BMC Nephrology

RESEARCH

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Continuous ambulatory peritoneal dialysis technique failure in adult patients treated at a tertiary hospital in central South Africa: a retrospective analytical study

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Abstract

Background Continuous ambulatory peritoneal dialysis (CAPD) is one of the kidney replacement therapy (KRT) modalities used in patients with kidney failure. It is the preferred modality in most resource-limited settings as it is more accessible and cost-effective. CAPD technique failure remains a challenge and is associated with an increased risk of morbidity and mortality. We aimed to describe the sociodemographic and clinical characteristics, CAPD survival rate and the reasons for CAPD technique failure over a five-year period among adult patients on CAPD at a tertiary hospital in South Africa.

Methods We conducted a retrospective analytical study reviewing files of patients with end-stage kidney disease (ESKD) whose peritoneal dialysis (PD) catheter was removed, or who died with a functioning PD catheter while on the PD program at Universitas Academic Hospital in Bloemfontein, South Africa, from 01 January 2015 until 31 December 2019. The demographic, clinical and laboratory data were collected from patients' medical records. Clinical outcomes were technique failure and survival.

Results Ninety-one patient records met the inclusion criteria of whom 51 (56.0%) were male. The median age at commencement of PD was 40 years (interquartile range [IQR] 18–58). Fifty-one (57.3%) patients were single and 64 (70.0%) were unemployed. Hypertension was the leading cause of ESKD ($n=47$; 51.6%), followed by human immunodeficiency virus- (HIV-) associated conditions ($n=18$; 19.8%). Technique failure rates at 1-, 2-, 3-, 4- and 5-years post-PD initiation were 31.9%, 35.2%, 13.2%, 8.8% and 11.0%, respectively. The 5-year survival rate was 63.7% ($n=58$), with a median survival time of 26 months (IQR 1–54). Peritonitis was the leading cause of technique failure ($n=52$; 57.1%), and almost a third ($n=29$ (31.9%)) had a fatal outcome. Younger age and using the Dianeal® PD system were associated with an increased likelihood of technique failure. No other sociodemographic, laboratory and clinical factors were associated with the development of technique failure or death.

Conclusions PD-associated peritonitis is the primary cause of technique failure, followed by sudden unexpected death occurring at home. Preventive measures need to be adhered to in order to avoid high rates of peritonitis.

Keywords Continuous ambulatory peritoneal dialysis, Technique failure, Kidney replacement therapy, Patient survival, Peritonitis

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Introduction

Peritoneal dialysis (PD) is a kidney replacement therapy modality that removes nitrogenous waste products and fluid by the infusion of dialysate via an indwelling catheter into the peritoneal space. After a predetermined dwell time, the fluid is drained out and replaced with fresh dialysate. Despite PD being underutilised, an increase in its use has been noted [1, 2].

Continuous ambulatory PD (CAPD) is a manual method of performing bag exchanges, whereas automated peritoneal dialysis (APD) uses a cycler, typically performed overnight. As CAPD is more affordable, it is more widely used in low- and middle-income countries than APD. CAPD has the advantage of being a continuous flexible process performed throughout the day without requiring an electronic cycler.

Peritoneal dialysis is more affordable than haemodialysis (HD), and is the preferred form of kidney replacement therapy (KRT) for patients expecting to receive a kidney transplant. Furthermore, pre-transplant PD is associated with improved post-transplant survival and a decreased risk of delayed graft function [3]. Both PD and HD have similar survival rates, with some studies showing improved survival in the first two years of commencing PD therapy than those on HD [2, 4–6].

Non-infectious complications of PD are divided into five sub-groups: catheter-related problems, metabolic derangements, peritoneal membrane damage, problems related to increased intra-abdominal pressure, and psychosocial factors. Catheter-related complications include catheter malposition, exit site leakage, pain when infusing or draining fluid, and the omentum wrapping around the catheter. Metabolic complications include albumin loss, hyperglycemia, obesity, dyslipidemia and loss of appetite. Complications related to increased intra-abdominal pressure are formation of hernias, hydrothorax, leakage of the dialysate in the scrotum or vagina and back pain. Peritoneal membrane damage involves impairment of peritoneal host defense and encapsulating peritoneal sclerosis (EPS), resulting in ultrafiltration failure and malnutrition [1, 2, 7–9].

