Peritoneal dialysis related infections in a tertiary care hospital in Riyadh, Saudi Arabia

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ABSTRACT

الأهداف: للكشف عن حالات الإصابة بالالتهابات وعوامل الخطر لدى مرضى الفشل الكلوي في المرحلة النهائية والذين يخضعون لغسيل كلوي بيرتوني.

الطريقة: تم إجراء دراسة استعادية أترابية في قسم الغسيل الكلوي البيرتوني في مدينة الملك فهد الطبية. وأجريت الدراسة على مرضى الفشل الكلوي في المرحلة النهائية فوق سن الثانية عشرة، وبإدارة من قسم الغسيل الكلوي البيرتوني في الفترة ما بين شهر يناير 2006 وحتى شهر مارس 2016.

النتائج: شملت الدراسة 100 مريض يخضع للغسيل الكلوي البيرتوني خلال فترة مراقبة مجموعها 2,553 شهرًا. وكان أبرز مسببات مرض الفشل الكلوي في المرحلة النهائية هو ارتفاع ضغط الدم (26.3%). وكان متوسط مدة الغسيل الكلوي البيرتوني هو 28.05 شهرًا. كما تعرض ما مجموعة 45 مريضًا إلى 101 حالة التهاب متعلقة بنوع الغسيل الكلوي، وتمثل التهابات الصفاق غالبية هذه الحالات (90 حالة) بمعدل حالة واحدة في كل 28.3 شهر. ونجمت هذه الالتهابات عن المكورات العنقودية السلبية المخثرة. وتعرض ما مجموعه 12 مريضًا إلى حالات التهاب أخرى غير متعلقة بنوع الغسيل الكلوي. كان هنالك فرق ملحوظ من الناحية الإحصائية بين المرضى الذي تعرضوا لحالة التهاب متعلقة بنوع الغسيل الكلوي وبين المرضى الذين تعرضوا لالتهابات أخرى فيما يتعلق بوجود مرض السكري وبمدة الغسيل الكلوي. لم يلاحظ وجود حالات وفاة بسبب التهابات الصفاق، بينما استمر 21 مريضًا على الغسيل الكلوي البيرتوني، وتم تحويل 18 مريضًا إلى الغسيل الكلوي الدموي.

الخاتمة: وفقًا للدراسة فإن مرضى الفشل الكلوي في المرحلة النهائية الذين يخضعون للغسيل الكلوي البيرتوني هم أكثر عرضة للالتهابات المتعلقة بنوع الغسيل الكلوي أكثر من الالتهابات الأخرى. ويزيد مرض السكري من خطورة التعرض للالتهابات المتعلقة بنوع الغسيل الكلوي. كما يشير ارتفاع معدل التعرض للالتهابات بسبب المكورات العنقودية السلبية المخثرة إلى التلوث بالملامسة.

Objectives: To detect the incidence of and risk factors for infections among patients with end-stage renal disease (ESRD) undergoing peritoneal dialysis (PD).

Methods: A retrospective cohort study was conducted at the PD unit of King Fahad Medical City. End-stage renal disease patients above the age of 12 years who were undergoing PD management between January 2006 and March 2016 were included.

Results: One hundred PD patients were enrolled in the study and examined over a total observation period of 2,553 patient-months. The leading ESRD etiology was hypertension (26.3%). The mean duration of PD was 28.05 months. A total of 45 patients developed 101 episodes of technique-related infections (TRIs). Peritonitis represented the majority of these episodes (90 episodes), with an overall rate of one episode per 28.3 patient-months. TRIs were mostly caused by coagulase-negative staphylococci. A total of 12 patients developed non-technique related infections (NTRIs). There was a statistically significant difference between patients with TRI and non-infected patients regarding the presence of diabetes and duration of dialysis. No peritonitis-related deaths were noted. In total, 21 patients continued on PD and 18 patients were shifted to hemodialysis (HD).

Conclusion: In our setting, ESRD patients undergoing PD are more susceptible to TRIs than NTRIs. Diabetes increases the risk of developing TRIs. The high incidence of coagulase-negative staphylococcal TRI suggests touch contamination.

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End-stage renal disease (ESRD) is defined as an irreversible decline in kidney function that requires renal replacement therapy (RRT) for survival.[1] It is a major healthcare problem; the prevalence and global incidence of cases with high costs and poor outcomes are increasing.[2] According to a meta-analysis, the leading cause of ESRD in Gulf countries is diabetic nephropathy (17%), followed by glomerulonephritis (13%) and hypertensive nephropathy (8%), and the prevalence of diabetic nephropathy has significantly increased over time.[3] The RRT required by patients with ESRD involves dialysis or a kidney transplant.

