Prognostic Factors of Peritonitis in Patients on Peritoneal Dialysis: a Retrospective Observational Study

Articoli originali

Cinzia Fabbri[1,2], Elisa La Malfa[3], Mattia Ricco[3], Lea Godino[2,4], Stefano Mancin[5], Walter Longo[1,2], Giovanni Spadafora[1,2], Beatrice Del Grosso[3], Marco Sguanci[2,6], Maria Pia Zito[2], Sergio Cinocca[7], Domenica Gazineo[2,7]


Stefano Mancin

1 Nephrology, Dialysis, Hypertension Unit, IRCCS Azienda Ospedaliero-Universitaria di Bologna
2 SIAN, Italian Nephrological Nursing Society, Olbia, Italy
3 Department of Medical and Surgical Sciences (DIMEC), University of Bologna, Bologna, Italy
4 Medical Genetics Unit, IRCCS Azienda Ospedaliero-Universitaria di Bologna, Bologna, Italy
5 IRCCS Humanitas Research Hospital, Rozzano, Italy
6 Department of Medicine and Surgery, Research Unit of Nursing Science, Università Campus Bio-Medico di Roma, Italy
7 Governo Clinico e Qualità, IRCCS Azienda Ospedaliero-Universitaria di Bologna, Bologna, Italy

Corresponding author:
Dr. Stefano Mancin
IRCCS Humanitas Research Hospital,
Via Manzoni 56, 20089
Rozzano, Italia
E-mail: stefano.mancin@humanitas.it

ABSTRACT

Background/Objectives. Peritoneal dialysis stands as an established form of renal replacement therapy; yet peritonitis remains a major complication associated with it. This study, analyzing two decades of data from the Nephrology, Dialysis, and Hypertension Division of the University-Hospital IRCCS in Bologna, aimed to identify prognostic factors linked to peritonitis events. It also sought to evaluate the suitability of different peritoneal dialysis techniques, with a focus on Automated Peritoneal Dialysis (APD) and Continuous Ambulatory Peritoneal Dialysis (CAPD). Additionally, the study assessed the impact of an educational program introduced in 2005 on peritonitis frequency.

Methods. Conducting an observational, retrospective, single-center study, 323 patients were included in the analysis, categorized based on their use of APD or CAPD.

Results. Despite widespread APD usage, no significant correlation was found between the dialysis technique (APD or CAPD) and peritonitis onset. The analysis of the educational program's impact revealed no significant differences in peritonitis occurrence. However, a clear relationship emerged between regular patient monitoring at the reference center and the duration of peritoneal dialysis.

Conclusions. Despite the absence of a distinct association between peritonitis onset and dialysis technique, regular patient monitoring at the reference center significantly correlated with prolonged peritoneal dialysis duration.

KEYWORDS: end-stage renal disease, peritoneal dialysis, peritonitis, peritoneal catheter

Introduction

Peritoneal dialysis (PD) is an effective treatment option for patients with end-stage renal disease, particularly for populations such as elderly individuals, diabetics, and those with concomitant pathologies [1, 2]. This technique involves the exchange of solutes and fluids between the patient's peritoneal capillary blood and the introduced dialysis solution, a process made feasible by the Tenckhoff catheter [3]. This catheter has multiple benefits, including effective fluid exchange, a barrier against infections, and cost-effectiveness [4]. Since 2001, there has been a significant rise in the number of patients opting for dialysis treatments, witnessing an annual growth of approximately seven per cent [5, 6]. This surge can be attributed to an aging population, improved life expectancy for those with end-stage renal disease, and increased access to dialysis for younger patients [7]. The decision between PD and hemodialysis (HD) depends largely on regional and individual circumstances. In developed countries, the choice might be driven by patient preference or accessibility constraints to HD units. In contrast, economic challenges in less affluent regions might render PD as the primary choice [6]. In the context of Italy, nearly 4,600 patients are on PD, with a significant portion relying on Continuous Ambulatory Peritoneal Dialysis (CAPD) [8]. Interestingly, a considerable number of these patients, around 22.2%, are assisted by caregivers, with family members playing a pivotal role in 80.5% of the cases [8]. Adherence to the correct PD technique is associated with better outcomes, including extended patient survival rates and decreased hospitalization instances [9]. Furthermore, health-related quality of life (HR-QOL) is an imperative measure in assessing the effectiveness of treatments like PD [10]. It's worth noting that techniques do vary, with CAPD patients exchanging solutes during the day and automated PD patients doing so at night.

