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Factors predicting clinical outcomes of continuous ambulatory peritoneal dialysis associated peritonitis – A single centre study

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ABSTRACT

Background: Peritonitis is the common complication among Continuous Ambulatory Peritoneal Dialysis (CAPD) patients. This study is aimed to identify the factors predicting clinical outcomes of peritonitis in patients undergoing CAPD and the demographic, clinical and microbiological features of CAPD patients who were diagnosed with peritonitis.

Materials and Methods: This is a retrospective observational study conducted to identify factors predicting clinical outcomes of CAPD associated peritonitis over a four-year period in Taiping Hospital, Malaysia.

Results: A total of 109 episodes of CAPD associated peritonitis in 54 patients was enrolled with a median age being 56.5 years. In all 43.1% of these were complicated peritonitis. About half (n=54, 49.5%) of the peritonitis was caused by a single gram-positive organism. Coagulase negative *Staphylococcus (CoNS)* and *Escherichia coli* was the most often isolated gram-positive and gram-negative microorganism, respectively. We observed that less likelihood of developing complicated peritonitis in presence of abdominal pain (Odd ratio, OR 0.25, 95% confidence interval, 95%CI: 0.10, 0.63). In contrast, presence of more than one previous episode of peritonitis (OR 2.79, 95%CI: 1.11, 7.04) and previous migration and readjustment of Tenkchoff catheter (OR 7.48, 95%CI: 1.39, 40.41), were factors significantly associated with complicated peritonitis.

Conclusion: Presence of abdominal pain, more than one previous episode of peritonitis, and previous migration and readjustment of Tenkchoff catheter, were found as significant factors in predicting clinical outcomes of CAPD associated peritonitis.

KEYWORDS:
Complicated episode; Continuous Ambulatory Peritoneal Dialysis; Factors; Peritonitis

INTRODUCTION

Peritoneal dialysis (PD) is a home-based therapy and offers clear advantages over haemodialysis (HD), such as simplicity, minimal technical support requirements, non-dependence on electricity and issues regarding water purification, in addition to cost saving.[1] A study reported approximately one-fourth of total population of PD in the world are from the Asia Pacific region.[2]

Peritonitis remained the main reason for PD patients to drop out of the PD modality[3-5] and a common cause of catheter loss and subsequent transfer to HD temporarily or permanently.[6] Based on data from Malaysian registry, excluding death as a cause for drop-out from PD, peritonitis remained as the most common cause of treatment failure over the last decade, and contributed to 18% of PD dropout in the year of 2016.[7]

Strategies such as dissemination of risk factors, publication and adherence to guidelines, development of new techniques, and implementation of more effective therapies have led to a reduction in the prevalence of PD associated peritonitis globally. However, studies done in Malaysia on factors predicting clinical outcomes are limited and published data have only listed demographic factors, clinical characteristics of peritonitis and the spectrum of microorganism as potential risk factors for PD associated peritonitis.[8,9]

We conducted this retrospective observational study to identify the demographic characteristics of Continuous Ambulatory Peritoneal Dialysis (CAPD) patients who were diagnosed with peritonitis, to identify the clinical characteristics and microbiological features of the peritonitis and the factors that can predict the clinical outcomes of peritonitis in patients undergoing CAPD.

MATERIALS AND METHODS

The study was performed at Taiping Hospital, Malaysia which is a 608-bedded multidisciplinary public hospital. All episodes of CAPD associated peritonitis diagnosed in Taiping Hospital from October 2015 until October 2019 as referred to the census were enrolled in the study. Peritonitis was defined as the presence of at least two of the following criteria: (a) clinical features consistent with peritonitis, for example abdominal pain and/or cloudy dialysate effluent; (b) presence of white blood cells (WBC) in the dialysate effluent in excess of 100 cells/mm^3 with more than 50% polymorphonuclear cells and; (c) positive dialysate culture.[10] Peritonitis that occurred before patient underwent the intended CAPD training, patient with concurrent presence of malignancy or concurrently on any immunosuppressant were excluded. All data were retrieved manually from the

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medical record file of eligible patients and entered into a predesigned data collection form. The data collection form included patient demographic data, medical history data, patient's dialysis treatment data, and information regarding the pre-initiation of CAPD of patients. Additionally, for each episode of peritonitis, data regarding clinical characteristics, microbiological data, antibiotic treatment, clinical outcome, and length of hospitalisation were collected.

