SOCIO-ECONOMIC STATUS AND PERITONITIS IN AUSTRALIAN NON-INDIGENOUS PERITONEAL DIALYSIS PATIENTS

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◆ **Background:** The aim of the present study was to investigate the relationship between socio-economic status (SES) and peritoneal dialysis (PD)-related peritonitis.

◆ **Methods:** Associations between area SES and peritonitis risk and outcomes were examined in all non-indigenous patients who received PD in Australia between 1 October 2003 and 31 December 2010 (peritonitis outcomes). SES was assessed by deciles of postcode-based Australian Socio-Economic Indexes for Areas (SEIFA), including Index of Relative Socio-economic Disadvantage (IRSD), Index of Relative Socio-economic Advantage and Disadvantage (IRSAD), Index of Economic Resources (IER) and Index of Education and Occupation (IEO).

◆ **Results:** 7,417 patients were included in the present study. Mixed-effects Poisson regression demonstrated that incident rate ratios for peritonitis were generally lower in the higher SEIFA-based deciles compared with the reference (decile 1), although the reductions were only statistically significant in some deciles (IRSAD deciles 2 and 4–9; IRSD deciles 4–6; IER deciles 4 and 6; IEO deciles 3 and 6). Mixed-effects logistic regression showed that lower probabilities of hospitalization were predicted by relatively higher SES, and lower probabilities of peritonitis-associated death were predicted by less SES disadvantage status and greater access to economic resources. No association was observed between SES and the risks of peritonitis cure, catheter removal and permanent hemodialysis (HD) transfer.

◆ **Conclusions:** In Australia, where there is universal free healthcare, higher SES was associated with lower risks of peritonitis-associated hospitalization and death, and a lower risk of peritonitis in some categories.

Perit Dial Int 2015; 35(4):450–459 www.PDIConnect.com
epub ahead of print: 04 Feb 2014 doi:10.3747/pdi.2013.00004

KEY WORDS: Peritoneal dialysis; peritonitis; socio-economical status; mortality; outcomes; education; income.

Peritonitis remains a leading complication of peritoneal dialysis (PD), which contributes to patient mortality and technique failure (1–3). Factors associated with the risk of peritonitis have been well documented, and have been attributed to patient, therapeutic and organism-specific variables (4–7).

Although many studies have addressed the effects of socio-economic status (SES) on PD outcomes (8–11), scant attention has been paid to the possible relationship between SES and peritonitis. A few studies from USA (12), Hong Kong (13) and Brazil (14) generated inconclusive results. In a study of 1,595 incident PD patients in USA, Farias *et al.* (12) demonstrated that certain socio-economic factors, such as unemployment, student status, and renting a house, were associated with increased risks of peritonitis. On the other hand, data from Hong Kong demonstrated that increased peritonitis hazard was predicted by lower educational level and receipt of social security payments at PD commencement, but not

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Received 5 January 2013; accepted 9 July 2013.

by occupational status, rental status, living arrangements (alone or with family), marital status or surface area of residence (13). Finally, the Brazilian Peritoneal Dialysis Multicenter study (BRAZPD) study observed that lower educational level, but not family income, was independently associated with increased risk of peritonitis (14). These studies have all investigated indicators of individual-level SES. To our knowledge, there has been no study investigating associations between area-level SES and peritonitis rates, or any published nation-wide study of associations between SES and peritonitis.

The aim of the present study, therefore, was to investigate the associations between area SES on the rate of peritonitis, time to first peritonitis and the outcome of peritonitis using national registry data in Australia (ANZDATA).

MATERIAL AND METHODS

STUDY POPULATION

In the present study, all non-indigenous Australian patients from the ANZDATA Registry who received treatment with PD between 1 October 2003 (when detailed peritonitis data started to be collected) and 31 December 2010 were analyzed. The data collected included demographic data, postal codes at the time of commencing renal replacement therapy, cause of primary renal disease, comorbidities at the start of dialysis (recorded by the patient's attending nephrologist), smoking status, body mass index (BMI) (< 18.5, 18.5 – 24.9, 25 – 29.9 and ≥ 30 kg/m²) and late referral (defined as commencement of dialysis within three months of referral to a nephrologist). The data were collected throughout the calendar year by medical and nursing staff in each renal unit and submitted annually to the ANZDATA Registry. Indigenous patients (Australian Aborigines and Torres Strait Islanders) were excluded because residential postal code at the commencement of PD does not always reflect their usual place of residence (15).