Peritonitis, mainly due to touch contamination, remains a significant complication for PD [11]. It's predominantly triggered by staphylococcal species but can also be attributed to fungal sources, like Candida. Recognizing signs of peritonitis is vital, and while treatments typically involve antibiotics, severe recurrences may necessitate catheter removal and a shift to HD. The benchmarks set by the International Society for Peritoneal Dialysis (ISPD) in 2016 and 2022 emphasize the importance of addressing peritonitis and ensuring optimal PD application through appropriate technique and ongoing training [12, 13]. Tailoring treatments to individual patient needs, backed by the support of a multidisciplinary team, is essential for success [14]. Training remains paramount in achieving these objectives, yet a standardized approach regarding its length and content is still elusive [15, 16].

Study Objectives

The primary objective of the study was to identify prognostic factors linked to peritonitis events to enhance peritoneal dialysis techniques. Secondary objectives encompassed analyzing peritonitis episodes from the last 24 years using clinical reports and medical records, understanding its signs and symptoms, assessing peritonitis rates per patient, and evaluating both APD and CAPD dialysis techniques. The study also explored the characteristics of patients affected by peritonitis, their comorbidities, monitoring duration by a nephrological center, and reasons for treatment discontinuation. Additionally, it considered the training strategies, technologies, and devices used throughout the study.

Methods

Study design

This study consisted of an observational, retrospective, single-center study, conducted in accordance with the STROBE (Strengthening the Reporting of Observational Studies in

Epidemiology) guidelines [17]. The study was approved by the Ethical Committee Wide Area Emilia Centro (Protocol No. 896 2021 Oss AOUBo FAPEDIP of 08 02 2022).

Setting and study population

Our study was conducted in the Nephrology Dialysis and Hypertension Unit of University- Hospital IRCCS in Bologna during the period from the 1st of January 1997 to 31st December 2020. Out of 323 enrolled patients on peritoneal dialysis, 32 of them were excluded because it was not possible to identify the peritoneal dialysis technique used (APD or CAPD).

Inclusion and exclusion criteria

The study included outpatients older than 18 who have consented to participate in this study, who have a Tenckhoff catheter implanted for peritoneal dialysis, and with clinical documentation available. Patients transferred to other centers post catheter's implant were excluded.

Peritoneal dialysis (PD) technique training protocol

The University-Hospital IRCCS of Bologna has introduced the *PD technique training* in 2005. As required by protocol, patients and/or caregivers are trained at home by specialized nurses for both CAPD and APD techniques. The aim of the intervention was to ensure more adequate and high-quality information, more correct and safe dialysis technique at home, prevention of peritonitis in peritoneal dialysis and other adverse events. In addition, patients have been subjected to the monitoring of parameters such as leukocyte counts in peritoneal fluid, earlier assessment of infection (symptoms such as abdominal pain, diarrhea, spike of temperature). As required by protocol, patients must be trained to contact the referral center as soon as possible.

Statistical analysis

The analyzed variables were demographic data and clinical documentations; Dialysis Peritoneal Training protocol; CAPD and APD techniques; episodes of peritonitis after peritoneal catheter's placement; caregivers involved in the dialysis training session; length of training, compliance to dialysis techniques; exit-site infections related to peritoneal dialysis and peritonitis events.

The data were collected in pseudonymized Excel by assigning a serial number. The data were analyzed using the Statistical Package for the Social Sciences program (Ver. 28 for Windows). The mean, standard deviation, median, minimum, and maximum were assessed for continuous variables. The frequency and the percentage have been calculated for categorical variables. For dichotomous variables was used the Fisher's exact test, while for nominal variables we assessed the Pearson Chi- squared test. T-test for independent samples was used to assess the differences between the averages.

A multiple logistic regression was conducted to identify the factors associated with the occurrence of peritonitis, in relation to risk factors as: age, sex, patient known in the center before peritoneal dialysis, dialysis technique. Finally, Kaplan-Meier analysis was used for estimating survival. The statistical significance was considered reached if $p < 0.05$.