The clinical outcomes of patients were divided into two groups: those with curable episodes and those with complicated episodes. An episode was considered curable when resolution occurred with an appropriate duration of antibiotic therapy as recommended by the International Society for Peritoneal Dialysis (ISPD) guideline 2016, without catheter removal.[10] An episode was considered complicated if there were recurrent episodes, relapsed, repeated, catheter removal took place and/or there was a need for temporary or permanent HD and/or death. Episodes due to a different organisms occurring within four weeks period after completion of therapy were defined as recurrent, while episodes due to a same organism or one sterile episode occurring within a four week period after completion of therapy was defined as relapsed.[10] An episode considered as repeated if it was due to the same organism but occurred after the four week period following the completion of therapy.[10] Death was defined as fatal event with active peritonitis within the four week period of a peritonitis episode or during hospitalisation for a peritonitis episode.[10] In the Taiping Hospital, CAPD patients are implanted with double cuff coiled Tenckhoff catheter. For each episode of peritonitis, specimens were collected for aerobic, anaerobic, fungal and mycobacterium cultures. This study protocol was registered with the National Medical Research Register (NMRR), and ethical approval was obtained from the Medical Research & Ethics Committee (MREC) with reference KKM/NIHSEC/P19-2398(7). Informed consent is waived since this is a retrospective study looking into the patient's medical record.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Science Software version 26.0. Descriptive statistics, such as mean and standard deviation, median and interquartile range (IQR), frequencies, and percentages, were used to explore, summarize, and describe the parametric and non-parametric data, respectively. Between-group comparison analysis was carried out using Pearson Chi-Square (χ^2) or Fisher's exact test for categorical variables. While for continuous variables, normality of the data was tested by using Kolmogorov-Smirnov statistic with a Lilliefors significance level for sample sizes ≥100, or by referring to Shapiro-Wilks statistic for sample size <100. Any differences between continuous variables were tested by using Independent t-test for normally distributed data, while the Mann Whitney U test was used for non-normally distributed data. Variables with a p-value of <0.05 were considered statistically significant. Those variables which were found statistically significant were taken forward to the next stage, whereas repeated measure simple logistic regression with Generalised Estimating Equation (GEE) was conducted to assess the factor predicting the complicated outcomes of CAPD associated peritonitis and the results were expressed as the odds ratio (OR) with a 95% confidence interval (95%CI).

RESULTS

A total of 123 episodes of CAPD associated peritonitis were identified. After excluding ten episodes which did not fulfill the diagnostic criteria of CAPD associated peritonitis, and four episodes that happened before the intended CAPD training, a total of 109 episodes of CAPD associated peritonitis were identified in 54 patients and included in this study. The demographic characteristic of the included subjects is summarised in Table I. The median age of patients was 56.5 years (IQR 44-60.6), with a minimum age of 22.6 years and a maximum of 82.5 years. There were 22 males (40.7%) and 32 females (59.3%), with a majority of patients of being Malays (85.2%) followed by Indians (9.3%) and Chinese (5.6%).

Diabetic nephropathy (44.4%) and hypertensive nephrosclerosis (42.6%) were the two main primary renal diseases that caused end-stage renal disease (ESRD). Among the 54 patients, 88.9% of them had hypertension, 44.4% had diabetes mellitus, and 18.5% had ischemic heart disease. The majority (63%) of them received PD as their first renal replacement therapy (RRT) modality, while others (37%) were transferred from HD. More than half of the patients were on the Fresenius CAPD system, while the others were on the Baxter CAPD system. All the patients underwent the intended CAPD training before they proceeded with CAPD at home. The median duration of CAPD training of seven days (IQR 6-9) were recorded. The majority of the patients (61.1%) required assistance while doing CAPD.