The introduction of continuous ambulatory peritoneal dialysis (CAPD) in 1976 led to an increase in the international use of peritoneal dialysis (PD).[4] PD may be recommended over hemodialysis (HD) for younger patients and adults with no serious comorbidities.[5] In 2015, the Saudi Center for Organ Transplantation (SCOT) reported that 16,897 patients underwent dialysis in Saudi Arabia. A total of 1,307 patients underwent PD. Of these, 68% received continuous cycler peritoneal dialysis (CCPD), 27% received CAPD and 5% received intermittent peritoneal dialysis (IPD).[6] Dialysis effectively relieves the signs and symptoms of uremia and fluid overload, but it is a chronic therapy that is associated with discomfort, inconvenience, and some complications for the patient.[7] Infectious complications among patients undergoing dialysis are a major cause of morbidity and hospitalization, and they are the most common cause of death among these patients after cardiovascular causes.[8] The main technique-related infections (TRIs) that occur during PD include peritonitis, exit-site infection (ESI), and tunnel infection. In addition, peritonitis is a major complication of PD, resulting in around 18% of the infection-related mortality among PD patients.[9] Even though less than 4% of peritonitis episodes lead to death, this complication is still a risk for mortality.[9,10] It can also cause peritoneal membrane damage, which is the main cause of technique failure and why patients switch to HD. A 5-year single-center study that was carried out in Riyadh[11] reported the peritonitis rate as one episode per 24.51 patient-months, while the ESI rate was one episode per 56.21 patient-months. Non-technique related infections (NTRIs) associated with PD, such as pneumonia, are not as common as in HD patients.[12]

The current study was conducted to determine the incidence of PD-related infections at a tertiary care hospital in Riyadh and to assess the possible risk factors associated with these infections.

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Methods. The study was approved by the Institutional Review Board (IRB) of the College of Medicine at Princess Nourah bint Abdulrahman University (PNU) as well as the IRB of King Fahad Medical City (KFMC). It is a retrospective cohort study that was conducted within the dialysis unit at KFMC, Riyadh, Saudi Arabia. All ESRD patients above the age of 12 years who underwent PD (APD and CAPD) between January 2006 and March 2016 were included. In addition patients who did dialysis by themselves or required a helper were included. No exclusion criteria were applied. The medical records of the in- and outpatients included in the study were reviewed. A data sheet was used to collect information from the records, including patients' demographics, body mass index (BMI), smoking status, ESRD etiology, Charlson Comorbidity Index (CCI) score,[13] initial dialysis modality, dialysis vintage (duration of dialysis), type of PD, incidence of TRI, and NTRI. For patients with peritonitis, additional information was collected, including the causative organism and outcome of each episode. Prior studies were identified by searching Pubmed and Google Scholar. Some of the keywords used were "peritoneal dialysis" and "peritonitis".

All patients had Tenckhoff indwelling silicone double-cuff catheters, which were surgically placed after administration of a prophylactic antibiotic. A full PD prescription was started two weeks after catheter insertion. All patients and caregivers received condensed three-day training at the Baxter and Fresenius PD training centers in Riyadh. The patients were followed in the outpatient clinic every 4-8 weeks and were asked to inform the hospital if the PD fluid became turbid or if they experienced abdominal pain, vomiting, or diarrhea.

All PD patients suspected to have an infection were evaluated by a nephrologist. Peritoneal dialysis-associated peritonitis was defined as inflammation of the peritoneal membrane in a patient receiving PD with abdominal pain, vomiting, fever, and cloudy fluid. A diagnosis was confirmed by obtaining an effluent cell count, differential, and culture (White blood cells WBC >100 cells/ml, 50% polymorphonuclear leukocytes in PD fluid, or a positive culture).[9] Exit-site infection was defined as the presence of purulent discharge with or without erythema of the skin at the catheter–epidermal interface.[9] Tunnel infection was suspected when erythema, edema, or tenderness over the

subcutaneous pathway were observed.[9] Non-technique related infections indicate that the patient may have pneumonia, a urinary tract infection (UTI), or a soft tissue infection.

Statistical analysis. Descriptive statistics (means and standard deviations) were used to describe the studied sample. Quantitative data were analyzed by a t-test and qualitative variables were associated by a Chi-square test. P-values less than 0.05 were considered to be statistically significant. All statistical analyses were conducted using the Statisitcal Package for Social Sciences Version 23 (Armonk, NY: IBM Corp.).