SOCIO-ECONOMIC STATUS

Socio-economic status was obtained based on Australian Socio-Economic Indexes for Areas (SEIFA) from the Australian Bureau of Statistics (ABS) (http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Seifa_entry_page) similarly to previous investigations (16,17). Socio-Economic Indexes for Areas are summary measures of a number of variables that represent different aspects of relative socio-economic disadvantage and/or advantage in a geographic area. They provide more

general measures of SES than are given by measuring income or unemployment alone. In this study, postal codes (postcodes) were used as the area unit. Postcodes were ranked into deciles, based on each of the four SEIFA variables. Decile 1 is the most deprived or disadvantaged group of postcodes. A summary measure for a particular community was created by combining information about the households and individuals who live in that area based on Australian Census data. Each of the four available SEIFA variables were separately evaluated:

- a) Index of Relative Socio-economic Disadvantage (IRSD): derived from 17 census variables related to disadvantage, such as low income, low educational attainment, high unemployment, unskilled occupations and dwellings without motor vehicles. Decile 1 represented the most disadvantaged group and decile 10 the least disadvantaged.
- b) Index of Relative Socio-economic Advantage and Disadvantage (IRSAD): derived from 21 census variables related to both advantage (e.g., people with tertiary education, households with internet connection, professional occupation) and disadvantage (e.g., individuals with low education level, households with low income). Decile 1 represented the most disadvantaged group and decile 10 the most advantaged group.
- c) Index of Economic Resources (IER): derived from 15 census variables reflecting the economic resources of households within an area, such as household income, housing expenditures (e.g., rent), household wealth (e.g., home ownership) and other economic resources (e.g., unemployment, ownership of an unincorporated enterprise). The index does not include education or occupation measures. Decile 1 represented the poorest access to economic resources and decile 10 the greatest access.
- d) Index of Education and Occupation (IEO): derived from 9 census variables relating to the area's educational characteristics (e.g., qualifications achieved and whether further education is being undertaken) and occupational characteristics (e.g., levels of unemployment and mix of skilled versus unskilled occupations). Decile 1 represented the lowest educational and occupational status and decile 10 the highest.

PERITONITIS RISK AND OUTCOMES

The risk of developing peritonitis was assessed as overall peritonitis rates. Peritonitis was defined as clinical features of peritonitis (abdominal pain or cloudy dialysate) and dialysate leukocytosis (white blood cell

count > 100/ μ L with > 50% neutrophils). Peritonitis rates were calculated according to the standardized recommendations made by the International Society of Peritoneal Dialysis (ISPD) (2). Peritonitis rate was defined as the total number of episodes of peritonitis per number of years of PD therapy (episodes per patient-years at risk). In keeping with ISPD recommendations (1,3), relapsed peritonitis was counted as a single episode and patients with a PD catheter *in situ* who were not receiving PD were not included in peritonitis rate calculations.

The clinical outcomes examined were peritonitis cure, peritonitis-associated hospitalization, catheter removal, temporary hemodialysis (HD) transfer (in which patients subsequently resumed PD without a time frame requirement), permanent HD transfer and peritonitis-related death. A peritonitis episode was considered 'cured' by antibiotics alone if the patient was symptom free, the PD effluent was clear and the episode was not complicated by relapse, catheter removal or death. Peritonitis-related death was defined as any death within 30 days after an episode of peritonitis (18).

STATISTICAL ANALYSIS

Categorical results were analyzed using chi-square tests and presented as frequencies and percentages. Normally distributed results were analyzed using ANOVA and presented as mean $\pm$ standard deviation (SD). Non-normal continuous variables were analyzed using Kruskal-Wallis tests and presented as median (25th – 75th percentile). Predictors of rates of PD peritonitis were determined by mixed-effects Poisson regression with initial PD hospital treated as a random effect (17). The independent predictors of the clinical outcomes of peritonitis were determined by mixed-effects multivariable binomial logistic regression model with both initial PD hospital and patient treated as random effects. Mixed models are one of the standard tools for the analysis of clustered data where a sample of cases is repeatedly assessed (19). The covariates included in all the models were SEIFA deciles (IRSAD, IRSD, IER or IEO), age, gender, racial origin, BMI, late referral within three months of dialysis commencement, end-stage renal failure cause, smoking status and comorbidities, and estimated glomerular filtration rate. Initial empiric antibiotic regimens were added in the model of peritonitis outcomes as covariates. All the models were run separately for each SEIFA index. Data were analyzed using the software packages PASW Statistics for Windows release 18.0 (SPSS Inc., North Sydney, Australia) and Stata/SE version 12.0 (StataCorp. College Station, TX, USA). *P* values < 0.05 were considered statistically significant.

