

Peritonitis in patients on peritoneal dialysis: a 12-year experience from a large medical center in Bursa

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ABSTRACT

Objectives: Despite all technical advances, Peritonitis remains the most important peritoneal dialysis (PD) complication. Peritonitis causes complications such as additional hospitalization, technical failure, peritoneal membrane damage, consequent transition to hemodialysis, and death in this patient group. Early diagnosis, isolation of the causative pathogen with appropriate methods as soon as possible, and determination of antibiotic susceptibilities play a crucial role in solving the problem of treating peritonitis in PD. This study evaluated the frequency of peritonitis, culture positivity rate, and prognosis in peritoneal dialysis patients in our unit for 12 years.

Methods: A total of 171 patients (80 F, 91 M; mean age: 51.9±15.3 years; mean PD duration 36.5±36.4 months) who were followed up in our department between January 2009 and July 2021 were included in the study. Patient records were retrospectively analyzed.

Results: Peritonitis never occurred in 105 of the 171 patients included in the study. Of the remaining 66 patients, 43 had one peritonitis attack, and 23 had more than two. The mean peritonitis rate was 1.68±1.36. One hundred eleven episodes of peritonitis were detected in 66 of the patients. Bacterial growth was observed in 63.06% of the culture samples obtained from the 93 peritonitis episodes. The peritoneal catheter was withdrawn in 14 (21.21%) cases.

Conclusions: In our unit, the rate of culture positivity was 63.06%, and the peritonitis attack rate was 0.017 per patient-month and 0.211 per patient-year over a period of twelve years, with a mean of 57.1 patient months of peritonitis.

Keywords: Peritoneal dialysis, peritonitis, infections

Peritonitis is a common and serious complication of peritoneal dialysis (PD) and causes significant morbidity, mortality, and healthcare expenses. It also significantly limits the use of this critical dialysis method. Recurrent episodes of peritonitis are the most important causes of technical inadequacy of dialysis and transition to hemodialysis. The incidence of peritonitis varies according to age,

race, education level, dialysis type, and environmental factors, while the course of peritonitis depends on the causative microorganism [1]. PD-associated peritonitis is a leading cause of mortality in over 15% of peritoneal dialysis patients. Single or multiple episodes of severe peritonitis can reduce the efficiency of peritoneal ultrafiltration and are the most common cause of conversion in long-term hemodialysis [2]. After

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each episode of peritonitis, a root cause analysis is recommended to identify the cause and possible interventions to reduce the risk of recurrence. The PD catheter should be considered for replacement after recurrent or repeated peritonitis [3]. The International Society for Peritoneal Dialysis (ISPD) recommends monitoring the overall rate of peritonitis, the rate of peritonitis due to specific organisms, the percentage of patients free of peritonitis per year, and the extent of antibiotic resistance [3].

This study aimed to analyze the clinical features of peritonitis associated with continuous ambulatory peritoneal dialysis (CAPD) characteristics, causative organisms, and antibiotic susceptibilities.

METHODS

Study Population and Baseline Characteristics

A total of 171 patients (80 F, 91 M; mean age 51.9 ± 15.3 years; mean PD duration 36.5 ± 36.4 months) who were followed up in our department between January 2009 and July 2021 were included in the study. Patient records were retrospectively analyzed.

Baseline demographics included sex, age, body mass index (BMI), cause of end-stage renal disease (ESRD), PD modality (automated PD or continuous ambulatory PD), duration of PD at study entry, presence of diabetes mellitus (DM), and residual urine volume. Clinical features included fever, jaundice, abdominal pain, previous peritonitis, extraperitoneal tuberculosis, and time from diagnosis to treatment initiation (days). Laboratory parameters included peritoneal dialysis effluent characteristics with white blood cell (WBC) count, including neutrophil and lymphocyte percentage, erythrocyte count, polymerase chain reaction (PCR), and peritoneal fluid culture. Blood analysis included WBC count, hemoglobin (Hb), platelet (PLT) count, C-reactive protein (CRP), blood urea nitrogen (BUN), creatinine, and albumin.

Peritonitis Diagnosis

The following criteria were used to diagnose peritonitis: (1) Gram stain of the peritoneal dialysis fluid or culture for micro-organisms; (2) The number of white blood cells in the peritoneal dialysis fluid exceeds 100 cells/mm^3 . The percentage of neutrophils is greater than 50%; and (3) There are signs of inflam-

mation of the peritoneum. All patients were tested for tuberculosis and fungal infection if peritoneal fluid cultures were negative for microorganisms. Patients' peritoneal fluid samples were analyzed at least three times using the alcohol-resistant bacilli (AARB) staining technique, and mycobacteria and fungi were cultured. Lowenstein Jensen and Sabouroud dextrose were used for mycobacterial culture, and agar medium was used for fungal culture. Tuberculosis was diagnosed by microscopic examination or detection of *Mycobacterium tuberculosis* in culture.