Results

Features of participants

Our study included 323 patients, 101 subjects (34.7%) were female and 74 (33.5%) used the APD technique, while 27 patients (36.6%) used the CAPD technique. 190 (65.3%) enrolled patients were male, 147 (66.5%) employed the APD technique, while 43 (61.4%) the CAPD technique. 32 patients were excluded because of missing or insufficient data. The average age of sample is 66.83 ± 15.86

years, for CAPD and APD techniques. Our analysis had identified etiological causes involved in renal failure grouped in eight macro categories. 96 patients (33.0%) belong to the cardio-vascular diseases category, 56 patients (19.1%) to the genitourinary system diseases category, 29 (10.0%) to diabetes category, 35 (12.1%) to multifactorial causes category, 18 (6.2%) to autoimmune diseases category, 23 (7.9%) to genetic diseases, 5 cases (1.7%) are represented by metabolic diseases category, 2 cases (0.7%) by malformations/anephrosis/solitary kidney, 10 cases (3.4%) by other causes. In 17 (5.8%) of cases no causes were identified.

Out of 291 enrolled patients, 236 (81.1%) participants were followed by the reference center of peritoneal dialysis, while 55 (18.9%) of them had never been followed by the center (Table 1). Our sample resulted in 119 (40.9%) peritonitis cases: 88 (39.8%) of them occurred in patients on peritoneal dialysis with APD technique, while 31 (44.3%) in patients with CAPD technique. 49 (16.8%) patients developed one peritonitis event: 34 (15.4%) of them occurred in patients on peritoneal dialysis with APD technique, while 15 (21.4%) in patients with CAPD technique. 32 (11.0%) patients had 2 peritonitis events, and 14 (4.8%) patients had 3 peritonitis events: 10 (4.5%) of them occurred in patients on peritoneal dialysis with APD technique, while 4 (5.7%) in patients with CAPD technique. 11 (3.8%) patients had 4 peritonitis events: 7 (3.2%) of them occurred in patients on peritoneal dialysis with APD technique, while 4 of them (5.7%) in patients on CAPD technique. 6 (2.1%) patients had 5 peritonitis events: 5 of them (2.3%) occurred on APD, and 1 (1.4%) on CAPD technique. 6 peritonitis events occurred in 2 (0.7%) patients on APD technique. 7 cases of peritonitis occurred in 3 (1.9%) patients, 2 (0.7%) in the APD technique and 1 (1.4%) in the CAPD technique. In 1 patient on APD technique 9 cases of peritonitis occurred, and in 1 patient on CAPD technique 17 cases of peritonitis occurred (Table I).

		APD media ± ds	CAPD media ± ds	*p-value*
Age		66.83 ± 15.86	69.84 ± 12.38	0.134
	Totali n (%)	**APD n (%)**	**CAPD n (%)**	***p-value***
Sex				
Female	101 (34.7)	74 (33.5)	27 (36.6)	0.472
Male	190 (65.3)	147 (66.5)	43 (61.4)	
In charge of the dialysis center				
Yes	55 (18.9)	41 (18.6)	14 (20.0)	0.861
Not	236 (81.1)	180 (81.4)	56 (80.0)	
Causes involved in renal failure				
Diabetes	29 (10.0)	27 (12.2)	2 (2.9)	0.149
Genetic diseases	23 (7.9)	17 (7.7)	6 (8.6)	
Cardiovascular diseases	96 (33.0)	69 (31.2)	27 (38.6)	
Malformations/anephrosis/solitary kidney	2 (0.7)	1 (0.5)	1 (1.4)	
Genitourinary system diseases	56 (19.2)	47 (21.3)	9 (12.9)	
Autoimmune diseases	18 (6.2)	12 (5.4)	6 (8.6)	
Metabolic diseases	5 (1.7)	4 (1.8)	1 (1.4)	
Multifactorial diseases	35 (12.0)	27 (12.2)	8 (11.4)	
Not known	17 (5.8)	12 (5)	5 (7.1)	
Other causes	10 (3.4)	5 (2.3)	5 (7.1)	

Table 1. Features of study population. APD: automated peritoneal dialysis; CAPD: continuous ambulatory peritoneal dialysis; Dialysis peritoneal techniques not known: 32 cases.

Positive cultures in peritonitis events

In 231 patients (75.0%), a positive culture was recorded in relation to peritonitis events. Two positive cultures were recorded in 55 (17.9%) of the patients, while three positive cultures were identified in 22 (7.1%). Most of the positive cultures were recorded in the group of patients undergoing APD technique. More details can be found in Table 2.