RESULTS

From 1 October 2003 to 31 December 2010, a total of 7,419 non-indigenous Australian patients received PD treatment, with 3,585 patients experiencing 7,299 peritonitis episodes. SEIFA were unavailable for recorded postcodes in two patients (four episodes of peritonitis). Consequently, 7,417 patients were included in the analysis and were followed for 16,242 patient-years. Their characteristics are depicted in Table 1.

PERITONITIS RATE

The overall peritonitis rate was 0.45 episodes per patient-year of treatment. Calculated peritonitis rates for deciles of each SEIFA variable are shown in Figure 1. No clear pattern was able to be identified between any of the SEIFA-based deciles and peritonitis rate. Mixed-effects Poisson regression demonstrated that incident rate ratios for peritonitis were generally lower in the higher SEIFA-based deciles compared with the reference (decile 1), although the reductions were only statistically significant in some deciles (IRSAD deciles 2 and 4 – 9; IRSD deciles 4 – 6; IER deciles 4 and 6; IEO deciles 3 and 6) (Table 2). In a subgroup analysis of gram-positive bacterial peritonitis, no clear or consistent relationship was observed with SES (Supplemental Table 9).

PERITONITIS OUTCOMES

A total of 7,417 patients with 7,295 episodes of peritonitis in 3,583 PD patients were included in the final peritonitis outcome analyses. Clinical outcomes of peritonitis within deciles of each SEIFA variable were generally similar (Supplemental Tables 1 – 4), with the exception of significantly lower percentages of hospitalization in decile 10 of each SEIFA variable and significantly shorter hospitalization durations in decile 10 of each SEIFA variable, except IRSAD. Using mixed-effects multivariable logistic regression with decile 1 of each SEIFA variable as reference (Table 3 and Supplemental Tables 5 – 8), after adjusting for other confounding factors, SES did not predict cure of peritonitis, catheter removal or permanent HD. However, the lower probabilities of hospitalization were predicted by better SES advantage status (IRSAD decile 9), less SES disadvantage status (IRSD deciles 7, 9, 10), greater access to economic resources (IER deciles 9, 10) and higher educational and occupational status (IEO deciles 7, 8, 10), respectively. Moreover, lower probabilities of peritonitis-associated death were predicted by less SES disadvantaged status (IRSD deciles 7, 8, 10 and IER deciles 5, 8, 10).

TABLE 1
Characteristics of All Non-Indigenous Australian PD Patients in the Present Study

Characteristic	PD patients without peritonitis (n=3,834)	PD patients with peritonitis (n=3,583)
Age (years)	56.9±18.5	58.9±17.3 ^c
Male gender	2,185 (57%)	2,061 (58%)
Racial origin		
Caucasian	3,253 (85%)	3,034 (85%)
Asian	367 (10%)	350 (10%)
Other	214 (6%)	199 (6%)
BMI (kg/m ²)	25.8±5.4	26.2±5.4 ^c
eGFR at dialysis start (mL/min/1.73m ²)	8.5±4.6	8.2±5.0 ^b
Late referral (%)	807 (21%)	741 (21%)
ESRF cause		
Chronic glomerulonephritis	1,116 (29%)	1,012 (28%)
Diabetes nephropathy	962 (25%)	957 (27%)
Renovascular disease	563 (15%)	526 (15%)
Polycystic kidneys	277 (7%)	235 (7%)
Reflux nephropathy	163 (4%)	150 (4%)
Other	506 (13%)	481 (13%)
Unknown	247 (6%)	222 (6%)
Smoking status		
Current	422 (11%)	407 (11%)
Former	1,378 (36%)	1,386 (39%)
Never	2,011 (53%)	1,778 (50%)
Chronic lung disease	511 (13%)	495 (14%)
Coronary artery disease	1,317 (34%)	1,274 (35%)
Peripheral vascular disease	871 (23%)	758 (21%)
Cerebrovascular disease	476 (12%)	505 (14%) ^a
Diabetes mellitus	1,308 (34%)	1,270 (35%)

PD = peritoneal dialysis; BMI = body mass index; eGFR = estimated glomerular filtration rate; ESRF = end-stage renal failure.