Clinical history, clinical symptoms, and laboratory findings of 109 episodes of CAPD associated peritonitis is summarised in Table I. The median duration of CAPD with the onset of CAPD associated peritonitis was 10.6 months (IQR 5-19). A total of 20 episodes (18.3%) had a history of migration and readjustment of Tenckhoff catheter, and 27 episodes (24.8%) had a history of exit site infection (ESI). There were 53 episodes (48.6%) being the first episodes of peritonitis, while other episodes were relapsed, repeat or recurrent ones. There were 94.5% (n=103) and 69.7% (n=76) of the peritonitis presented with turbid dialysate and abdominal pain, respectively.

Overall, the peritonitis presented with raised in dialysate WBC count on day one (median 940 cells/mm^3, IQR 322.5-2000) and on day three (median 180 cells/mm^3, IQR 45.25-592.50), while the median of day five dialysate effluent WBC count was lower than 100 cells/mm^3 (median 60 cells/mm3, IQR 0-352.50). The median of 4 days (IQR 3-7) was required for the dialysate effluent WBC count to be less than 100 cells/mm^3. Hypoalbuminemia (mean±SD, 26.26±7.47g/L), low serum total protein (60.14±8.86g/L), normokalaemia (3.79±0.82mmol/L) and raised serum C-Reactive Protein (CRP) level (123.13±82.68 mg/L) was noted in these patients. Table II lists the causative organisms of the 109 episodes of CAPD associated peritonitis. About half (n=54, 49.5%) of the peritonitis was caused by a single gram-positive organism, 15.6% (n=17) caused by a single gram-negative organism, and 6.4% (n=7) was caused by a fungal infection. The culture was sterile in 27.5% (n=30) of the cases, and one case caused by polymicrobial infection. Coagulase negative Staphylococcus (CoNS) were accounting for almost two-thirds of the gram-positive episodes. Methicillin-resistant CoNS was

Table I: Demographic characteristics of the 54 patients on Continuous Ambulatory Peritoneal Dialysis (CAPD) and clinical characteristics of 109 episodes of CAPD associated peritonitis.

	Value
Demographic characteristics of the 54 patients	
Age, years old, median, (IQR)	56.5 (44-60.6)
Distance of residence to CAPD centre, km, median, (IQR)	8.4 (5-36.7)
BMI, kg/m^2, median, (IQR)†	23.02 (20.44-28.37)
Gender, n (%)	
Male	22 (40.7)
Female	32 (59.3)
Ethnicity, n (%)	
Malay	46 (85.1)
Chinese	3 (5.6)
Indian	5 (9.3)
Marital Status, n (%)	
Single	8 (14.8)
Married	41 (75.9)
Widowed	5 (9.3)
Education Level, n (%)	
No formal education	2 (3.7)
Primary	15 (27.8)
Secondary	28 (51.9)
Tertiary	9 (16.6)
Family Monthly Income, n (%)	
<RM1000	29 (53.7)
RM1000-RM3000	19 (35.2)
RM3001-RM5000	5 (9.3)
RM5001-RM10000	1 (1.9)
Smoking status, n (%)	
Smoker	2 (3.7)
Ex-smoker	1 (1.9)
Non-smoker	51 (94.4)
Primary renal disease, n (%)	
Diabetic nephropathy	24 (44.4)
Hypertensive nephrosclerosis	23 (42.6)
Obstructive uropathy	2 (3.7)
Glomerulonephritis	2 (3.7)
Unknown etiology	3 (5.6)
Diabetes mellitus, n (%)	
Yes	24 (44.4)
No	30 (55.6)
Hypertension, n (%)	
Yes	48 (88.9)
No	6 (11.1)
Ischemic heart disease, n (%)	
Yes	10 (18.5)
No	44 (81.5)
First renal replacement therapy, n (%)	
Haemodialysis	20 (37)
Peritoneal dialysis	34 (63)
CAPD system, n (%)	
Fresenius	33 (61.1)
Baxter	21 (38.9)
Duration of CAPD training, days, median, (IQR)†	7 (6- 9)
CAPD care, n (%)	
Self-care	21 (38.9)
Assisted	33 (61.1)
Number of peritonitis episodes, n (%)	
1	32 (59.3)
2	10 (18.5)
3-4	8 (14.8)
≥5	4 (7.4)
Clinical characteristics of the 109 episodes of CAPD associated peritonitis	
Duration of CAPD with the onset of CAPD associated peritonitis, months, median, (IQR)	10.6 (5-19)
History of migration and readjustment of Tenckhoff catheter, n (%)	
Yes	20 (18.3)
No	89 (81.7)
History of ESI, n (%)	
Yes	27 (24.8)
No	82 (75.2)