Peritonitis Treatment

After obtaining the appropriate microbiological specimens, empirical antibiotic therapy was initiated following ISPD recommendations [3]. The fundamental principle ensures sufficient coverage of Gram-positive and Gram-negative organisms, including *Pseudomonas* species. The current guidelines suggest vancomycin or first-generation cephalosporin for Gram-positive organism coverage and third-generation cephalosporin or aminoglycoside for Gram-negative organism coverage. The decision to use vancomycin or a first-generation cephalosporin relied on the results of the patient's previous peritoneal fluid culture. Vancomycin was administered if Methicillin-resistant *Staphylococcus aureus* (MRSA) was detected in the last culture, whereas a first-generation cephalosporin was used otherwise.

Statistical Analysis

Statistical analysis was performed using SPSS 19.0 software (SPSS Inc., Chicago, IL, USA). The Shapiro-Wilk test was used to assess the normal distribution of numerical variables. Descriptive statistics were presented as mean \pm standard deviation and median (range) for numerical variables and as numbers and percentages for categorical data.

RESULTS

The mean age was 51.9 ± 15.3 years. Ninety-one (43.3%) patients were male, and 80 (46.7%) were female. Of the 105 patients diagnosed with peritonitis, 36 (54.5 %) were male and 30 (45.5%) females, and their mean age was 49.9 ± 16.2 years.

Cloudiness of the peritoneal fluid was observed in

Table 1. Patients’ symptoms and signs during peritonitis episodes

Symptom and Sign	n	%
Cloudy fluid	50	75
Abdominal pain	38	57.5
Fever	3	4.5
Nausea	7	10.6
Vomiting	2	3
Diarrhea	2	3

50 (75.7%) patients. In addition, 38 (57.5%) of patients reported abdominal pain, 3 (4.5%) had fever, and 2 (3.0%) had nausea. Seven (10.6%) of patients had vomiting, and 2 (3.0%) had diarrhea (Table 1 and 2).

During a period of 6329 patient months (or 527.4 patient-years), 111 peritonitis attacks were observed. The attack rates were 0,017 per patient-month and 0,211 per patient-year. On the mean, peritonitis was observed in 57.01 patient-month.

Peritonitis never occurred in 105 of the 171 patients included in the study. Of the remaining 66 patients, 43 had one peritonitis attack, and 23 had more than two. The mean peritonitis rate was 1.68±1.36. One hundred eleven episodes of peritonitis were detected in 66 of the patients. Bacterial growth was observed in 63.06% of the culture samples taken from the 93 attacks of peritonitis. In 38.46% of peritonitis episodes, no microbial growth was observed in culture. Gram-positive factors comprised 40.0% of the micro-organisms that grew, while gram-negative factors accounted for 10.8%. Staphylococci, responsible

Table 2. Patients laboratory findings during peritonitis episodes

Biochemistry	mean±SD
C-reactive protein (mg/L)	59.7±53.4
Sedimentation (%)	77.8±30.8
WBC (mm ³)	8652±3769
Albumin (g/L)	3.14±0.5
PF-WBC (mm ³)	3195±3434

WBC=white blood cell, PF-WBC=peritoneal fluid white blood cell, SD=standard deviation

for 27.7%, were the most common bacteria. Among the gram-negative bacteria, Escherichia. coli was identified as the most common causative agent (7.7%) (Fig. 1).

Medical treatment was successful in 74.24% of cases, according to empirical and antibiogram results. In 14 (21.21%) patients, hemodialysis was performed after peritoneal catheter removal, and one patient died during the follow-up period.

DISCUSSION

Preventing and reducing peritonitis can improve longevity and quality of life in peritoneal dialysis patients. The incidence of peritonitis and positive culture rates in our peritoneal dialysis patients were comparable to those in previous studies. In our unit, the culture positivity rate was 63.06%, and the peritonitis attack rate was 0.017 per patient-month and 0.211 per patient-year over twelve years, with a mean of 57.1 patient-months of peritonitis. In the 2019 National Nephrology, Dialysis, and Transplantation Registry System Report, the frequency of peritonitis in PD patients was reported as 0.46 attacks/patient-year [4]. This registry was established with the results of 29 principal peritoneal dialysis centers in the country. Compared to our country's registration system, the peritonitis rates we found in our study were better. There may be many reasons related to patients and