^a $p < 0.05$.

^b $p \leq 0.01$.

^c $p \leq 0.001$.

DISCUSSION

This retrospective, multicenter registry analysis found that, compared with the lowest decile of area SES, higher SES was generally associated with lower peritonitis rates, although these risk reductions were only statistically significant in some deciles and they varied both within and between each of the four SEIFA variables used. The highest deciles of SES for each of the four SEIFA variables were associated with lower probabilities of hospitalization and the least disadvantaged decile and the decile with greatest access to economic resources experienced significantly lower probabilities of peritonitis-associated death.

Studies investigating the relationship between SES and peritonitis are sparse. Similar to the findings of the

present study, a recent large, multicenter study of 2,032 incident and prevalent Brazilian PD patients (BRAZPD) showed that SES based on family income was not clearly associated with peritonitis risk (14). However, contrary to the findings of the present study, lower educational level was associated with heightened time to first peritonitis risk. In contrast, a Hong Kong study involving 102 consecutive incident PD patients demonstrated that peritonitis risk was predicted by receipt of social security payments at PD commencement, although not by occupational status, rental status, living arrangements (alone or with family), marital status or surface area of residence (13). A subsequent study of 1,595 incident PD patients in the USA observed that indices of lower SES, such as unemployment, student status, and renting a house, were independently associated with increased risks of

Figure 1 — Calculated peritonitis rates for deciles of each SEIFA index during the study period 2003–2010. # $p < 0.05$ versus decile 1; * $p < 0.01$ versus decile 1; & $p < 0.001$ versus decile 1; decile 1 is the most deprived or disadvantaged group.

peritonitis (12). The disparity in findings between the different studies may be explained by the appreciable differences in healthcare, education and welfare systems that exist between the different countries (20,21). Australia provides universal access to government-funded free healthcare, heavily government-subsidized medications (with a modest annual “safety net” cap on out-of-pocket expenses incurred by Australian residents), universal mandatory free education to high school, and welfare payments for disadvantaged groups (such as unemployed, elderly, and people with disabilities). These factors, which are not uniformly present in the countries of the other studies, may have significantly mitigated the impact of lower SES on PD peritonitis risk and outcomes. In contrast, SES may be expected to have more impact in countries which require individuals to make significant copayments towards their healthcare, thereby potentially disadvantaging patients from lower SES backgrounds who cannot even afford small out-of-pocket expenses. For example, disadvantaged US citizens are less likely to have insurance, and may face significant out-of-pocket

costs for many services (17). Consequently, the observed associations between SES and peritonitis risk may be healthcare system-specific, such that the results of the present study may not be generalizable to other countries with appreciably different healthcare systems.

Another potential factor accounting for the observed differences in impact of SES on peritonitis risk and outcome in Australia compared with other countries may relate to differences in methods used to evaluate SES. The present study utilized Socio-Economic Indexes for Areas (SEIFA) rather than individual-level SES, used in previous studies, which, by utilizing up to 21 different census variables for each SES index, provided a more comprehensive assessment of SES than the limited number of single variables used in other studies (such as family income, educational level, house rental, etc.).

To our knowledge, the present study is the first to have investigated the effect of SES on peritonitis outcomes. Although no association was observed between SES and rates of peritonitis cure, catheter removal or permanent HD transfer, we found that groups with the least

socio-economic disadvantage and the greatest access to economic resources experienced significantly lower risks of both hospitalization and peritonitis-associated death, in spite of the availability of universal access to free healthcare. Previous investigations have shown that Australians from advantaged backgrounds were more likely to have additional health insurance (22) and more likely to receive longer consultations with general practitioners (23). These factors may have contributed to superior peritonitis outcomes in the highest SES decile in the current study. For example, it is possible that higher SES patients may have had better access to healthcare leading to earlier presentation with peritonitis symptoms, earlier diagnosis and treatment, and ultimately better outcomes. Alternatively, other factors such as

lesser household crowding in higher SES patients may have been operative. These hypotheses were unable to be tested in the present study due to the limited data collected by the ANZDATA Registry. In addition, there is likely to be differential selection of patients who commence PD in Australia. PD is uncommon in privately-funded hospitals (24) and is more common among patients from remote areas of Australia, who have generally lower SES than city dwellers (25).