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Abdominal pain, n (%)	
Yes	76 (69.7)
No	33 (30.3)
Turbid dialysate effluent, n (%)	
Yes	103 (94.5)
No	6 (5.5)
Fever, n (%)	
Yes	26 (23.9)
No	83 (76.1)
Diarrhoea, n (%)	
Yes	18 (16.5)
No	91 (83.5)
Nausea or vomiting, n (%)	
Yes	12 (11.0)
No	97 (89.0)
Number of previous peritonitis episodes, n (%)	
0	53 (48.6)
1	23 (21.1)
2	12 (11.0)
3	7 (6.4)
4	4 (3.7)
≥5	10 (9.2)
Use of antifungal for secondary prophylaxis, n (%)	
Yes	26 (23.9)
No	83 (76.1)
Day one dialysis effluent WBC count, cells/mm^3, median, (IQR)	940 (322.5-2000)
Day three dialysis effluent WBC count, cells/mm^3, median, (IQR)†	180 (45.25-592.50)
Day five dialysis effluent WBC count, cells/mm^3, median, (IQR)†	60 (0-352.50)
Days for dialysis effluent WBC count < 100 cells/mm^3, median, (IQR)†	4 (3-7)
Serum albumin, g/L, mean±SD†	26.26±7.47
Serum total protein, g/L, mean±SD†	60.14±8.86
Serum potassium, mmol/L, mean±SD†	3.79±0.82
Serum CRP level, mg/L, mean±SD †	123.13±82.68

CAPD = continuous ambulatory peritoneal dialysis; BMI = body mass index; RM = ringgit Malaysia; ESI = exit site infection; WBC = white blood cells; CRP = C-reactive protein; IQR = interquartile range; SD = standard deviation., †Missing data were excluded from analysis

the most commonly isolated microorganisms leading to CAPD associated peritonitis. Escherichia coli was the most common gram-negative organisms isolated.

The type of peritonitis episode and clinical outcomes of all cases included in the study is summarised in Table III. More than half (n=62, 56.9%) of the peritonitis was cured with antibiotic treatment. 43.1% (n=47) were considered complicated which included relapsed peritonitis (9.2%), repeat peritonitis (9.2%) and recurrent peritonitis (2.8%). Of these, 17.4% required removal of catheter and 4.6% resulted in death. 79 episodes (72.5%) of peritonitis required hospitalisation and the median length of hospitalisation was seven days (IQR 5-13).

The possible factors predicting the clinical outcomes of CAPD associated peritonitis have been divided into categorical factors and numerical factors. The factors and their effect on the complicated episodes are listed in Table IV. Males were significantly associated with lower complicated peritonitis compared with the females (27.8% vs. 50.7%, p<0.05). The presence of abdominal pain was found significantly lower in the complicated course compared with episodes without the presence of abdominal pain (32.9% vs. 66.7%, p<0.05). History of migration and readjustment of Tenckhoff catheter (p<0.001), the presence of dialysate effluent WBC counts more than 100cells/mm^3 on day five (p<0.05), history of peritonitis (p<0.05) and fungal peritonitis (p<0.05) was associated with a complicated course. There was a difference between curable and complicated episode in regard to the number of previous episodes of peritonitis (p<0.05).