Results. The medical records of 100 patients were reviewed. The proportions of patients who were male and female were almost equal (53% and 47%). The mean age was 40.7±19.3 years. The mean BMI was 23.9±5.7 kg/m^2. A total of 32 patients (32%) were diabetic. The mean CCI was 3.4±1.9. The leading ESRD etiology was hypertension (26.3%), followed by an unknown etiology (23.7%), glomerulonephritis (23%), diabetic nephropathy (22%), polycystic kidney (2%), obstructive uropathy (2%), and reflux (1%). The mean duration for which patients received PD was 28.05±24.4 months.

A total of 45 patients developed a TRI, such as peritonitis, ESI, and tunnel infection. In total, 101 episodes were reported, most of which involved peritonitis (90 episodes). Of the 45 patients, 35 developed only peritonitis, 3 developed an ESI, 1 patient developed a tunnel infection, 5 developed peritonitis and an ESI, one patient had both infections in the same episode, while 4 patients had each infection in a different episode, and one patient had peritonitis and tunnel infection in the same episode. Only 12 patients developed an NTRI, usually pneumonia or a UTI.

Table 1 shows the baseline characteristics of the patients who developed a TRI. It shows that no statistically significant difference was found between patients with and without TRIs in terms of age, gender, or BMI, while a statistically significant difference was found in terms of CCI, dialysis vintage, and diabetes. Patients who had TRIs had more comorbidities and longer dialysis vintage, while patients with diabetes were more likely to develop TRIs (62.5%) than non-diabetics (36.8%). No relationships or differences were observed for the variables associated with the 12 patients with NTRIs (**Table 2**).

A total of 15 patients (36.6%) had one episode of peritonitis, 10 (24.4%) had 2 episodes, 6 (14.6%) had 3 episodes, 3 (7.3%) had 4 episodes, 2 (4.9%) had 5 episodes, and 2 (4.9%) had 6 episodes. While the number of episodes for 3 patients (7.3%) was unknown. The Pearson correlation coefficient was used to analyze the correlation between age, BMI, CCI, and dialysis vintage and the number of episodes. No correlation was observed, as shown in **Table 3**.

Technique-related infections were mostly caused by

Table 1 - Relation between baseline characteristics and the occurrence of technique-related infections.

Baseline characteristics	Technique related infections		*P*-value
	Yes	No	
Age, year (mean±SD)	43.4±22.7	38.4±15.7	0.215
Gender n (%)			0.456
Male	22 (41.5)	31 (58.5)	
Female	23 (48.9)	24 (51.1)	
BMI [(kg/m^2) (mean±SD)	23.7±6.2	24.05±5.3	0.798
Diabetes n (%)			0.016*
Yes	20 (62.5)	12 (37.5)	
No	25 (36.8)	43 (63.2)	
Charlson comorbidity index score (mean±SD)	4.02±2.2	3.01±1.5	0.014*
Dialysis vintage (mean±SD)	34.5±24.7	22.2±22.8	0.015*

*significant *p*-value; BMI - body mass index

Table 2 - Relation between baseline characteristics and the occurrence of non-technique related infections.

Baseline characteristics	Non technique related infections		*P*-value
	Yes	No	
Age, year (mean±SD)	47.5 ± 21.5	39.7±18.9	0.196
Gender n (%)			0.146
Male	4 (7.5)	49 (92.5)	
Female	8 (17.0)	39 (83.0)	
BMI [(kg/m^2) (mean±SD)	24.3 ± 5.8	23.8±5.7	0.776
Diabetes n (%)			0.444
Yes	5 (15.6)	27 (84.4)	
No	7 (10.3)	61 (89.7)	
Charlson comorbidity index score (mean±SD)	4.5 ± 2.7	3.3±1.7	0.15
Dialysis vintage (mean±SD)	34.4 ± 25.9	27.2±24.3	0.388

BMI - body mass index

Table 3 - Pearson correlation coefficient of the number of episodes with different variables.

Variables	Number of episodes	
	Correlation coefficient	*P*-value
Age	0.008	0.939
Body mass index	-0.057	0.599
Charlson comorbidity index	0.103	0.317
Dialysis vintage	0.182	0.090

coagulase-negative staphylococci (23% of the episodes), followed by culture-negative (22%). Most peritonitis episodes were also caused by coagulase-negative staphylococci (24.4%). One patient was diagnosed with TB peritonitis based on a CT scan. The causative organisms of peritonitis over a 10-year period are shown in **Table 4**. Of the 90 peritonitis episodes, the patient continued on PD in 65 episodes, while 18 episodes ended with the patient shifting to HD. The outcome of 7 episodes was unknown. Although a higher percentage of episodes caused by gram negative organisms ended with catheter removal than those caused by gram positive organisms (46.7% versus 21.6%), the difference was not statistically significant. Out of the 41 patients who developed peritonitis, 21 patients continued on PD and 18 patients were shifted to HD. The outcome of 2 patients was unknown. No peritonitis-related deaths were noted.