The strengths of this study include its very large sample size and inclusion of virtually every Australian patient receiving PD during the study period. SES was evaluated using four indices, which in turn include a range of factors, rather than being primarily related to income. Moreover, a range of peritonitis outcomes was

TABLE 2
Multivariable Poisson Regression Models of Peritonitis Incident Rate Ratios (IRR) for All Non-Indigenous PD Patients in Australia Between 2003 and 2010^a

Variables	IRSD	IRSD	IER	IEO
Deciles				
1	Reference	Reference	Reference	Reference
2	0.88 (0.77–1.00) ^c	0.90 (0.81–1.01)	0.91 (0.82–1.01)	0.94 (0.84–1.04)
3	0.92 (0.81–1.05)	0.98 (0.88–1.09)	0.95 (0.86–1.056)	0.88 (0.79–0.97) ^c
4	0.82 (0.72–0.93) ^d	0.88 (0.79–0.97) ^c	0.86 (0.78–0.95) ^d	1.03 (0.93–1.14)
5	0.87 (0.77–0.98) ^c	0.87 (0.78–0.97) ^c	1.04 (0.94–1.16)	0.87 (0.77–0.95)
6	0.76 (0.67–0.85) ^e	0.90 (0.81–0.99) ^c	0.78 (0.70–0.88) ^e	0.86 (0.77–0.95) ^d
7	0.88 (0.79–0.99) ^c	0.95 (0.85–1.06)	0.94 (0.85–1.06)	0.89 (0.80–0.99)
8	0.87 (0.77–0.98) ^c	0.91 (0.81–1.01)	0.98 (0.88–1.09)	0.89 (0.79–1.00)
9	0.84 (0.74–0.95) ^d	0.91 (0.81–1.01)	0.95 (0.85–1.07)	0.95 (0.85–1.06)
10	0.91 (0.80–1.04)	0.97 (0.86–1.10)	0.94 (0.84–1.06)	0.96 (0.86–1.08)
Age (per decade)	^b	^b	^b	^b
Female gender	^b	^b	^b	^b
Racial origin				
Caucasian	Reference	Reference	Reference	Reference
Asian	0.84 (0.78–0.92) ^e	0.84 (0.77–0.92) ^e	0.84 (0.77–0.92) ^e	0.85 (0.78–0.92) ^e
Other	0.84 (0.75–0.94) ^d	0.83 (0.75–0.93) ^d	0.84 (0.75–0.94) ^c	0.84 (0.75–0.94) ^d
BMI (per kg/m ²)	^b	^b	^b	^b
Normal weight	Reference	Reference	Reference	Reference
Underweight	^b	^b		
Overweight	1.08 (1.02–1.15) ^d	1.08 (1.02–1.14) ^c	1.08 (1.02–1.14) ^d	1.07 (1.01–1.14) ^d
Obesity	1.29 (1.21–1.38) ^e	1.29 (1.21–1.38) ^e	1.29 (1.20–1.37) ^e	1.29 (1.21–1.38) ^e
Late referral	1.13 (1.07–1.20) ^e	1.13 (1.07–1.20) ^e	^b	^b
Smoking status				
Never	Reference	Reference	Reference	Reference
Former	1.14 (1.08–1.21) ^e	1.14 (1.08–1.21) ^e	1.14 (1.08–1.21) ^e	1.14 (1.08–1.20) ^e
Current	1.11 (1.03–1.21) ^d	1.11 (1.02–1.20) ^c	1.11 (1.02–1.20) ^c	1.11 (1.03–1.21) ^d
Chronic lung disease	^b	^b	^b	^b
Coronary artery disease	^b	1.06 (1.00–1.13) ^c	1.06 (1.00–1.13) ^c	1.06 (1.00–1.13) ^c
Cerebrovascular disease	1.10 (1.03–1.19) ^d	1.10 (1.02–1.18) ^c	1.09 (1.02–1.18) ^c	1.09 (1.02–1.18) ^c
Peripheral vascular disease	0.93 (0.87–1.00) ^c	0.93 (0.87–1.00) ^c	0.93 (0.87–1.00) ^c	^b
Diabetes mellitus	^b	^b	^b	^b

TABLE 2 (cont'd)