Repeated measure simple logistic regression analysis (Table V) revealed that history of migration and readjustment of Tenckhoff catheter (OR 7.48, 95%CI: 1.39, 40.41), history of more than one episode of peritonitis (OR 2.79, 95%CI: 1.11, 7.04) are significant factor predicting a complicated course of CAPD associated peritonitis, while presence of abdominal pain (OR 0.25, 95%CI: 0.10, 0.63) were associated with lower risk. However, history of peritonitis (OR 2.23, 95%CI: 0.94,5.31), presence of dialysate effluent WBC count more than 100cells/mm^3 on day five (OR 2.71, 95%CI: 0.98, 7.50) and male gender (OR 0.37, 95%CI: 0.13, 1.04) did not demonstrate any relationship with a complicated course of CAPD associated peritonitis.

DISCUSSION

Peritonitis is an important complication of CAPD.[9] PD patients in the age group of 55 to 64 years have greater preponderance towards peritonitis based on data from the Malaysian registry.[7] This is consistent with patients in the Taiping Hospital who were mostly older adults (median 56.5, IQR 44.0-60.6). However, two studies conducted in Malaysia observed higher proportion of younger patients being diagnosed with CAPD associated peritonitis.[11,12]

Table II: Causative organisms of 109 episodes of Continuous Ambulatory Peritoneal Dialysis (CAPD) associated peritonitis

Causative organism	Number of episodes, n (%)
Gram-Positive	**54 (49.5)**
Coagulase-negative Staphylococcus (CoNS)	
Methicillin-resistant	21 (19.3)
Methicillin-sensitive	12 (11.0)
Staphylococcus Aureus	
Methicillin-resistant	4 (3.7)
Methicillin-sensitive	4 (3.7)
Bacillus spp.	7 (6.4)
Streptococcus spp.	2 (1.8)
Vancomycin-resistant Enterococcus faecium (VRE)	1 (0.9)
Enterococcus spp.	1 (0.9)
Diphtheroids	1 (0.9)
Rotria dentocariosa	1 (0.9)
Gram-Negative	**17 (5.6)**
Escherichia coli (E. coli)	
ESBL (-)	3 (2.8)
ESBL (+)	1 (0.9)
Amp C beta lactamase (+)	1 (0.9)
Carbapenem resistant	1 (0.9)
Escherichia hermanii	1 (0.9)
Klebsiella pneumoniae	
ESBL (-)	1 (0.9)
ESBL (+)	1 (0.9)
Acinetobacter baumanii	4 (3.7)
Stenotrophomonas maltophilia	2 (1.8)
Pseudomonas aeruginosa	1 (0.9)
Pseudomonas stutzeri	1 (0.9)
Fungal	**7 (6.4)**
Candida spp.	4 (3.7)
Candida parapsillosis	1 (0.9)
Cryptococcus laurenti	1 (0.9)
Rhodorula glutinitis	1 (0.9)
Polymicrobial	**1 (0.9)**
Culture negative	**30 (27.5)**

ESBL = extended spectrum beta-lactamase.

Table III: Type of peritonitis episodes and clinical outcomes of 109 episodes of Continuous Ambulatory Peritoneal Dialysis (CAPD) associated peritonitis

Outcomes	Value
Curable episodes, n (%)	**62 (56.9)**
Complicated episodes, n (%)	**47 (43.1)**
Relapsed peritonitis, n (%)	10 (9.2)
Repeat peritonitis, n (%)	10 (9.2)
Recurrent peritonitis, n (%)	3 (2.8)
Catheter removal required, n (%)	19 (17.4)
Death, n (%)	5 (4.6)
Hospitalised, n (%)	**79 (72.5)**
Length of hospitalisation, days, median, (IQR)	**7 (5-13)**

IQR = interquartile range.