	Total cases n (%)	APD n (%)	CAPD n (%)	*p-value*
Peritonitis				
Yes	119 (40.9)	88 (39.8)	31(44.3)	0.577
No	172 (59.1)	133 (60.2)	39 (55.7)	
Episodes of peritonitis				
0	172 (59.1)	133 (60.2)	39 (55.7)	0.527
1	49 (16.8)	34 (15.4)	15 (21.4)	
2	32 (11.0)	27 (12.2)	5 (7.1)	
3	14 (4.8)	10 (4.5)	4 (5.7)	
4	11 (3.8)	7 (3.2)	4 (5.7)	
5	6 (2.1)	5 (2.3)	1 (1.4)	
6	2 (0.7)	2 (0.9)	0 (0.0)	
7	3 (1.0)	2 (0.9)	1 (1.4)	
9	1 (0.3)	1 (0.5)	0 (0.0)	
17	1 (0.3)	0 (0.0)	1 (1.4)	
Total cases	291 (100)	221 (100)	70 (100)	
Positive cultures				
First	231 (75.0)	169 (71.6)	62 (86.1)	0.562
Second	55 (17.9)	47 (19.9)	8 (11.1)	0.070
Third	22 (7.1)	20 (8.5)	2 (2.8)	0.040
Exit-site infections				
0	262 (90.0)	199 (90.0)	63 (90.0)	0.892
1	22 (7.6)	16 (7.2)	6 (8.6)	
2	6 (2.1)	5 (2.3)	1 (1.4)	
3	1 (0.3)	1 (0.5)	0 (0)	
Total cases	291 (100)	221 (100)	70 (100)	
Peritonitis related to exit-site infections				
0	269 (92.4)	205 (92.8)	64 (91.4)	0.751
1	19 (6.5)	14 (6.3)	5 (7.1)	
2	2 (0.7)	1 (0.5)	1 (1.4)	
3	1 (0.3)	1 (0.5)	0 (0)	
Total	291 (100)	221 (100)	70 (100)	
Drop out				
Transferred to a different centre	11 (9.1)	10 (10.8)	1 (3.6)	0.451
Haemodialysis	69 (57.0)	51 (54.8)	18 (64.3)	
Transplanted	41 (33.9)	32 (34.4)	9 (32.1)	
Total cases	121(100)	93 (100)	28 (100)	
Dead patients				
Yes	152 (52.2)	114 (51.6)	38 (54.3)	0.784
No	139 (47.8)	107 (48.4)	32 (45.7)	
Average age				
Dead patients	74.33 ± 9.94	74.46 ± 9.94	73.84 ± 10.24	0.740
Survivors	59.97 ± 16.48	58.69 ± 16.95	65.31 ± 13.24	0.044
Lenght of PD and development of peritonits (days)		**APD Media ± DS**	**CAPD Media ± DS**	**p-value**
Peritonitis	598.87 ± 509.55*	596.31 ± 533.50	641.90 ± 437.55	0.641
Not peritonitis events	733.38 ± 645.11*	757.56 ± 677.21	944.11 ± 615.95	0.116

Table 2. Peritonitis events. *p=.040; APD: automated peritoneal dialysis; CAPD: continuous ambulatory peritoneal dialysis.

Exit-site infections

Infections were recorded in 37 cases, 22 patients (7.6%) of the sample developed only 1 infection, 16 (7.2%) in patients on APD treatment and six (8.6%) on the CAPD one. 6 (2.1%) patients developed 2 episodes of infection, 5 (2.3%) treated with APD and 1 (1.4%) with CAPD.

In 1 patient in the APD treatment's group, 3 exit-site infections occurred.

Peritonitis events related to exit-site infections

Peritonitis events were related to exit-site infections in 25 cases; in 19 (6.5%) cases a single event occurred, 14 (6.3%) in patients on APD and 5 (7.1%) in patients on CAPD.

In 2 (0.7%) cases 2 events occurred, 1 (0.5%) in a patient on APD and 1 (1.4%) in 1 patient receiving CAPD. In 1 case, a patient on APD, (0.3%) 3 events of ex-site infections occurred (Table 2).

Drop out of peritoneal dialysis

Patients enrolled dropped out, totaling 121: 69 (57.0%) dropped to haemodialysis, 11 (9.1%) were transferred to another facility, 41 (33. 9%) were transplanted. For more details, see Table 2.

Patient Mortality Rates

Data shows 152 (52.2%) deaths in patients with a mean age of 74.33 ± 9.94, 114 (51.6%) treated with APD and 38 (54.3%) with CAPD.

Non-death patients were 139 with a mean age of 59.97 ± 16.48 years. The major causes of death reported were cardiovascular events, cerebral events, and cachexia. For more details, see Table 2.