Variables	IRSAD	IRSD	IER	IEO
ESRF causes	b	b	b	b
Chronic glomerulonephritis	Reference	Reference	Reference	Reference
Diabetes nephropathy	1.20 (1.09–1.34) ^e	1.21 (1.09–1.34) ^e	1.20 (1.09–1.33) ^e	1.21 (1.09–1.33) ^e
Renovascular disease	b	b	b	b
Polycystic kidneys	b	b	b	b
Reflux nephropathy	b	b	b	b
Unknown	b	b	b	b
Other	b	b	b	b
eGFR at dialysis start (mL/min/1.73m ²)	1.01 (1.00–1.01) ^d	1.01 (1.00–1.01) ^d	1.01 (1.00–1.01) ^d	1.01 (1.00–1.01) ^d

PD = peritoneal dialysis; IRSAD = Index of Relative Socio-economic Advantage and Disadvantage; IRSD = Index of Relative Socio-economic Disadvantage; IER = Index of Economic Resources; IEO = Index of Education and Occupation; BMI = body mass index; ESRF = end-stage renal failure; eGFR = estimated glomerular filtration rate; SEIFA = Australian Socio-Economic Indexes for Areas; SES = socio-economic status.

^a Multivariable Poisson regression models with initial PD hospital treated as a random effect; results are expressed as adjusted incident rate ratios (IRR) (95% confidence interval). Except for each SEIFA-based decile, results that were not statistically significant are not displayed. Decile one is the most deprived or disadvantaged group of SES status.

^b Not significant in multivariable Poisson model.

^c $p < 0.05$.

^d $p \leq 0.01$.

^e $p \leq 0.001$.

TABLE 3

Mixed-Effects Logistic Regression Analyses of Clinical Outcomes of Peritonitis Episodes During the Study Period 2003–2010^a

Variable	Cure	Peritonitis-associated hospitalizations	Catheter removal	Permanent hemodialysis	Death
Model 1 IRSAD-based deciles					
1	Reference	Reference	Reference	Reference	Reference
2	0.86 (0.65–1.13)	1.06 (0.68–1.66)	0.93 (0.66–1.29)	0.99 (0.69–1.40)	1.65 (0.77–3.51)
3	0.92 (0.69–1.22)	0.85 (0.53–1.36)	1.08 (0.77–1.50)	1.12 (0.79–1.59)	0.72 (0.31–1.65)
4	0.96 (0.73–1.27)	0.65 (0.41–1.01)	1.07 (0.77–1.48)	1.06 (0.75–1.51)	0.94 (0.43–2.02)
5	0.96 (0.73–1.25)	0.94 (0.61–1.44)	1.05 (0.77–1.44)	1.11 (0.79–1.54)	0.90 (0.43–1.89)
6	0.83 (0.65–1.08)	0.86 (0.57–1.29)	1.23 (0.92–1.66)	1.29 (0.94–1.77)	1.02 (0.50–2.08)
7	1.04 (0.81–1.35)	0.79 (0.53–1.19)	1.02 (0.75–1.37)	1.02 (0.74–1.39)	0.71 (0.34–1.48)
8	0.91 (0.71–1.17)	0.75 (0.50–1.13)	1.12 (0.84–1.51)	1.10 (0.80–1.51)	0.66 (0.32–1.36)
9	1.01 (0.78–1.31)	0.60 (0.39–0.90) ^b	0.99 (0.73–1.34)	1.00 (0.72–1.39)	0.77 (0.37–1.62)
10	0.97 (0.74–1.27)	0.70 (0.45–1.09)	0.99 (0.71–1.36)	1.00 (0.71–1.41)	0.67 (0.31–1.46)
Model 2 IRSD-based deciles					
1	Reference	Reference	Reference	Reference	Reference
2	0.97 (0.77–1.22)	0.85 (0.58–1.23)	0.96 (0.73–1.27)	1.07 (0.80–1.43)	0.65 (0.34–1.23)
3	0.89 (0.71–1.11)	0.75 (0.53–1.08)	1.12 (0.87–1.46)	1.06 (0.80–1.41)	0.76 (0.42–1.41)
4	1.03 (0.83–1.29)	0.85 (0.58–1.21)	0.98 (0.75–1.27)	0.97 (0.73–1.29)	0.62 (0.34–1.15)
5	0.91 (0.72–1.14)	0.79 (0.55–1.13)	1.01 (0.77–1.32)	1.10 (0.83–1.47)	0.66 (0.35–1.24)
6	0.91 (0.73–1.13)	0.86 (0.61–1.21)	1.19 (0.93–1.54)	1.18 (0.90–1.55)	0.65 (0.35–1.18)
7	0.99 (0.77–1.25)	0.65 (0.44–0.94) ^b	1.05 (0.80–1.39)	0.99 (0.74–1.33)	0.35 (0.17–0.72) ^c
8	1.10 (0.86–1.41)	0.71 (0.48–1.05)	1.09 (0.82–1.44)	1.14 (0.85–1.54)	0.47 (0.24–0.95) ^b
9	1.07 (0.84–1.35)	0.62 (0.43–0.90) ^b	0.86 (0.64–1.13)	0.76 (0.56–1.03)	0.70 (0.37–1.33)
10	1.07 (0.83–1.38)	0.59 (0.40–0.87) ^c	1.01 (0.76–1.36)	1.02 (0.74–1.39)	0.33 (0.15–0.70) ^c

