



Original Research

Comparison of Exit-Site Infection Frequency in Continuous Ambulatory Peritoneal Dialysis and Automated Peritoneal Dialysis Patients: A Single-Center Experience

Mustafa Sevinç,¹ Nuri Barış Hasbal,² Elbis Ahbap,¹ Yener Koç³

¹Department of Nephrology, Sisli Hamidiye Etfal Training and Research Hospital, Istanbul, Turkey

²Department of Nephrology, Hakkari State Hospital, Hakkari, Turkey

³Department of Nephrology, Istanbul Bilim University Faculty of Medicine, Istanbul, Turkey

Abstract

Objectives: Catheter exit-site infection (ESI) is generally caused by skin flora. Continuous ambulatory peritoneal dialysis (CAPD) patients have more contact with their catheters than automated peritoneal dialysis (APD) patients as a result of performing multiple exchanges per day. The aim of the present study was to compare the frequency of ESIs between these 2 peritoneal dialysis (PD) modalities.

Methods: PD patients from 2001 to 2015 were enrolled in the study. Patients transferred from CAPD to APD were excluded. All of the data were collected retrospectively. The rate of ESI occurrence and culture results in the CAPD and APD groups were compared.

Results: The data of 280 patients were evaluated. APD patients represented 23.2% of the study cohort. Prevalence of peritonitis was 87.6% if a patient had an ESI and 50.7% if there was no ESI ($p=0.000$). The frequency of ESI was similar between the 2 peritoneal dialysis modalities ($p=0.343$). There was a statistically significant difference in the causative organism of infection between the 2 groups ($p=0.021$).

Conclusion: The ESI rate was similar in the CAPD and APD patients though CAPD requires more exchanges, and therefore there is more contact with the catheter. All PD patients, regardless of the treatment modality used, are expected to perform exchanges according to standard rules for connecting the catheter to the PD solution bag. As long as patients observe these guidelines, there would appear to be no increased ESI risk related specifically to the modality.

Keywords: Automated peritoneal dialysis; continuous ambulatory peritoneal dialysis; exit-site infection; peritoneal dialysis.

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The use of peritoneal dialysis (PD) has decreased both in parts of Europe and in our country.^[1,2] Catheter exit-site infection (ESI) is a significant concern during PD therapy, and may cause significant comorbidities, including peritonitis and technique failure.^[3–5]

ESI increases the risk of peritonitis due to the transfer of microorganisms from the exit site to the peritoneal cavity through the peritoneal catheter.^[6–8] ESI is defined as the

presence of purulent discharge, with or without erythema of the skin at the catheter-epidermal interface.^[9] According to 2017 Turkish Society of Nephrology report, PD-related infections led to 23.02% of transfers to hemodialysis (HD).^[1] PD training is crucial to prevent PD-related infections because many organisms, including skin flora, may cause catheter ESI.^[9]

Training is provided until patients can perform manual PD

Address for correspondence: Mustafa Sevinç, MD. Sisli Hamidiye Etfal Egitim ve Arastirma Hastanesi, Nefroloji Klinigi, Istanbul, Turkey

Phone: +90 530 929 12 39 **E-mail:** musevinc@hotmail.com

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exchanges and manage their treatment without any help from the nurses. It is repeated after any infection episode. PD patients receive extensive education from 2 experienced PD nurses in our institution. Training is provided until patients can perform manual PD exchanges and manage their treatment without any help from the nurses. It is repeated after any infection episode. Continuous ambulatory peritoneal dialysis (CAPD) requires regular exchanges every 6 hours. Automated peritoneal dialysis (APD) is performed at night, giving patients more freedom during the day. The peritoneal cavity may be empty or filled with solution during the day, according to the volume and uremic status of the patient.

There is no universal policy for directing patients to a specific PD modality; the sum of relative benefits remains a decision usually guided by the patient's needs and social environment.

CAPD patients usually perform 4 exchanges per day, which means they have contact with the PD catheter at least 4 times. APD patients generally drain their peritoneal cavity once a day, which requires contact with the PD catheter only 1 time per day.

The aim of this study was to determine any difference in the frequency of catheter ESI between these 2 PD modalities related to the need for contact each day and to evaluate if the causative organisms of infection were different between CAPD and APD patients.

Methods

All of the patients who started PD therapy between 2001 and 2015 were included in the study. The details of age, sex, end-stage renal disease (ESRD) etiology, PD modality, initiation of PD (self decision or not), the person performing the PD, history of hemodialysis (HD) before PD, follow-up time, presence of peritonitis, number of catheter ESIs, and organisms responsible for infections were noted. Causative agents were compared according to the PD modality. Patients with insufficient data and patients who transferred from CAPD to APD during the follow-up period were excluded from the study. All of the data were collected from patient files retrospectively. Due to the retrospective design of the study, ethics committee approval was not required.