Length of peritoneal dialysis and peritonitis events

The development of peritonitis occurred on average at 598.87 ± 509.55* day, with a mean of 596.31 ± 533. 50 in patients on APD and 641.90 ± 437. 55 in patients on CAPD (Table 2).

Germs of PD effluent related to peritonitis

In 78 (26.9%) cases, the germ most related to peritonitis events was Staphylococcus epidermidis, while in 29 (10%) cases was Staphylococcus aureus; in 13 (4.5%) cases the germ was Escherichia coli, in 5 (1.5%) cases was Staphylococcus haemolyticus and in 12 (4.1%) cases was Candida albicans. Microbial etiology was not determined in 46 cultures (Table 3).

Germs associated with peritonitis	n (%)
Unknown microbial etiology	46 (15.9)
Staphylococcus epidermidis	78 (26.9)
Staphylococcus aureus	29 (10.0)
Escherichia coli	13 (4.5)
Candida albicans	12 (4.1)
Others	107 (37.1)

Table 3. Germs associated with peritonitis.

Overall Survival post catheter's implant

Kaplan-Meier analysis shows the number of died patients corresponding to one-fifth of the population one year after the peritoneal catheter's implant. Four years after the start of dialysis the survival curve tends to stabilize. The curve shows the mortality of 50% of the population at 45 months after catheter implant (Figure 1).

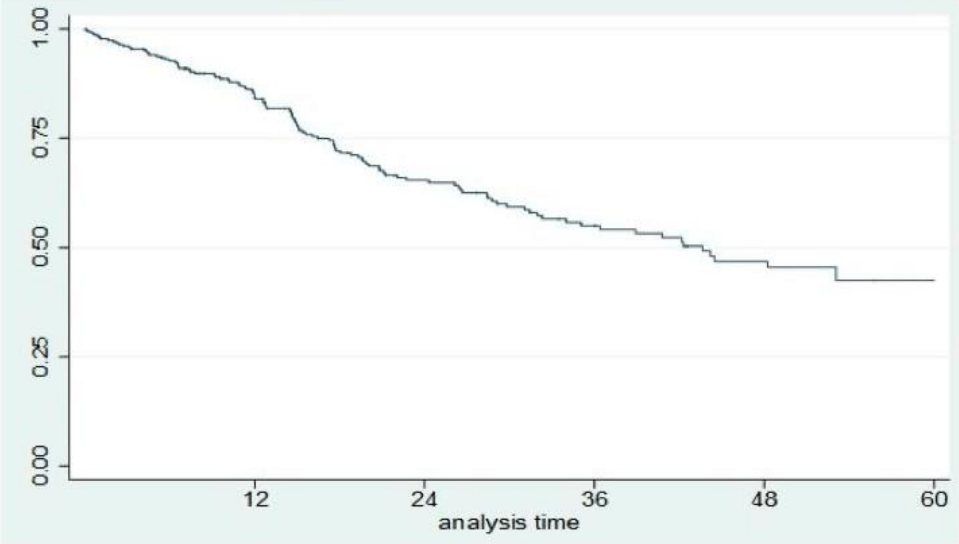

Figure 1. Kaplan-Meier survival analysis.

Peritoneal dialysis technique training

Patients enrolled received the peritoneal dialysis technique training in 184 cases (63.7%) of 291: 147 (67.1%) of them received the APD training, and 37 (52.9%) received the CAPD one. 105 patients did not receive training, while two patients did not report the execution of training (Table 4).

Educational training of peritoneal dialysis techniques	Total n (%)	APD n (%)	CAPD n (%)	*p-value*
Executed	184 (63.7)	147 (67.1)	37 (52.9)	0.033
Not executed	105 (36.7)	72 (32.9)	33 (47.1)	
Unknown	2	2		
Educational training of peritoneal dialysis techniques				
Executed	258 (88.7)	189 (85.5)	69 (98.6)	0.001
Not executed	33 (11.3)	32 (14.5)	1 (1.4)	
Avarage lenght of training (days)	7.19 ± 1.21	7.40 ± 1.00	6.65 ± 1.41	<0.001
Avarage lenght of training and development of peritonitis				
Peritonitis	7.33 ± 1.04**	7.44 ± 0.84	6.97 ± 1.35	0.077
Not peritonitis events	7.09 ± 1.31**	7.36 ± 1.11	6.39 ± 1.42	<0.001

