http://www.kidney-international.org

Predictors and outcomes of fungal peritonitis in peritoneal dialysis patients

Rhianna Miles[1,2], Carmel M. Hawley[1,2], Stephen P. McDonald[1,3], Fiona G. Brown[1,4], Johan B. Rosman[1,5], Kathryn J. Wiggins[1,6], Kym M. Bannister[1,7] and David W. Johnson[1,2]

[1]Australia and New Zealand Dialysis and Transplant Registry, Adelaide, Australia; [2]Department of Renal Medicine, University of Queensland at Princess Alexandra Hospital, Brisbane, Australia; [3]Department of Nephrology and Transplantation Services, University of Adelaide at the Queen Elizabeth Hospital, Adelaide, Australia; [4]Department of Nephrology, Monash Medical Center, Clayton, Victoria, Australia; [5]Renal Department, Middlemore Hospital, Otahuhu, Auckland, New Zealand; [6]University of Melbourne Department of Medicine, St Vincent's Hospital, Fitzroy, Victoria, Australia and [7]Department of Nephrology, Royal Adelaide Hospital, Adelaide, Australia

Fungal peritonitis is a serious complication of peritoneal dialysis but previous reports on this have been limited to small, single-center studies. Using all Australian peritoneal dialysis patients, we measured predictors, treatments, and outcomes of this condition by logistic regression and multilevel, multivariate Poisson regression. This encompassed 66 centers over a 4-year period that included 162 episodes of fungal peritonitis (4.5% of all peritonitis episodes) that occurred in 158 individuals. *Candida albicans* (25%) and other *Candida* species (44%) were the most common fungi isolated. Fungal peritonitis was independently predicted by indigenous race and prior treatment of bacterial peritonitis. Peritonitis episodes occurring after 7 and 60 days of treatment for previous bacterial peritonitis decreases in the probability of fungal peritonitis 23 and 6%, respectively. Compared with other organisms, fungal peritonitis was associated with significantly higher rates of hospitalization, catheter removal, transfer to permanent hemodialysis, and death. The risks of repeat fungal peritonitis and death were lowest with catheter removal combined with antifungal therapy when compared to either intervention alone. Our study shows that fungal peritonitis is a serious complication of peritoneal dialysis and should be strongly suspected in the context of recent antibiotic treatment for bacterial peritonitis.

Kidney International (2009) **76,** 622–628; doi:10.1038/ki.2009.202; published online 10 June 2009

KEYWORDS: antifungal agents; *Candida*; fungus; peritonitis; outcomes; yeast

Correspondence: *David W. Johnson, Department of Nephrology, Level 2, ARTS Building, Princess Alexandra Hospital, Ipswich Road, Woolloongabba, Brisbane Qld 4102, Australia. E-mail: david_johnson@health.qld.gov.au*

Received 2 January 2009; revised 11 March 2009; accepted 21 April 2009; published online 10 June 2009

Fungal peritonitis is a serious complication of peritoneal dialysis (PD). It is reported to be caused by yeast (*Candida* species) in at least 75% of cases, account for between 1% and 15% of all PD-associated peritonitis episodes, respond variably to treatment and result in high rates of both technique failure ($\geqslant$40%) and death (5–53%).[1–4] The 2005 update of the International Society of PD (ISPD) Guidelines for Management of PD-related Infections recommends immediate catheter removal after fungi are identified by microscopy or culture, followed by continuation of antifungal therapy for an additional 10 days.[5] However, these recommendations are based on the limited observations involving relatively small case series (5–70 cases) from the 1980s and 1990s involving single centers (often where PD expertise is concentrated).[1–4,6–15] Moreover, there has not been a comprehensive examination of different therapeutic approaches to fungal peritonitis within each of these centers.

The aim of this study was to examine the frequency, predictors, treatment and clinical outcomes of fungal peritonitis in all Australian PD patients involving 66 PD centers.