Patients with assisted CAPD has significantly higher risk in developing peritonitis.[7] Our study found that most patients lack self-care capabilities due to advancing age and low levels of literacy. In fact, the presence of medical and social conditions were potential barriers to self-care PD, especially in the elderly, thus contributing to elevated complication risk.[13] Performing this RRT modality is perceived as tedious process, involving proper handwashing technique and hygiene, CAPD exchange procedures, exit-site care, recording of blood pressure, weight and ultrafiltration, in addition to recognition of peritonitis and management.[11] Such added responsibility may provoke reduced self-confidence leading to reliance on partial or complete assistance when carrying out CAPD.[14]

The microbiological spectrum observed in CAPD associated peritonitis in our study population did not show discrepancies with other studies. The main causative microorganisms were gram-positive bacteria which were reported in numerous studies[5,7-9,15,16] often with CoNS presenting as the most ubiquitous gram-positive pathogen, while Escherichia coli was more often isolated in gram-negative peritonitis.[3,5,7,9,12,16]

Table IV: Categorical and numerical factors and their effect on 109 episodes of CAPD associated peritonitis

	Complicated episode if factor present, n (%)	Complicated episode if factor absent, n (%)	p-value*
Demographic data			
Male gender	10 (27.8)	37 (50.7)	0.023
Self-care CAPD	23 (53.5)	24 (36.4)	0.078
Comorbidities			
Diabetes mellitus	20 (43.5)	27 (42.9)	0.948
Hypertension	42 (44.7)	5 (33.3)	0.410
Ischemic heart disease	5 (25.0)	42 (47.2)	0.070
Clinical history			
History of migration and readjustment of Tenckhoff catheter	16 (80.0)	31 (34.8)	<0.001
History of peritonitis	29 (52.7)	18 (33.3)	0.041
History of ESI	10 (37.0)	37 (45.1)	0.462
Clinical findings			
Abdominal pain	25 (32.9)	22 (66.7)	0.001
Turbid dialysate effluent	45 (43.7)	2 (33.3)	0.619
Fever	9 (34.6)	38 (45.8)	0.316
Diarrhoea	5 (27.8)	42 (46.2)	0.150
Nausea and vomiting	5 (41.7)	42 (43.3)	0.914
Clinical findings			
Dialysate effluent WBC counts >1000cells/mm^3 on day three†	10 (55.6)	28 (37.3)	0.139
Dialysate effluent WBC counts >100cells/mm^3 on day five †	19 (57.6)	16 (33.3)	0.030
Gram-positive peritonitis	24 (44.4)	23 (41.8)	0.782
Gram-negative peritonitis	7 (41.2)	40 (43.5)	0.860
Culture negative peritonitis	9 (30.0)	38 (48.1)	0.088
Fungal peritonitis	7 (100.0)	40 (39.2)	0.002**
Age at the onset of peritonitis, years old, median, (IQR)	55.8 (37.8-60.5)	56.6 (51.8-61.8)	0.702
Distance of residence to CAPD centre, km, median, (IQR)†	6.4 (3.2-36.6)	9.6 (9.6-45.4)	0.126
BMI, kg/m^2, median, IQR†	23.28 (19.63-28.91)	22.83 (21.91-28.32)	0.967
Duration of CAPD training, days, median, (IQR)†	7 (6-10)	7 (5-8)	0.057
Number of previous episodes of peritonitis, median, (IQR)	0 (0-1)	1 (0-3)	0.002
Duration of CAPD, months, median, (IQR)	10 (3.2-19)	11.3 (6.5-18.8)	0.482
Day one dialysate effluent WBC count, cell/mm^3, median, (IQR)	1000 (365-2000)	560 (260-2000)	0.376
Days for dialysate effluent WBC counts <100cell/mm^3, median, (IQR)†	5 (3-7)	4 (3-6)	0.329
Serum albumin, g/L, mean±SD†	27.1±7.72	25.05±7.04	0.229##
Serum total protein, g/L, mean±SD†	60.92±9.08	59.03±8.54	0.359##
Serum CRP, mg/L, mean±SD†	118.76±68.31	129.78 ± 102.29	0.640##
Length of hospital stay, days, median, (IQR)	5 (0-7)	6 (0-14)	0.184

CAPD = continuous ambulatory peritoneal dialysis; ESI = exit site infection; BMI = body mass index; WBC = white blood cells; CRP = C-reactive protein; IQR = interquartile range; SD = standard deviation, *Pearson Chi-Square; **Fisher exact test; #Mann-Whitney U Test; ##Independent T-test, †Missing data were excluded from analysis.

