Original Article

Microbiological Profile of Peritoneal Dialysis-Related Peritonitis at Dr. Hasan Sadikin Hospital, Bandung

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ABSTRACT

Background: Peritonitis is a frequent complication in patients undergoing peritoneal dialysis. To provide appropriate therapy, identification of the pathogen that causes peritonitis is required.

Objective: This study aims to understand the microbiological profile of CAPD peritonitis in hospitalized patients at Dr. Hasan Sadikin Hospital, Bandung.

Methods: This was a descriptive retrospective study using secondary data of peritonitis patients undergoing CAPD in 2020-2023. A total sampling technique was used, where all cases that met the inclusion criteria were included. The criteria were patients aged ≥ 18 years with CAPD peritonitis, having complete medical record data, and CAPD fluid culture results. In addition, the data were analyzed using SPSS software.

Results: A total of 67 peritonitis patients undergoing CAPD were included, with 36 (53.7%) having monomicrobial infections. In addition, 7.5% had polymicrobial infection and 38% had culture-negative. Gram-negative bacteria were the most common microbe found in 18 cases, and most patients recovered from peritonitis (86.6%), followed by catheter removal (9%), and death (4.5%). Gram-negative predominance contrasts with Ozdemir et al.'s findings, possibly due to regional antibiotic practices.

Conclusion: Empirical antibiotic treatment and culture results helped in providing effective management. Adhering to ISPD guidelines and improving sampling techniques could improve microbiological diagnosis and patient outcomes.

Keywords: CAPD, Microbiological Profile, Peritonitis.

Introduction

In end-stage kidney disease, kidney replacement therapy, such as hemodialysis, peritoneal dialysis, or transplantation, is required. The number of patients receiving kidney replacement therapy exceeds 2.5 million and is projected to double to 5.4 million by 2030.[1] Peritoneal dialysis is an effective and commonly used modality. The main and serious complication of peritoneal dialysis is peritonitis, which necessitates hospitalization and hemodialysis, with a variable mortality rate ranging from 2 to 25%.[2] Continues Ambulatory Peritoneal Dialysis (CAPD)-related peritonitis was defined, based on ISPD criteria, as at least two of the following criteria are present: (1) abdominal pain and/or cloudy dialysis effluent, (2) effluent WBC >100/μL with >50% PMN after ≥2 hours dwell, and (3) positive effluent culture. The microbiological profile in this study encompasses the identity of causative organisms in CAPD-associated peritonitis, as determined by culture of peritoneal effluent.

Several factors have been reported to be associated with the incidence of CAPD peritonitis, but remain inconsistent, including age, gender, body mass index (BMI), race, and

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comorbidities, such as diabetes mellitus. Other factors include hypoalbuminemia, hypokalemia, vitamin D supplementation, and a history of previous infection. Understanding the risk factors, microbiological profile, and antibiotic resistance patterns is crucial for the management of peritonitis.[3,4]

The most common microbes causing peritonitis in patients undergoing PD are gram-positive pathogens. However, *Pseudomonas aeruginosa* and fungi are associated with prolonged infection and worse outcomes.[4] The early diagnosis and rapid initiation of therapy are essential to prevent poor outcomes. To provide appropriate therapy, it is important to identify the microorganism causing the complication.[5] This study aims to (1) characterize the microbiological profile of CAPD peritonitis, and (2) evaluate clinical outcomes. Therefore, this study aims to determine the characteristics of patients with peritoneal dialysis-related peritonitis, identify risk factors, and analyze the microbiological profile causing infection. The clinical outcomes of patients after treatment, including the success rate of therapy and the mortality rate, were also assessed. By understanding the microbiological profile, this study can be an important reference in the initial management, selection of appropriate antibiotics, and improvement of the quality of care. In addition, it can contribute to reducing the mortality rate of peritoneal dialysis-related peritonitis.

Methods

Design and participants

Secondary data were obtained from medical records, and data collection was carried out from July to August 2024, hence, this was a descriptive retrospective study. The population in this study was all patients who underwent *Continuous Ambulatory Peritoneal Dialysis* (CAPD), experienced peritonitis, and were hospitalized at Dr. Hasan Sadikin Central Hospital, Bandung, during the period 2020-2023. The study sample used a total sampling technique, in which all cases that met the inclusion criteria were included in the study. Inclusion criteria included patients older than 18 years, confirmed according to the criteria for diagnosis of CAPD peritonitis, having complete medical record data, and CAPD fluid culture results. As exclusion criteria, incomplete medical records were excluded from the analysis, and the total sample was 67 subjects. This study had received approval from the Hasan Sadikin Hospital Bandung Study Ethics Committee under reference number DP.04.03/D.XIV.6.5/302/2024.