Table 4. Educational training and peritonitis events. **p = 0.101

Educational training of peritoneal dialysis techniques

Enrolled patients received the peritoneal dialysis technique training in 258 cases (88.7%) of 291: 189 (85.5%) received the APD-related training, while 69 (98.6%) received the CAPD-related one. 33 (11.3%) patients did not perform the educational training — 32 (14.5%) in the APD group and 1 (1. 4%) in the CAPD group. The average length of training was 7.19 ± 1.21 days, with a minimum of 3 days and a maximum of 12 days. The average length of APD educational training was 7.40 ± 1.00 with a minimum of 3 days and a maximum of 12 days, while for CAPD educational training was 6.65 ± 1.41 with a minimum of 4 days and a maximum of 11 days. Differences of 0.75 days were reported between the APD and CAPD educational training ($p < 0.001$) (Table 4).

Average length of educational training and peritonitis events

The average length of educational training was 7.33 ± 1.04 in patients who developed peritonitis. For the APD technique it was 7.44 ± 0.84, while for the CAPD technique it was 6.97 ± 1.35. The average length of training in patients who did not develop peritonitis was 7.09 ± 1.31 (7.36 ± 1.11 for the APD technique, and 6.39 ± 1.42 for the CAPD technique).

Of 184 patients on dialysis training, 78 cases developed at least one episode of peritonitis, while 43 of them have developed two or more peritonitis. Patients did not perform educational training were 105: 46 subjects of them have developed peritonitis at least once, and 27 have developed two or more peritonitis events. No correlations were found between the technique used and the development of peritonitis. The APD technique was the most used in the sample. There is a statistically significant correlation between being known to the center and duration of treatment, particularly patients known to the center had a longer duration of treatment ($p<0.001$). There is not a statistically significant correlation between the use of different peritoneal dialysis kits and peritonitis events (Table 4).

Discussion

Our study is the first study in Italy that has examined a large population of patients undergoing peritoneal dialysis for twenty years. The aim of the study was to identify prevention areas including the treatment of peritonitis events. Data shows a prevalence of participants women over men. No significant correlations were found between etiological causes of end-stage renal disease and the development of peritonitis events. The most represented etiological causes of end-stage renal disease related to peritoneal dialysis was the cardiovascular disease category, in accordance with the current literature. Bacterial culture positivity was found in 80% of patients who developed peritonitis, while the literature shows culture-negative in the development of peritonitis episodes. Observational data suggest that Staphylococcus Epidermidis is the germ mainly present in positive culture of effluent, as confirmed in the literature [18]. Peritonitis episodes caused by germs are often secondary to exit-site or tunnel infection, although “touch contamination” can be contributory.

The most used technique in our sample is the APD compared to CADP, but no statistically significant correlations were found between the type of technique used and the development of peritonitis. Moreover, no statistically significant difference was found in the use of different kits used for peritoneal dialysis. The aim was to analyze the effects of educational training for patients conducted by the trained nurses. The educational training was set at 10 days, but course participation in the patients in our sample had a recorded average length of 7.19 days ($p = 1.21$) with a minimum of three days and a maximum of 12. For 36 enrolled patients this data was not reported. In more detail, the data showed the average length of training of 7.40 days ($p = 1.003$) with a minimum of 3 days and a maximum of 12 for APD techniques, while for CAPD techniques was of 6.65 ($p = 1.41$) with a minimum of 4 days and a maximum of 11. A difference of 0.75 days with a p-value <0. 001 was reported between the two techniques.

Despite the original intent of this study in wanting to demonstrate a correlation between improvement of educational training for dialysis techniques and the reduction of adverse events such as peritonitis, our data showed no significant correlation. However, a statistically significant correlation emerged between being known to the referral center and the length of treatment; in particular, the data showed that patients known to the center had a longer treatment’s length than patients who did not have such a referral. This data points out that within the framework of appropriate environmental conditions, shared paths within dedicated places and through the support of trained professionals, good motivation for self-management and proper knowledge of the dialysis technique can be achieved, prerequisites for the success of the treatment program over time.

In addition, the study enabled a more detailed analysis of the relevant care context. In fact, the sample recorded an average of 2.001 ($p =1.63$) episodes of peritonitis in a year of treatment, in contrast to the benchmark proposed in 2022 by the “International Society for Peritoneal Dialysis”

(ISPD) of 0.4 episodes/year. This condition calls for further reflection on how to improve this data from a future perspective based on current scientific evidence.

According to Kaplan-Meier survival curves, one year after peritoneal catheter implantation, about one fifth of the population experienced death. The number of deaths recorded during the study was 152; the most frequent cause of death was cachexia. A statistically significant prevalence of the death event was recorded in elderly patients.