Table 4 - Causative organisms of peritonitis among peritoneal dialysis patients over a 10-year period.

Causative organism of peritonitis	n (%)
Coagulase-negative ***Staphylococci***	22 (24.4)
Staphylococcus aureus	4 (4.4)
Pseudomonas	5 (5.6)
Klabsiella	4 (4.4)
Enterobacter	3 (3.3)
Culture negative	22 (24.4)
E.coli	2 (2.2)
Streptococcus species	3 (3.3)
Multiple organisms	5 (5.6)
Bacillus species	2 (2.2)
Enterococcus	3 (3.3)
Micrococcus species	3 (3.3)
Acinetobacter	2 (2.2)
Fungal	0 (0)
Unknown	10 (11.1)
Total	**90 (99.7 ≈ 100)**

Discussion. This retrospective cohort study reported the incidence of PD-related infections in a tertiary care hospital in Riyadh and assessed the possible risk factors associated with these infections. Of the 100 patients enrolled in the study, there was no major difference in the proportions of males and females. The mean age was 40.7±19.3, which was younger than the mean age reported in another study (53.8±17.52).[14] Hypertension was the most common cause of ESRD (26.3%), followed by unknown etiology (23.7%). This finding was inconsistent with a study conducted in Riyadh, which reported that diabetic nephropathy was the leading cause of ESRD (23.6%), followed by nephrosclerosis and an unknown etiology (20%).[15]

A total of 45 patients developed TRIs. Peritonitis represented the majority of these infections, with one episode occurring per 28.3 patient-months. This rate is lower than the rate reported in an earlier study conducted at King Khalid University Hospital in Riyadh over a period of 5 years (one episode per 24.51 patient-months).[11] It is also lower than the rate reported in a study conducted at the Security Forces Hospital Program in Riyadh (one episode per 21 patient-months).[15] A higher rate was reported in Sudan (one episode per 13.9 patient-months).[16] Lower rates were reported in North India (one episode per 30.6 patient-months)[17] and in the US (one episode per 32.7 patient-months), while Canada had a comparable rate (one episode per 27.6 patient-months).[18] In this study, patients with TRIs had a mean CCI score of 4.02. In the current study, there was no relationship between gender and the incidence of TRI. However, a previous study found that females were at greater risk of developing peritonitis.[19] The current study also found no significant association between age and BMI and increased risk of TRI. However, other studies showed that older age was a risk factor for peritonitis.[19,20] Two prior studies reported different results regarding BMI; one found that obesity is a risk factor for peritonitis when patients start PD,[21] while the other found no association between obesity and the risk of developing peritonitis.[22]

The current study found that diabetic patients have a higher risk of developing TRIs (62.5%) compared to non-diabetics (36.8%), similar to the results of another study.[20] However, diabetes, as a risk factor for infections, does not exclude the benefits of PD for diabetic patients.[23] Further, this study found no correlation between age, BMI, CCI, and dialysis vintage and the number of peritonitis episodes. In a review article, there were contradicting results regarding gender, age, BMI and comorbidities as risk factors for peritonitis, however diabetes was an established risk for peritonitis.[24]

Although this topic was not discussed in the current study, some studies showed that there is a relationship between the type of organism and the risk of developing multiple episodes of peritonitis.[25,26] In the current study, TRIs were mostly caused by coagulase-negative staphylococci (23% of episodes), followed by culture negative (22%). This is consistent with a study carried out in Riyadh that reported staphylococcus (epidermidis and aureus) was the most common organism leading to infection (24% of cases).[15] Similar results were reported in Korea; most peritonitis cases were caused by coagulase-negative staphylococci (39.9%) and culture negative (36.9%).[27] No peritonitis-related deaths were reported in the current study.

The duration of PD was longer for patients who had infections (mean = 34.5 months). Twenty-one patients continued to receive PD after developing peritonitis, and 18 patients shifted to HD. Another study with 72 patients conducted in Riyadh reported that 35 patients continued to receive PD, and 13 patients shifted to HD.[11]

Our study was limited by being a single center study. A multi-center study with a larger sample size is recommended.

In conclusion, this study found that patients receiving PD are more susceptible to TRIs than to NTRIs. In addition, it found that diabetes increases the risk that patients undergoing PD will develop TRIs. The high incidence of coagulase-negative staphylococcal TRIs suggests touch contamination. Further, controlling diabetes is important for decreasing the incidence of TRIs. It is recommended that healthcare professionals educate and train patients and families about PD infection control procedures.

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