Study Covariate

In this study, CAPD-associated peritonitis was diagnosed based on ISPD-recommended criteria.[6] Data on baseline characteristics and laboratory characteristics were extracted from medical records. Baseline characteristics included age, gender, education, CAPD duration, etiology of CKD, comorbid, BMI, and Peritoneal Equilibration Test (PET). In addition, laboratory characteristics included culture results, hemoglobin, albumin, random blood glucose, urea, and creatinine.

Microbiological procedures

Effluent was obtained in cases of suspected peritonitis (cloudy dialysate and/or abdominal pain). Using aseptic technique, 5–50 mL of dialysate was drained into a sterile container. Effluent cultures were inoculated into aerobic BACTEC bottles. Laboratory analysis included Gram staining, cell count, and standard culture, with additional fungal, mycobacterial, or molecular studies performed when indicated.

Statistical analysis

Data analysis was performed descriptively using IBM SPSS Statistics. Descriptive analysis aimed to describe the characteristics of CAPD peritonitis patients, including frequency distribution, mean, and proportions of the studied variables. The analysis results were presented in table form to facilitate the interpretation and understanding of the microbiological profile of peritonitis in CAPD.

Results

In A total of 67 cases of peritonitis in CAPD patients were included in the study. The mean age was 44 years (23 - 70 years), with 43 male patients (64.2%) and 24 female patients (35.8%). Based on education level, most patients had senior high school education with 34 patients (50.7%), followed by bachelor's 30 patients (44.8%), diploma 2 patients (3%), and junior high school 1 patient (1.5%). Furthermore, the mean duration of CAPD used until peritonitis occurred was 29 months (± 23.625). The etiology of CKD was mostly caused by hypertensive nephrosclerosis in 27 patients (40.3%), followed by diabetic kidney disease in 20 patients (29.9%), glomerulonephritis in 16 patients (23.9%), and other causes in 4 patients (6%). The most common comorbidity was hypertension, which was present in all patients (100%). Diabetes mellitus found in 21 patients (31.3%), coronary artery disease in 1 patient (1.5%), heart failure in 16 patients (23.9%), hepatitis C in 19 patients (28.4%), hepatitis B in 7 patients (10.4%), gout in 13 patients (19.4%), stroke in 2 patients (3%), HIV in 1 patient (1.5%), and tuberculosis in 2 patients (3%). Based on BMI, 44 patients (65.7%) had normal body weight, followed by overweight 14 patients (20.9%), obese 5 patients (7.5%), and underweight 4 patients (6%). Peritoneal Equilibration Test (PET) results showed 21 patients (31.5%) were low average transporters, 19 (28.4%) were high average transporters, and 8 (11.9%) were high transporters. There were no patients in the low transporter category.

Table 1. Demographic Characteristics

Variables	N = 67
Age (years)	44.81 years (23-70)
Gender	
Male	43 (64.2%)
Female	24 (35.8%)
Education	
Junior high school	1 (1.5%)
Senior high school	34 (50.7%)
Diploma	2 (3%)
Bachelor	30 (44.8%)
CAPD duration (month)	29.776 months (23.625)
Etiology of CKD	
Hypertension	27 (40.3%)
Diabetes Mellitus	20 (29.9%)
Glomerulonephritis	16 (23.9%)
More	4 (6%)
Comorbid	
Hypertension	67 (100%)
Diabetes Mellitus	21 (31.3%)
Coronary Artery Disease	1 (1.5%)
Heart Failure	16 (23.9%)
Stroke	2 (3%)
Uric Acid	13 (19.4)
Hepatitis B	7 (10.4%)
Hepatitis C	19 (28.4%)
HIV	1 (1.5%)
Tuberculosis	2 (3%)
BMI	
Underweight	4 (6%)
Normal	44 (65.7%)
Overweight	14 (20.9%)
Obesity	5 (7.5%)

Variables	N = 67
Peritoneal Equilibration Test (PET)	
Low transporter	0 (0%)
Low average transporter	21 (31.3%)
High average transporter	19 (28.4%)
High transporter	8 (11.9%)
Not yet PET	19 (28.4%)
Dialysis Center	
Hasan Sadikin Hospital	44 (66.7%)
Other	23 (34.3%)

Patients participating in this study showed laboratory results with varying mean values and ranges of values. The mean hemoglobin was 9.003 g/dL (± 8.372), with values ranging from 5.10 to 13.6 g/dL. Mean albumin was 2.417 g/dL (± 0.726), with a range of values between 0.79 and 4.09 g/dL. Random blood glucose had an average of 115.746 mg/dL (± 52.357), with values ranging from 72 to 470 mg/dL. The patients' urea average level was 89.531 mg/dL (± 38.893), with a range of 33.4 to 248 mg/dL. The average creatinine level was 10.295 mg/dL (±3.314), with a range of values between 4.77 to 22.98 mg/dL. These values reflected the clinical condition of the patients at the time of sampling and provided an overview of their health status in terms of kidney function, nutritional status, and glucose control (Table 2).

