemodialysis in renal satellite units in England and Wales. *Am J Kidney Dis* 2004; 44: 121-131.
18 Saran R, Bragg-Gresham JL, Rayner HC, et al. Nonadherence in hemodialysis: associations with mortality, hospitalization, and practice patterns in the DOPPS. *Kidney Int* 2003; 64: 254-262.
19 Stewart MA. Effective physician-patient communication and health outcomes: a review. *CMAJ* 1995; 152: 1423-1433.
20 Rocco MV, Frankenfield DL, Hopson SD, et al. Relationship between clinical performance measures and outcomes among patients receiving long-term hemodialysis. *Ann Intern Med* 2006; 145: 512-519.
21 Nissenson AR, Collins AJ, Dickmeyer J, et al. Evaluation of disease-state management of dialysis patients. *Am J Kidney Dis* 2001; 37: 938-944.
22 Nissenson AR. What common practices in dialysis units can be altered to improve patient care? *Semin Dial* 2004; 17: 12-13.

*(Received 29 Jan 2010, accepted 1 Jun 2010)* ❑