In 2018, the International Society for Peritoneal Dialysis (ISPD) with respect to the overall rate of peritonitis for patient, had proposed a benchmark of 0.5 episodes of peritonitis for year or one episode every two years [18]. The ISPD recommendations updated to 2022 have then defined new recommended targets for the overall rate of peritonitis, i.e. no more than 0.40 episodes for year. The recommendations have also defined new categories of peritonitis, with specific considerations for contamination management of peritoneal dialysis systems, antibiotic prophylaxis for invasive catheter insertion procedures, and education and reevaluation processes. In addition, the systematic review of 77 studies (three randomized controlled trials) demonstrated a large variability in the definitions of peritonitis, allowing for further classification based on cause, association with exit site/tunnel infection, timing in relation to previous episodes and outcomes [4]. Despite the marked reduction in the incidence of peritonitis compared to the past, it is still essential to recognize the risk of early onset. In dialysis patients was calculated a mortality rate of 5.0% associated with single episodes of peritonitis, and the mortality rate of 16% in patients with other concomitant diseases [8]. Inadequate care management of peritonitis leads to failure of dialysis treatment in 29.0% of cases, and it causes death of patients in 2.6% of cases [11]. Most cases of peritoneal dialysis-related peritonitis are the result of “tactile contamination” of the peritoneal catheter or its connections by the patient himself or his caregiver [8]. A small percentage of peritonitis results from infections that mainly affect the exit-site of the catheter emerged through the skin, but there may also be infections resulting from the spread of germs along the catheter tunnel to the peritoneum [18].

Finally, we can get peritonitis from transmural contamination, that is, through the intestinal wall. The germs that can most commonly colonize the devices used in dialysis treatment to proliferate within the same peritoneal cavity and cause peritonitis, are mainly of negative coagulase staphylococcal species, among which stands out Staphylococcus Aureus, normally present on the skin and hands as a resident bacterial flora, and responsible alone for 50.0% or more of peritonitis [19]. Furthermore, the causes of peritonitis can also be traced back to fungal organisms, responsible for the incidence of peritonitis in 5% to 15% of total cases; among these Candida alone is responsible for 90.0% or more of the recorded episodes of fungal peritonitis [7].

Study Limitations

Our study has some inherent limitations. First of all, the retrospective nature of the research could lead to selection or information bias, considering that the data were collected in the past without the primary objective of the present study. Furthermore, the monocentricity of the study narrows the reference context. Therefore, it would be of interest to conduct a multicenter study to verify if the results could be confirmed in a larger sample of Italian patients.

Conclusions

The results of our study conducted on a large population of patients have showed how the reduction of cases of peritonitis requires the cooperation of the patient as well as the attention of the healthcare professional. PD-associated peritonitis is a serious complication; it is the most common

type of PD-related infection resulting in increased healthcare utilisation and is associated with significant harms including pain, treatment costs, transfer to haemodialysis and death. Peritonitis event is a critically important outcome for all key stakeholders including patients, caregivers, clinicians, researchers, and policymakers.

As healthcare professionals we must prioritize patient engagement, continuous monitoring, and informed decision-making for optimal adherence to treatment, particularly in selecting the dialysis method. Transformation to a high-value care delivery system has physicians and provider organizations taking the lead, but each of the other stakeholders — including the patient — has a role to play in improving the value of care and hastening transformation by aligning incentives across stakeholders for mutual benefit [20]. New intervention strategies should limit adverse events for dialysis patients, including new training protocols for patients and healthcare professionals, which may require the introduction of new concepts, such as knowledge of aspects related to renal diet, healthy lifestyle, hygiene standards, and the organization of meetings between health professionals and patients, where patients can really feel supported, not only clinically.