Table 2. Laboratory Characteristics

Laboratory	Mean ± SD
Hemoglobin (g/dL)	9.003 ± 8.372
Albumin (g/dL)	2.417 ± 0.726
Random Blood Glucose (mg/dL)	115.746 ± 52.357
Ureum (mg/dL)	89.531 ± 38.893
Creatinine (mg/dL)	10.295 ± 3.314

The microbiological profile of peritoneal dialysis-related peritonitis in this study population was listed in Table 3. There were 36 (53.7%) patients with monomicrobial infection, which were mostly caused by gram-negative bacterial infection in 18 cases, followed by gram-positive in 15 cases, tuberculosis infection in 2 cases, and fungal infection in 1 case. There were 5 cases (7.5%) of polymicrobial infections, which were multiple gram-positive organisms found in 3 patients (*Staphylococcus aureus – Staphylococcus hominis, Staphylococcus epidermidis – Staphylococcus haemolyticus, Streptococcus mitis – Streptococcus gordonii*), and mixed gram-negative-positive organisms found in 2 patients (*Staphylococcus haemolyticus – Klebsiella pneumoniae, Pseudomonas aeruginosa – Acinetobacter baumanii – Enterococcus faecium*). In this study, there were 26 (38,8%) culture-negative cases, and based on outcomes (Table 4), there were 58 patients (86.6%) who recovered from peritonitis, 6 patients (9%) had catheter removal, and 3 patients (4.5%) died.

Table 3. Microbiological Profile

Pathogens	N = 67 (%)
Gram Positive	**15 (22.3%)**
Staphylococcus Aureus	3
Staphylococcus Epidermidis	2
Staphylococcus Haemolyticus	4

Staphylococcus Hominis	1
Staphylococcus Warneri	1
Enterococcus Faecalis	4
Gram Negative	**18 (26.9%)**
Pseudomonas Aeruginosa	11
Pseudomonas Fluorescens	1
Pseudomonas Putida	1
Escherichia Coli	3
Klebsiella Pneumoniae	1
Enterobacter aerogenes	1
Other	**3 (4.5%)**
Candida Tropicalis	1
Mycobacterium Tuberculosis	2
Polymicrobial	**5 (7.5%)**
Negative culture	**26 (38.8%)**

Table 4. Outcome

Outcome	**N = 67**
Recovery from peritonitis	58 (86.6%)
Catheter removal	6 (9%)
Died	3 (4.5%)

Discussion

This study investigated the microbiological profile in patients with peritonitis undergoing CAPD, which was the most common complication in this patients.[6] Gram-negative bacteria were the most common pathogen found in culture examinations, presented in 18 (26.9%) cases, followed by gram-positive bacteria in 15 (22.3%) cases, and other pathogens in 3 (4.5%) cases which included 1 fungal peritonitis and 2 tuberculosis peritonitis. Gram-negative predominance (26.9%) aligns with Solin et al.'s Indonesian cohort (29.4%) but contrasts with Ozdemir's Turkish data (32.1% Gram-positive). Regional variations in antibiotic prophylaxis may explain this disparity.[7,8]

In this study, the most common gram-negative bacteria were *Pseudomonas* sp, as many as 11 cases (61.1%) out of a total of 18 gram-negative cases. Özdemir's study showed that the most common gram-negative bacteria found were *Acinetobacter* sp. and *Pseudomonas* sp.[8] The most common gram-positive bacteria found in this study were coagulase-negative *Staphylococcus,* as many as 8 cases (53.4%) out of 15 gram-positive cases. This result was similar to Solin et al and Hu et al.[7,9] In addition, *Pseudomonas* was the most common pathogen found in 11 (16.4%) cases out of 67 culture examinations.