Table V: Factors predicting the complicated course of CAPD associated peritonitis

Variables	OR	95%CI	p-value
Male	0.37	0.13, 1.04	0.060
History of migrated and readjustment of Tenkchoff catheter	7.48	1.39, 40.41	0.019
History of peritonitis	2.23	0.94, 5.30	0.070
Presence of abdominal pain	0.25	0.10, 0.63	0.004
Presence of dialysate effluent WBC counts >100 cells/mm^3 on day five†	2.71	0.98, 7.50	0.054
History of > one episode of peritonitis	2.79	1.11, 7.04	0.029

CAPD = continuous ambulatory peritoneal dialysis; WBC = white blood cells; OR = odds ratio; CI = confidence interval; †Missing data were excluded from analysis.

Meanwhile, culture-negative peritonitis rate (27.5%) was comparable with local studies,[11,12] but was slightly higher than the national value of 24.5%.[8] Culture-negative rates were lower in studies involving Australian and Canadian PD patients,[5,9] thus fulfilling the standard of not more than 20% suggested by ISPD guidelines.[10] There were no cases of mycobacterium peritonitis being identified during this study period. High incidence of culture-negative may warrant further review and improvements on existing diagnostic methods in order to achieve the ISPD cut-off value.

In contrast to bacterial peritonitis, fungal peritonitis is uncommon.[17] We report here a rate of 6.4% which exceeded published values by other authors and the national report, ranging from 2.5% to 4.5%.[5,7,8,11,12,15,17] Limited prescription of antifungal for secondary prophylaxis, whereby only 23.9% of peritonitis events received antifungal prescription, as well as history of previous peritonitis episodes, prior use of antibiotics, immunosuppressed state, diabetes mellitus, malnutrition, prolonged time on PD[18] and presence of gastrointestinal disorder[17], were possible contributors of more

fungal peritonitis events in our patient population. Further analysis is required to identify the risk factors unique to this infection which was beyond the scope of the current study due to insufficient sample size and other limitations.

Our study found complicated episodes of peritonitis, was 43.1% compared to 26% in a single centre study in Greece.[8] This could be attributed to higher incidence of fungal peritonitis and around 26% isolated microorganisms were drug resistant. Other clinical outcomes such as mortality and hospital admission were found to be similar with numbers reported by other investigators. Fatality rates ranged from 2.3% to 5.7%,[3,8,9] hospitalisation frequencies were approximately 70%.[3,5] In order to reduce the need for admission and length of stay, our current practice allows for some clinically stable patients to be administered intraperitoneal antibiotics and assessed regularly for treatment response in the outpatient setting.

The first occurrence of peritonitis, and subsequently repeated episodes may cause pathological changes in the peritoneal membrane by inflicting severe injury to mesothelial cells. These are specialised epithelial cells that line the peritoneal membrane and play a crucial role in peritoneal host defence.[19,20] In their paper, Kofteridis and colleagues reported that a history of peritonitis and not the number of previous episodes was associated with a complicated episodes,[8] while we showed a statistically significantly higher risk of developed complicated episode in those with history of more than one episode of peritonitis.

The higher proportion of study subjects without presenting complaint of abdominal pain in the complicated CAPD peritonitis group may influence treatment outcomes. Data from two study centres namely in Canada and Thailand showed higher treatment success rates in patients with abdominal pain, though the figures were not statistically significant.[9,15] Apart from abdominal pain, another common clinical symptom of CAPD associated peritonitis is turbid dialysis effluent. While the former is usually the early presenting symptom when dialysate effluent might initially be clear, the latter may become turbid after the next exchange or on the very next day.[21] Hence, this earlier presenting symptom may result in early treatment, thus potentially lowering the incidence of complicated peritonitis. Migration of Tenckhoff catheter can impair dialysate outflow in peritoneal dialysis[22] resulting in subsequent catheter readjustment and increased preponderance to complicated episodes of peritonitis in our study. There is a lack of published reports examining the relationship between this phenomenon with clinical outcomes of CAPD associated peritonitis. Surgical readjustment of the catheter via laparoscopic surgery is a common practice in the Taiping Hospital setting for cases of migrated catheter. Hence, this may increase the risk of secondary or tertiary peritonitis. Besides, constipation is one of the predisposing factors of catheter migration,[23] which can be alleviated by prescribing laxatives and ensuring patient adherence to such treatment.