BIBLIOGRAPHY

1. Salek S. Quality-of-Life Assessment in Patients on Peritoneal Dialysis: A Review of the State of the Art. Peritoneal Dialysis International. 1996;16(2_suppl):398-402. https://doi.org/10.1177/089686089601601S76.
2. Teitelbaum I. E-Mail Ultrafiltration Failure in Peritoneal Dialysis: A Pathophysiologic Approach. Blood Purif 2015; 39: 70–73. https://doi.org/10.1159/000368972.
3. Gokal R, Mallick NP. Peritoneal dialysis. Lancet 1999; 353: 823–828. https://doi.org/10.1016/s0140-6736(98)09410-0.
4. Li PK, Chow KM, Cho Y, Fan S, et al. ISPD peritonitis guideline recommendations: 2022 update on prevention and treatment. Perit Dial Int. 2022 Mar;42(2):110-153. https://doi.org/10.1177/08968608221080586.
5. Moeller S, Gioberge S, Brown G. Invited Comment ESRD patients in 2001: global overview of patients, treatment modalities and development trends. https://doi.org/10.1093/ndt/17.12.2071.
6. Grassmann A, Gioberge S, Moeller S, Brown G. ESRD patients in 2004: global overview of patient numbers, treatment modalities and associated trends. Nephrol Dial Transpl 2005; 20: 2587–2593. https://doi.org/10.1093/ndt/gfi159.
7. Van Diepen ATN, Tomlinson GA, Jassal S V. The association between exit site infection and subsequent peritonitis among peritoneal dialysis patients. Clin J Am Soc Nephrol 2012; 7: 1266–1271. https://doi.org/10.2215/CJN.00980112.
8. Salzer WL. Peritoneal dialysis-related peritonitis: challenges and solutions. Int J Nephrol Renovasc Dis 2018; : 11–173. https://doi.org/10.2147/IJNRD.S123618.
9. Piraino B, Bailie GR, Bernardini J et al. ISPD GUIDELINES/RECOMMENDATIONS PERITONEAL DIALYSIS-RELATED INFECTIONS RECOMMENDATIONS: 2005 UPDATE. Perit Dial Int 2005; 25: 107–131. https://ispd.org/media/pdf/Copy%20of%20ISPD_Guidelines_2005__2_.pdf.
10. Barry AL, Jones RN. In vitro activities of ampicillin-sulbactam and cefoperazone-sulbactam against oxacillin-susceptible and oxacillin-resistant staphylococci. Antimicrob Agents Chemother 1990; 34: 1830–1832. https://doi.org/10.1128/AAC.34.9.1830.
11. Mujais S. Microbiology and outcomes of peritonitis in North America. Kidney Int 2006; 70: S55–S62. https://doi.org/10.1038/sj.ki.5001916.
12. Szeto C-C, Chow V-Y, Chow K-M et al. Enterobacteriaceae peritonitis complicating peritoneal dialysis: A review of 210 consecutive cases. Kidney Int 2006; 69: 1245–1252. https://doi.org/10.1038/sj.ki.5000037.
13. Figueiredo AE, Bernardini J, Bowes E et al. A SYLLABUS FOR TEACHING PERITONEAL DIALYSIS TO PATIENTS AND CAREGIVERS. Perit Dial Int 2016; 36: 592–605. https://doi.org/10.3747/pdi.2015.00277.
14. Russo R, Manili L, Tiraboschi G et al. Patient re-training in peritoneal dialysis: Why and when it is needed. Kidney Int 2006; 70: S127–S132. https://doi.org/10.1038/sj.ki.5001929.
15. Keane WF, Bailie GR, Boeschoten E et al. Adult peritoneal dialysis-related peritonitis treatment recommendations: 2000 update. Perit Dial Int 2000; 20: 396–411. https://doi.org/10.1177/089686080002000406.
16. Bender FH, Bernardini J, Piraino B. Prevention of infectious complications in peritoneal dialysis: best demonstrated practices. Kidney Int 2006; 70: S44–S54. https://doi.org/10.1038/sj.ki.5001915.
17. Cuschieri S. The STROBE guidelines. Saudi J Anaesth. 2019 Apr;13(Suppl 1):S31-S34. https://doi.org/10.4103/sja.SJA_543_18.
18. Kam-Tao Li P, Chun Szeto C, Piraino B et al. ISPD PERITONITIS RECOMMENDATIONS: 2016 UPDATE ON PREVENTION AND TREATMENT ISPD GUIDELINES/RECOMMENDATIONS. Perit Dial Int 2016; 36: 481–508. https://doi.org/10.3747/pdi.2016.00078.
19. Janež J, Čebron Ž. Peritonitis pri bolnikih na peritonealni dializi. Slov Med J 2019; 88: 23–49. https://doi.org/10.6016/ZdravVestn.2844.
20. Apel C, Hornig C, Maddux FW, Ketchersid T, Yeung J, Guinsburg A. Informed decision-making in delivery of dialysis: combining clinical outcomes with sustainability. Clin Kidney J 2021; 14(4): i98-i113. https://doi.org/10.1093/ckj/sfab193.