The 38.8% culture-negative rate, higher than International Society for Peritoneal Diagnosis (ISPD)'s recommended <15%, likely reflects non-compliance with effluent sampling guidelines (e.g., delayed processing, delayed sample delivery). Similar rates in Solin et al. (34.3%) suggest systemic challenges in resource-limited settings. Future interventions should prioritize bedside inoculation and rapid transport to mitigate false negatives.[7] Meanwhile, Abaraham et al showed a higher result of culture-negative cases with 64.7% of cases.[5] All 3 results did not meet the criteria recommended by the ISPD guidelines.[6] These guidelines recommend that sample collection should be performed at the bedside by inoculating 5-10 mL of effluent into two blood culture bottles (aerobic and anaerobic). Specimens must be delivered to the laboratory within 6 hours of collection. When immediate delivery is not possible, specimens should be maintained at 37°C.[6]

The difference in negative culture results among the 3 studies could be due to a different sampling process or examination methods that did not follow ISPD recommendations. In this study, the sample collection and delivery process were non-ISPD-compliant sampling, which caused the inoculation process not to be conducted directly bedside, resulting in a time gap between sample collection and effluent fluid inoculation into *BACTEC* culture bottles, and varied sample delivery times.

The examination of effluent fluid was limited to one sample due to the unavailability of anaerobic culture examinations and cost-control limitations in patient care. These factors likely contributed to the higher percentage of negative cultures compared to ISPD standards. This resulted in peritonitis, which could be caused by prior antibiotic exposure, non-ISPD-compliant sample collection, or the use of substandard techniques and culture media.[6]

Our data suggest, 58 patients (86.6%) showed improvement from peritonitis, these observations align with Abraham et al, where the total cases showing improvement were 95.5%.[5] The high rate of improvement could be related to the adequate management, empirical antibiotic use, and supported by culture results and antibiotic resistance testing.

Catheter removal was performed in 6 (9%) cases, and patients were transferred to hemodialysis. This study showed better outcomes compared to Abraham et al, with 19.3%, and Phui et al, with 26.6% of catheter removal cases.[5,10] In this study, indications for catheter removal were peritonitis caused by tuberculosis infection, fungal peritonitis, and recurrent peritonitis. Culture results included *Candida Tropicalis* in 1 patient, *Mycobacterium Tuberculosis* in 2 patients, and *Pseudomonas aeruginosa* in 3 patients. These results were similar to the study by Phui et al., where the majority of catheter removal cases were due to *Pseudomonas* infections. Peritonitis caused by *Pseudomonas, tuberculosis,* or *fungi* was associated with prolonged infections, antibiotic resistance, catheter removal, and poor outcomes.[4,10]

Our data demonstrate the risk factors and demographics of CAPD-associated peritonitis in our patient population. All patients had hypertension (100%), and 31.3% had diabetes mellitus. These observations align with findings from an Indian study reporting that diabetes increased Gram-negative infection risk (OR 2.3).[11] The mean CAPD duration was 29 months, consistent with ISPD guidelines indicating that long-term CAPD (>2 years) elevates biofilm-related infection risk.[6]

Our data suggest mortality rate (4.5%) was lower than North China (14.7%) but similar to Sarawak, Malaysia (5.1%),[10] possibly due to comorbidities, our cohort had fewer diabetics (31.3% vs. 45% in Hu et al.).[9] High Pseudomonas resistance in China vs. our isolates' susceptibility to empiric ceftazidime. The microorganisms causing peritonitis in the deceased patients included *Escherichia Coli*, *Enterococcus Faecalis,* and one case with no microorganisms found. The comorbidities in the patients included pneumonia, diarrhea, chronic hepatitis B, and diabetes mellitus. In this study, peritonitis was not the main cause of death, but all 3 patients were admitted with pneumonia, and respiratory failure was the cause of death.

Conclusion

Gram-negative bacteria, notably Pseudomonas, dominated CAPD peritonitis in our cohort. Despite suboptimal culture yields, adherence to ISPD sampling guidelines and targeted antibiotic therapy improved outcomes (86.6% cure rate). Improved sampling techniques and examination methods following ISPD recommendations could reduce negative culture rates and enhance the management of peritonitis in CAPD patients. Future studies should prospectively evaluate resistance patterns.

Limitations of the Study

This study has several limitations. First, its retrospective design may introduce selection bias, as only patients with complete medical records and culture results were included.

Second, the high culture-negative rate likely reflects non-ISPD-compliant sampling techniques (e.g., lack of bedside inoculation, delayed sample delivery), unavailability of anaerobic culture examinations, and cost-control limitations in patient care.

Declarations

Ethics approval and consent to participate

This study has received approval from The Hasan Sadikin Hospital Bandung Research Ethics Committee under reference number DP.04.03/D.XIV.6.5/302/2024.

Competing interests

There are no conflicts of interest in writing this article.

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Author's Contribution

Idea/concept: DA. Design: DA. Control/supervision: LS, RA. Data collection/ processing: DA. Analysis/interpretation: DA, LS, RA. Literature review: -. Writing the article: DA. Critical review: -. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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