Statistical Analysis

Statistical analyses were performed with SPSS for Windows, Version 15.0 (SPSS Inc., Chicago, IL, USA). A chi-square test was used to compare groups. The Mann-Whitney U test was used for comparisons of continuous variables. Differences were considered statistically significant with a p value <0.05 .

Results

The data for 366 patients were evaluated. Patients who transferred from CAPD to APD ($n=52$), patients with miss-

ing important data ($n=22$), patients with an unknown ESI history ($n=10$), and patients with unknown culture results ($n=2$) were excluded from the study. The data of 280 patients were evaluated retrospectively. Demographic data of the study patients are provided in Table 1. Median age of the patients was 44.5 years (range: 32-60 years). The etiology of ESRD was unknown in 34.3% of the whole cohort. The median age and ESRD etiology were similar between the CAPD and APD groups ($p=0.055$ and $p=0.176$, respectively). Median follow-up period for CAPD patients was 38 months (range: 12-72 months) and 20 months (range: 8-36 months) for APD patients ($p=0.001$). Among the CAPD patients, 87% performed PD themselves. This ratio was 68.3% in APD patients ($p=0.000$). In the CAPD group, 79.8% of patients decided to start PD voluntarily while 65.6% of APD patients began PD voluntarily ($p=0.019$). There was no statistical significance between ESI and sex, patient performing PD by themselves, or previous history of HD ($p=0.209$, 0.849, 0.489, respectively).

In the study group, 42% of patients who had not experienced a catheter ESI had never developed peritonitis. Only 12.3% of patients with a catheter ESI history were naïve for peritonitis ($p=0.000$) (Table 2).

In all, 163 episodes of catheter ESI in 73 patients were evaluated: 138 instances were recorded in CAPD patients and 25 episodes were recorded in APD patients. The number of episodes for all of the patients and the PD modality used is illustrated in Table 3. The causative organisms of infection are detailed in Table 4. Methicillin-sensitive *Staphylococcus aureus* (MSSA) was reported in 52.1% of ESIs overall and was the most common source of the ESI in both the CAPD and APD patients. The culture remained sterile in 12.9% of episodes. A comparison of microbial agents according to PD modality yielded a significant difference ($p=0.021$). APD patients did not have any *Pseudomonas*, *Enterococcus*, or *Streptococcus* infections, and CAPD patients did not have ESIs caused by *Klebsiella* species.

Discussion

This was a large, single-center, cohort study comparing catheter ESI rates and causative organisms in CAPD and APD patients. The infection rate was similar between the different PD modalities, although the cultured microorganisms did demonstrate a statistically significant difference.

The median age, ESRD etiology, and rate of HD history before PD were similar between groups. There were more female patients in the APD group, though the institution has no particular policy related to patient sex with regard to modality selection. The median follow-up period was longer in CAPD patients and more of them performed PD themselves when compared with APD patients.

To the best of our knowledge, there is no previous study comparing CAPD and APD patient ESI rates. Our results revealed that the likelihood of infection was similar between

Table 1. Demographic characteristics, peritoneal dialysis treatment details, and exit-site infection frequency of all PD patients and subgroups

	All patients (n=280) %	CAPD (n=215) %	APD (n=65) %	p
Median age, in years (interquartile range)	44.5 (32–60)	44 (32–59)	51 (32.5–66.5)	0.055
Sex, female	55.4	41.4	44.6	0.047
ESRD etiology				0.176
Unknown	34.3	36.4	27	
Diabetes	23.5	20.1	34.9	
Hypertension	8.7	8.9	7.9	
Glomerulonephritis	25.3	25.7	23.8	
Polycystic kidney	8.3	8.9	6.3	
Median follow-up, in months (interquartile range)	33.5 (12–62)	38 (12–72)	20 (8–36)	0.001
Patient performing PD	82.9	87.3	68.3	0.000
PD choice, voluntarily	76.5	79.8	65.6	0.019
HD history before PD, negative	78.2	78.1	78.5	0.956
Catheter exit site infection, negative	73.9	72.6	78.5	0.343

Automated peritoneal dialysis; CAPD: Continuous ambulatory peritoneal dialysis; ESRD: End-stage renal disease; HD: Hemodialysis; PD: Peritoneal dialysis.