RESULTS

Population characteristics

A total of 4675 patients received PD in Australia during the study period (1 October 2003 to 31 December 2006). They were followed for 6002 patient-years. One hundred and sixty-two episodes of fungal peritonitis occurred in 158 individuals. Fungi accounted for 4.5% of all peritonitis episodes. The rates of all peritonitis and fungal peritonitis were 0.60 and 0.03 episodes per patient-year of treatment, respectively. The organisms isolated in cases of fungal peritonitis included *Candida albicans* ($n=41$), other *Candida* species ($n=72$), and other fungi ($n=52$). In two cases, *C. albicans* was isolated together with another *Candida* species. Additional non-fungal organisms were isolated in 35 (22%) episodes of fungal peritonitis, including coagulase-negative staphylococci ($n=10$), *S. aureus* ($n=5$), streptococci ($n=3$), enterococci ($n=5$), other Gram-positive organisms ($n=1$), *Pseudomonas* ($n=2$), *Acinetobacter* ($n=2$), *Escherichia coli* ($n=5$),

Klebsiella ($n=6$), *Enterobacter* ($n=5$), other Gram-negative organisms ($n=4$), and anaerobic bacteria ($n=1$).

Predictors of fungal peritonitis

The characteristics of patients who did and did not experience fungal peritonitis are shown in Table 1. On univariate analysis, patients who experienced fungal peritonitis during the study period were more likely to be Aboriginal and Torres Strait Islander peoples, living in Western Australia or Northern Territory, and tended to be less likely to have missing baseline peritoneal equilibration test data than those individuals who did not experience fungal peritonitis.

The hierarchical multivariate poisson model showed that fungal peritonitis incidence was significantly and independently predicted by Aboriginal/Torres Strait Islander racial origin (adjusted incidence rate ratio (IRR) 1.94, 95%

Table 1 | Characteristics of all Australian PD patients who did or did not experience fungal peritonitis at any stage during the period 2003–2006

Characteristic	Fungal peritonitis (*n*=158)	No fungal peritonitis (*n*=4517)	*P*-value
Age (years)	62.7 ± 16.5	61.5 ± 16.7	0.4
Women	73 (46%)	2053 (45%)	0.9
Racial origin			0.001
Caucasian	109 (69%)	3471 (77%)	
Aboriginal/Torres Strait Islander	27 (17%)	361 (8%)	
Maori/Pacific Islander	5 (3%)	76 (2%)	
Asian	13 (8%)	428 (9%)	
Other	4 (3%)	180 (4%)	
BMI (kg/m^2)	26.0 ± 5.0	26.0 ± 6.1	1.0
eGFR at dialysis start (ml/min per 1.73 m^2)	6.7 ± 6.4	7.1 ± 4.4	0.4
Late referral	43 (27%)	1068 (24%)	0.6
ESRF cause			0.4
Chronic glomerulonephritis	44 (28%)	1279 (28%)	
Diabetic nephropathy	52 (33%)	1267 (28%)	
Renovascular disease	22 (14%)	617 (14%)	
Polycystic kidneys	3 (2%)	253 (6%)	
Reflux nephropathy	8 (5%)	189 (4%)	
Other	21 (13%)	624 (14%)	
Unknown	8 (5%)	288 (6%)	
Current smoker	26 (16%)	754 (17%)	0.16
Chronic lung disease	19 (12%)	580 (13%)	0.8
Coronary artery disease	66 (42%)	1601 (35%)	0.3
Peripheral vascular disease	32 (20%)	1014 (22%)	0.8
Cerebrovascular disease	22 (14%)	586 (13%)	0.9
Diabetes mellitus	63 (40%)	1675 (37%)	0.5
HIV positive	0 (0%)	6 (0.1%)	0.6
Previous failed kidney transplant	6 (4%)	206 (5%)	0.8
Peritoneal transport status			0.10
High	17 (11%)	454 (10%)	
High average	63 (40%)	1648 (36%)	
Low average	41 (26%)	1037 (23%)	
Low	10 (6%)	188 (4%)	
Unknown/not specified	27 (17%)	1190 (26%)	
Center size (no. PD patients)			0.9
Small ($\leqslant$10)	2 (1%)	53 (1%)	
Small–medium (11–38)	13 (8%)	308 (7%)	
Medium–large (39–98)	35 (22%)	993 (22%)	
Large ($\geqslant$99)	108 (68%)	3163 (70%)	
State			<0.001
New South Wales	54 (34%)	1778 (39%)	
Northern Territory	13 (8%)	72 (2%)	
Queensland	26 (16%)	929 (21%)	
South Australia	5 (3%)	290 (6%)	
Tasmania	0 (0%)	77 (2%)	
Victoria	34 (22%)	926 (21%)	
Western Australia	26 (16%)	445 (10%)	

BMI, body mass index; eGFR, epidermal growth factor receptor; ESRF, end-stage renal failure; PD, peritoneal dialysis.