There is no standardised definition of technique failure. However, it has generally been accepted that technique failure is defined as transfer to HD for 30 days or more, or death while on PD therapy [10–13].

Technique failure remains a challenge of PD and is associated with an increased risk of morbidity, mortality and healthcare costs, contributing to underutilisation of this form of KRT. The highest risk of technique failure occurs in the first two years after starting PD, with up to 25% of patients on PD experiencing technique failure annually [10, 14, 15].

The causes of PD technique failure are divided into two groups: infectious and non-infectious complications. Infectious complications include peritonitis, tunnel infection and exit site infection. PD-associated peritonitis is one of the leading causes of PD technique failure. It leads to a structural and functional alteration of the peritoneal membrane, which can cause ultrafiltration failure and membrane-related complications such as encapsulating peritoneal sclerosis (EPS). It increases the risk of hospitalisation and results in death in approximately 5% of cases. Several interventions have been used to assist in limiting the peritonitis rate, including the use of twin bags and a Y-set system [1, 2, 7, 8, 16].

Several factors influence the risk of PD technique failure. These include pre-existing conditions such as diabetes mellitus, advanced age, increased body mass index (BMI), malnutrition, lower baseline albumin levels, low creatinine clearance, and poor socioeconomic status. A history of being on HD has been reported to be a risk factor for technique failure possibly due to poor residual kidney function [13, 15, 17].

In a study in the Limpopo Province of South Africa, peritonitis was found to be the most common cause of PD technique failure. Predictors of outcome were not related to poor sociodemographic or socioeconomic factors, such as a long distance travelled to dialysis unit, lack of access to tap water and electricity, unemployment or lack of income. It was found that BMI, serum albumin level, haemoglobin (Hb) concentration and more than one episode of peritonitis were the factors associated with poor outcomes [18].

In another study in Tygerberg Hospital in Cape Town, South Africa, peritonitis was also a major cause of technique failure. In this study, mechanical complications were rarely associated with technique failure [19]. Similar to the Limpopo study, lower education, poor housing, and lack of access to running water and electricity did not influence technique survival. Gender, Hb and albumin levels were also not associated with technique failure [20].

The aim of the study was to describe the reasons for technique failure and patient outcomes at Universitas Academic Hospital. Our objective was to describe the demographic and clinical profile of adult ESKD patients who died or had CAPD technique failure, the reasons for CAPD technique failure and the outcomes of patients with CAPD failure, and to correlate these with the sociodemographic and clinical characteristics of the study population.

Methods

Study design

A retrospective analytical study was conducted.

Setting

Universitas Academic Hospital (UAH) is an academic hospital located in Bloemfontein, Free State (FS), South Africa. It provides tertiary services to the Free State, the neighbouring Lesotho and bordering parts of the Eastern Cape and Northern Cape provinces. All patients who receive kidney replacement therapy (KRT) in the form of CAPD in the Free State public healthcare sector are managed at UAH. The FS KRT program offers CAPD preferentially as the initial dialysis modality, unless contraindicated for patients who have been selected according to the local policy of rationing KRT services. Before enrolment in the KRT program, all patients undergo a vigorous multidisciplinary evaluation process to determine whether they are suitable for potential kidney transplantation. In our setting, most patients have their PD catheter inserted in theatre by a qualified surgeon, with the minority being inserted percutaneously at the bedside by a nephrology trainee. Most patients are placed on the Dianeal® system (Adcock Ingram; Johannesburg, South Africa) as the stock of the compatible sets and dialysate are readily available compared to other products. The records of these assessments constitute medical records and were the source of the sociodemographic data collected.

Participants

Medical records of all patients who were treated for kidney failure with CAPD and had technique failure or died between 01 January 2015 and 31 December 2019, were screened for inclusion in this study.

Inclusion criteria

The records of adult patients (≥18 years of age) with ESKD who died with a functioning PD catheter while undergoing CAPD, or whose PD catheter was removed and modality changed to HD at UAH in the study period, were eligible for inclusion in the study. Incomplete records were excluded.