Table 2. Distribution of patients according to peritonitis and exit site infection status

	Exit-site infection		p
	Positive (n)	Negative (n)	
Peritonitis			0.000
Positive, n	64	120	
Negative, n	9	87	

Table 3. Number of exit-site infections in all patients and PD modality

Number of episodes	All patients (%)	CAPD (%)	APD (%)
0	73.9	72.6	78.5
1	11.4	11.6	10.8
2	7.17	7.4	6.2
3	2.9	2.8	3.1
4	1.8	1.9	1.5
5	1.1	1.4	–
6	1.1	1.4	–
7	0.7	0.9	–

Automated peritoneal dialysis; CAPD: Continuous ambulatory peritoneal dialysis.

the CAPD and APD patients. Having different PD preference reasons and PD performing persons did not affect ESI rates. In this study, more contact with the PD catheter did not result in a greater incidence of ESI, so the null hypothesis of the research was rejected. Patient education is crucial to prevent PD-related infection. All of the patients had been educated about disinfection rules regardless of the PD modality, and this training may explain the results.

Table 4. Causative microorganisms for exit site infections

Causative agent	All episodes %	CAPD %	APD %	p=0.021
MRSA	22.1	21	28	
MSSA	52.1	52.2	52	
<i>Pseudomonas aeruginosa</i>	6.7	8	–	
<i>Klebsiella species</i>	1.2	–	8	
<i>Enterococcus species</i>	2.5	2.9	–	
<i>Streptococcus species</i>	2.5	2.9	–	
No growth	12.9	13	12	

Automated peritoneal dialysis; CAPD: Continuous ambulatory peritoneal dialysis; MRSA: Methicillin-resistant *Staphylococcus aureus*; MSSA: Methicillin-sensitive *Staphylococcus aureus*; PD: Peritoneal dialysis.

In our study, an episode of catheter ESI was related to an increased risk of peritonitis. An earlier study found a strong correlation between the development of peritonitis within 60 days after the development of ESI.^[10] However, though our results demonstrated an apparent relationship between catheter ESI and peritonitis risk, the dates of these 2 events were not always noted during data collection. We could not adequately evaluate if ESI progressed to peritonitis as expected due to a lack of data on the dates of culture results. A relationship between these PD-related infections has been established, but detailed record-keeping that also includes the organism responsible for a progression to peritonitis would be helpful.

MSSA was the most frequently isolated microorganism in both groups and in the whole patient cohort. Methicillin-resistant *Staphylococcus aureus* was the second most common organism isolated from the cultures. Other studies

have had similar results.^[11] Diepen et al.^[10] reported ESI causative agent culture findings of 36% *Staphylococcus* species, 6% *Streptococcus* species, 13% *Pseudomonas*, 2.2% *Klebsiella* species, 9% *Candida* species, 11.3% culture negative, 20.4% other species. Though Diepen et al.^[10] also found *Staphylococcus* species to be the most frequent source of infection, the rate reported was lower than that of our study. Our total *Staphylococcus* species infection burden represented nearly three-quarters of all ESIs. The reason for this might be that our PD patients did not apply any ointments and/or topical antimicrobials to their catheter exit site. Our patients only cleaned the catheter exit site regularly with povidone-iodine. Since the time frame of this study, topical application of an antibiotic cream or ointment to the catheter exit site was recommended in the International Society of Peritoneal Dialysis 2017 guideline.^[9] Our PD clinic has routinely advised the use of topical antimicrobials at the exit site since the publication of this guideline. Wang et al.^[12] reported ESIs due to *Pseudomonas aeruginosa* (40%), MSSA (20%), coagulase-negative *Staphylococci* (10%), *Escherichia coli* (6%), *Klebsiella* species (6%), *Enterobacter cloacae* complex (6%), other Gram-negative bacilli (6%), no growth (4%), and *Streptococci* (2%).^[12] We observed fewer instances of *Pseudomonas aeruginosa* infection and more culture negative results. Wang et al.^[12] reported that the high rate of *Pseudomonas* infection might have been due to infected saline used to clean the exit site. There was a significant difference in the organism responsible for infection between the APD and CAPD patients in our study. The most frequent bacteria found in both groups was MSSA. The difference might have arisen from unequal distribution of organisms other than *staphylococcus* species because those species were produced either in CAPD or APD patients. The method of connecting the catheter to a PD solution bag does not differ between PD modalities. To the best of our knowledge, there is no evidence-based reason for different catheter exit-site organisms in CAPD and APD based on the technique.

It was concluded that CAPD and APD patients demonstrated a similar frequency of developing an ESI. Disinfection rules and appropriate regular exit-site care are standards of PD therapy in both modalities. Longer term results including the use of topical antimicrobials to decrease skin flora-related ESI will be informative.

Disclosures

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