TABLE 3 (cont'd)

Variable	Cure	Peritonitis-associated hospitalizations	Catheter removal	Permanent hemodialysis	Death
Model 3 IER-based deciles					
1	Reference	Reference	Reference	Reference	Reference
2	1.03 (0.82–1.29)	0.81 (0.57–1.16)	0.91 (0.70–1.18)	0.95 (0.72–1.26)	0.79 (0.43–1.44)
3	0.96 (0.77–1.20)	0.70 (0.48–1.00)	0.98 (0.76–1.27)	1.01 (0.77–1.34)	0.56 (0.30–1.04)
4	1.03 (0.83–1.27)	0.84 (0.60–1.18)	0.98 (0.77–1.27)	0.99 (0.76–1.29)	0.84 (0.48–1.48)
5	1.06 (0.85–1.32)	0.88 (0.62–1.27)	0.96 (0.74–1.24)	0.98 (0.75–1.29)	0.51 (0.27–0.97) ^b
6	0.95 (0.75–1.21)	0.81 (0.56–1.17)	1.03 (0.78–1.36)	1.09 (0.81–1.46)	0.52 (0.24–1.01)
7	0.83 (0.67–1.04)	0.79 (0.55–1.13)	1.15 (0.89–1.49)	1.01 (0.77–1.34)	0.60 (0.31–1.15)
8	1.21 (0.96–1.53)	0.76 (0.53–1.09)	0.99 (0.76–1.28)	0.89 (0.67–1.18)	0.51 (0.27–0.98) ^b
9	1.01 (0.79–1.28)	0.67 (0.46–0.99) ^b	0.97 (0.73–1.28)	0.87 (0.64–1.18)	0.61 (0.32–1.19)
10	1.09 (0.86–1.38)	0.56 (0.39–0.81) ^c	0.93 (0.70–1.23)	0.93 (0.69–1.25)	0.36 (0.18–1.75) ^c
Model 4 IEO-based deciles					
1	Reference	Reference	Reference	Reference	Reference
2	0.96 (0.76–1.21)	0.94 (0.65–1.37)	1.14 (0.87–1.50)	1.18 (0.89–1.55)	0.93 (0.49–1.78)
3	0.92 (0.74–1.15)	0.79 (0.55–1.13)	1.04 (0.80–1.36)	1.01 (0.76–1.33)	0.84 (0.45–1.57)
4	0.91 (0.73–1.13)	0.83 (0.59–1.17)	1.16 (0.90–1.49)	1.04 (0.80–1.36)	0.89 (0.49–1.62)
5	1.10 (0.87–1.40)	0.89 (0.61–1.29)	1.04 (0.79–1.37)	1.00 (0.75–1.32)	0.97 (0.52–1.82)
6	0.91 (0.72–1.14)	0.87 (0.60–1.27)	1.20 (0.92–1.57)	1.25 (0.95–1.65)	0.58 (0.29–1.15)
7	1.15 (0.91–1.47)	0.63 (0.43–0.92) ^b	1.02 (0.77–1.35)	0.94 (0.70–1.26)	0.57 (0.28–1.15)
8	1.17 (0.91–1.50)	0.59 (0.40–0.86) ^c	0.91 (0.68–1.22)	0.90 (0.66–1.21)	0.98 (0.49–1.96)
9	1.00 (0.80–1.26)	0.80 (0.55–1.16)	0.97 (0.74–1.27)	0.99 (0.75–1.30)	0.60 (0.31–1.15)
10	1.06 (0.82–1.36)	0.65 (0.44–0.97) ^b	1.06 (0.79–1.42)	1.06 (0.79–1.43)	0.65 (0.32–1.33)

IRSAD = index of relative socio-economic advantage and disadvantage; IRSD = index of relative socio-economic disadvantage; IER = index of economic resources; IEO = index of education and occupation; SEIFA = Australian Socio-Economic Indexes for Areas. Decile 1 represented the most disadvantaged group and decile 10 the most advantaged group.