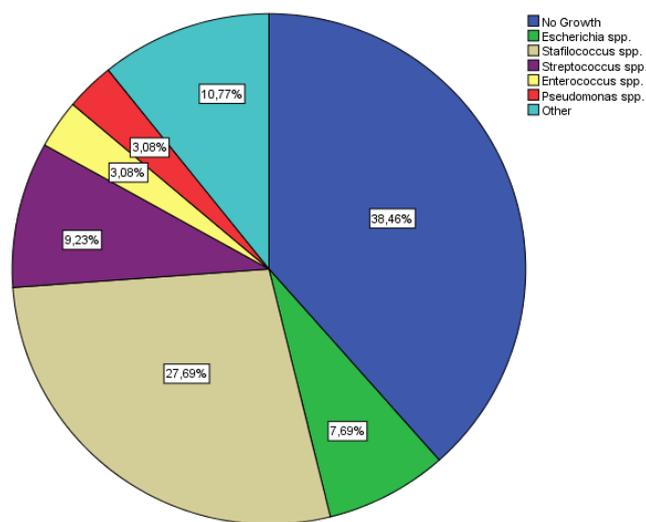


Fig. 1. Peritoneal fluids bacterial growth: distribution of pathogenic microorganisms in peritoneal fluid samples.

centers. There are several possible explanations for this finding. Disposable dialysate containers, the Y-connector as a single set, the routine use of disinfectants, and several technical enhancements have improved technical issues over time. However, the most important could be patient education in our unit. A study published in 2016 by Seker *et al.* [5] found an attack rate of 0.29 attacks/patient-year over 15 years (2000-2014). The study by Ozturk *et al.* [6] evaluated 65 patients between 2011 and 2017; the peritonitis attack rate was calculated as 0.224 attacks/patient-year (1 attack/53.57 patient-months). According to a systematic review, only 33 high- and middle-income countries monitor the peritonitis rate; within these countries, the global average peritonitis rate decreased from 0.6 episodes per patient-year in 1992 to 0.3 per patient-year in 2019. Asia-Pacific region had the highest rates, followed by Europe, the Middle East, and Africa. The Americas (including North, South, and Central America) had the lowest rate [7]. Consistent with our findings, peritonitis rates have also decreased worldwide.

Despite the ISPD recommendation that culture-negative peritonitis rates should be maintained at < 15%, most countries, including Canada (16.0%), Japan (21.0%), the United States (16.0%), and India (18.2%) failed to meet this target [3, 1]. While the culture negativity rate was 30.1% in the Seker *et al.*'s study [5], Ozturk *et al.* [6] reported 36.7% culture negativity rate [6]. In our study, the culture negativity rate was 36.07%. This is consistent with previous studies conducted in Turkey. Peritoneal fluid culture samples were collected by trained nurses for continuous ambulatory peritoneal dialysis (CAPD). A significant decrease was observed in the negativity rate. Our department's employing dedicated nurses to collect peritoneal fluid cultures has resulted in a low negative culture rate consistent with the literature.

In our study, gram-positive agents were the most frequently detected microorganisms in culture-positive cases, and staphylococci were the most common agents. This finding is in line with the literature. In a 2011 analysis of registries in Australia and New Zealand, Gram-positive organisms accounted for 53.4% of all episodes of peritonitis. The most common Gram-positive and -negative organisms were coagulase-negative staphylococci (27.2%) and *E. coli*

(6.3%) [8]. Similar findings were reported in North America - Gram-positive organisms caused 62.0% of infections in the USA and 61.0 % in Canada [9]. An international 2020 study found lower rates of Gram-positive peritonitis in Australia and New Zealand (39.0%), the United States (37.0%), and Canada (45.0%) than reported in previous studies [10]. Studies reported from our country were similar to our findings; Seker *et al.* [5] reported 58.3%, and Ozturk *et al.* [6] reported 42.84% gram-positive bacteria, respectively.

Peritonitis outcomes vary widely between countries. These include medical cure (69.0-80.7%), catheter removal (10.8-20.4%), and mortality (1.8-6.0%) [11, 8, 9, 12]. In our study, the complete recovery rate was 74.24%, and the hemodialysis initiation rate after catheter removal was 21.21%. One patient died. Our mortality rate is relatively low, and our recovery and catheter removal rates are comparable to those reported in the literature. This may be due to our strict adherence to the ISPD recommendations for catheter removal.

CONCLUSION

In conclusion, although the incidence of peritonitis has decreased in recent years, early and accurate diagnosis of peritonitis is essential for a successful PD program. Successful treatment of peritonitis attacks is also necessary. Therefore, prevention and early diagnosis of peritonitis can be achieved through continuous patient education. In addition, culture positivity can be increased by using the correct technique for dialysate collection by experienced nurses.

Authors' Contribution

Study Conception: CBG; Study Design: CBG; Supervision: N/A; Funding: N/A; Materials: N/A; Data Collection and/or Processing: CBG; Statistical Analysis and/or Data Interpretation: CBG; Literature Review: CBG; Manuscript Preparation: CBG and Critical Review: CBG.

Conflict of interest

The author disclosed no conflict of interest during the preparation or publication of this manuscript.

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