Dialysate effluent WBC count may be an index of peritonitis severity and a prognostic factor for CAPD associated peritonitis clinical outcome.[8,9,15,24,25] Dialysate effluent WBC counts exceeding 100 cells/mm^3 on day five were indicative of a complicated episode, a finding which was supported by Nochaiwong and colleagues.[15] There was association between the number of days with dialysate effluent WBC counts >100cells/mm^3 with the occurrence of complicated peritonitis, more so if such counts persisted beyond five days.[8,9,24,25] Meanwhile, early dialysate effluent WBC counts of >1000cells/mm^3 on days three to four was associated with higher treatment failure risk.[15,24] Conversely, we report no statistically significant differences for day one and day three dialysate effluent WBC counts between curable and complicated episodes, as well as no evidence of increased complicated disease risk in patients with dialysate WBC count >100cells/mm^3 on day five. Nevertheless, clinical relevance of early dialysate WBC count has resulted in less treatment delay because most of the causative organisms, if any, will likely be cultured after five days of incubation. Published guidelines have also recommended catheter removal in patients with unresolved turbid dialysate effluent after five days of appropriate antibiotics.[10]

This study found that male gender does not associated with lower risk of developing complicated peritonitis. The finding is consistent with numerous studies which have shown that gender did not influence the course and clinical outcomes of peritonitis.[8,9,15] While the type of causative organisms (gram-positive or gram-negative) were not proven to influence infection outcome apart from fungal peritonitis in our patients and another study,[8] several authors have reported significant association between cultured pathogens with overall course of peritonitis.[9,15,26,27] The time taken for the identification of organism, which involved the process of culture and sensitivity, may delay the management of CAPD associated peritonitis.[15] As such, its clinical value remained limited in the initial stage of treatment where physicians will more likely to adopt early dialysate cell count, effluent appearance and other parameters to diagnose CAPD associated peritonitis and initiate prompt antibiotic treatment.

Long-term PD therapy has been linked to alteration of peritoneal membrane structure and peritoneal macrophage function, resulting in decreased peritoneal host defence.[8,9] Our study did not demonstrate any relationship between duration of PD with the clinical outcomes of peritonitis, which was consistent with other papers.[8,28] Several studies with duration of PD ranging from 28.8 to 60 months (versus a median of 10 months in our study) described that the occurrence of unsatisfactory outcomes was related to longer time on this RRT modality.[9,29,30] Due to conflicting results, duration of CAPD should not be used as the only parameter to ascertain patients' risk of developing complicated peritonitis.

In terms of serum CRP, those with poor clinical outcomes were presented with higher baseline values.[23,28] Our study did not show significant association between serum CRP and clinical outcomes. Besides, in CAPD associated peritonitis, many researchers were unable to establish a relationship between serum albumin and disease outcomes[8,9,15] which is consistent with our study finding. On the other hand, Zhen and colleagues reported significantly lower serum albumin levels in fatal peritonitis, patients with catheter removal, and those experiencing relapsed peritonitis.[30] Therefore, serum CRP and serum albumin monitoring at baseline and during the course of peritonitis may be considered in the clinical management of CAPD peritonitis.

This study was conducted at the current point of time where locally published reports on factors predicting clinical outcomes of CAPD associated peritonitis was noticeably lacking. The findings will set the pace for future research and establishment of clinical practice guidelines to focus on development and implementation of new strategies, and improvement of existing disease management. Incomplete data, small number of patients and retrospective data are limitations noted in this study.

CONCLUSION

In conclusion, presence of abdominal pain, more than one previous episode of peritonitis and previous migration and readjustment of Tenkchoff catheter were found as significant factors in predicting clinical outcomes of CAPD associated peritonitis.

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CONFLICT OF INTEREST

We have no conflicts of interest.

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