^a Each SEIFA-based decile was included as an independent variable in models 1 to 4, respectively. In each mixed-effect model, both initial peritoneal dialysis hospital and patients were considered as a random effect. Results are expressed as adjusted odds ratio (95% confidence interval).

^b $p < 0.05$.

^c $p \leq 0.01$.

examined in addition to peritonitis risk. These strengths should be balanced against the study's limitations, which included limited depth of data collection. ANZDATA does not collect important information, such as the presence of concomitant exit-site and tunnel infections, duration of peritonitis symptoms prior to presentation, antimicrobial susceptibilities of isolated microorganisms, patient compliance, individual unit management protocols, PD center medical and nursing staffing levels, duration of cloudy dialysate, laboratory values (such as C-reactive protein and dialysate white cell counts), severity of comorbidities, disconnect systems used, antibiotic dosages or routes of antibiotic administration. Moreover, not all patients within a given postcode necessarily attended the same PD center. Center effects may also have influenced the findings, although this was minimized by treating the PD center as a random effect in

the multivariable models. Even though a large number of patient characteristics were adjusted for, the possibility of residual confounding could not be excluded. The influence of era on the association between peritonitis rate and each of the 10 SEIFA deciles was not able to be meaningfully analyzed due to the relatively short period of the study, although overall peritonitis rates in Australia were relatively constant between 2003 and 2010. The study was unable to examine the relationship between peritonitis and socioeconomic status in indigenous patients, a group at increased risk of peritonitis, due to the fact that residential postal code at the commencement of PD does not always reflect the usual place of residence in this specific group. In common with other registries, ANZDATA is a voluntary registry and there is no external audit of data accuracy, including the diagnosis of peritonitis. Consequently, the possibility of coding/classification

bias cannot be excluded. Finally, SES was evaluated according to postcode of patient residence, which may have provided less precise information than individual- or family-specific data. As mentioned above, selection of patients who commence PD may vary with SES.

In conclusion, in Australia, where there is universal nearly-free healthcare, higher SES was associated with lower risks of both peritonitis-associated hospitalization and death, but similar risks of peritonitis cure, catheter removal and permanent HD transfer. The effect of SES on peritonitis rates was uncertain as the general reductions in peritonitis rates observed in higher SES categories were modest and only statistically significant in some (but not all) categories in a manner which varied within and between each of the four SES variables examined. Further research evaluating strategies for overcoming poorer peritonitis outcomes in socio-economically disadvantaged patients is warranted.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the substantial contributions of the entire Australian and New Zealand nephrology community (physicians, surgeons, database managers, nurses, renal operators, and patients) in providing information for and maintaining the ANZDATA Registry database. Wen Tang was supported by an International Society of Peritoneal Dialysis Scholarship (ISPD fellowship program), grants from National Natural Science Foundation of China (Project 30900681), Beijing Municipal Science & Technology Commission (D09050704310905) and Fund of Peking University Third Hospital (76496-02).

DISCLOSURE

Professor David Johnson is a consultant for Baxter Healthcare Pty Ltd and has previously received research funds from this company. He has also received speakers' honoraria and research grants from Fresenius Medical Care and is a current recipient of a Queensland Government Health Research Fellowship. Dr. Fiona Brown is a consultant for Baxter and Fresenius and has received travel grants from Amgen and Roche. Dr. Stephen McDonald has received speaking honoraria from AMGEN Australia, Fresenius Australia and Solvay Pharmaceuticals and travel grants from AMGEN Australia, Genzyme Australia and Jansen-Cilag. Associate Professor Carmel Hawley has received research funds from Amgen, Roche, Shire and Abbott, travel grants from Amgen, speaking honoraria from Amgen, Roche, Shire, Genzyme and Fresenius. Professor Neil Boudville has previously received research funds from Roche, travel grants from Roche, Amgen and Jansen Cilag, and speaking

honoraria from Roche. The remaining authors have no competing financial interests to declare.

The results presented in this paper have not been published previously in whole or part, except in abstract format.

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