Variables

The following demographic data were collected as categorical variables: sex, marital status, highest level of education, employment status, type of dwelling, number of persons living in a household, availability of running water and electricity, and the residential municipal district. Peritoneal dialysis data collected as categorical data were the first report from the PD registered nurse indicating patient willingness to use PD, method of PD insertion (surgical, percutaneous or unknown), PD system used, history of prior dialysis, peritoneal membrane characteristics, main reason of PD discontinuation, type of peritonitis (aetiology, if relevant), mechanical reason for PD removal (if relevant) and type of membrane failure (if relevant). Clinical data collected as categorical variables included comorbidities, human immunodeficiency virus (HIV) status, aetiology of chronic kidney disease, use of and type of immunosuppressive therapy, history of previous abdominal surgery, outcome and cause of death, if relevant.

Numerical variables included the dates of birth, initiation of PD, removal of PD catheter, laboratory values (Hb, ferritin and albumin levels at the time of PD catheter insertion and removal), CD4 count, if relevant, HIV viral load, if relevant, BMI at the time of PD insertion and removal, and the number of documented peritonitis episodes between initiating PD and the occurrence of technique failure.

Data sources/measurement

Data were collected between June and December 2022, with the date of final data collection being 31 December 2022. Sociodemographic, clinical and laboratory information was obtained from the patient files, the hospital electronic patient record system (Meditech®), and the National Health Laboratory Service (NHLS) laboratory information system (Labtrak®).

Study size

A population study was performed, and thus sample size was not determined.

Quantitative variables

- *Peritoneal dialysis technique failure:* Transfer to HD for 30 days or more, or death while on PD.
- *Patient survival:* Death from any cause.
- *PD peritonitis:* Cloudy PD fluid and/or abdominal pain with a total white cell count of 100 or more (with > 50% neutrophils) with or without a cultured organism.
- *PD technique survival period:* The time in years that the PD was in situ from date of insertion to date of removal or death.
- *PD technique survival rate:* PD survival period divided by the study population size.

Data analysis

Data were analysed by the Department of Biostatistics at the University of the Free State (UFS) using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). Continuous variables were summarised by medians, minimum, maximum or percentiles. Categorical variables were summarised by frequencies and percentages. Differences

between groups was evaluated using appropriate statistical tests (chi square or Fisher's exact test) for unpaired data.

Ethical considerations

The study was approved by the Health Sciences Research Ethics Committee (HSREC) of the University of the Free State (UFS-HSD2021/1450/2501) and the Free State Province Department of Health. Each patient file was allocated a study number used to collect data anonymously. Due to the retrospective nature of the study, informed consent was not required.

Results

A total of 101 adult patients had technique failure during the study period, of whom 10 patients were excluded from the study. The reasons for exclusion are shown in Fig. 1.

The patients' demographic characteristics are summarised in Table 1. A male predominance was observed ($n=51$; 56.0%). The median age of patients was 40 years (interquartile range [IQR] 18–58 years), with the majority (48.4%) falling in the 31–45 years age group. Most patients were single (57.3%) and unemployed (70.0%). Most patients completed secondary school (65.8%), while more than a quarter of patients (28.9%) completed only primary school education. Approximately 80.5% lived in a brick house, 98.9% had access to electricity, and 62.5% had running water inside the house. Most patients lived in a house with fewer than five persons in the household (86.2%). Approximately a third of the participants (35.2%) resided in the urban Mangaung Metropolitan district, while the remaining majority were from rural areas.

Table 2 summarises the patients' baseline clinical and PD data. Hypertension was the leading cause of ESKD in this study population (51.7%), and the most prevalent comorbidity (96.7%). HIV-associated conditions were the second most common aetiology, noted in 19.8% of patients. Only one patient was on immunosuppressive therapy (cyclophosphamide) at the time of initiating CAPD. A quarter (25.3%) of the study population were HIV-positive. The majority of the participants (56.0%) had a normal BMI at the time of PD catheter insertion, whereas 20.9% were overweight and 7.7% were obese, as classified by the World Health Organization (WHO) [21].

A small number (12.2%) of patients had prior abdominal surgery, with details summarised in Table 2. Most patients (86.7%) received acute HD for less than three months prior to initiation of PD. Prior to PD insertion, 18. 2% of the patients were reluctant to accept CAPD as a recommended KRT modality. Most participants had their PD catheter inserted in theatre by a surgeon (84.6%) and most (86.8%) were placed on the Dianeal® system (Adcock Ingram; Johannesburg, South Africa).

PD technique failure

The median time on CAPD was 17 months (IQR 1–66). Figure 2 shows the technique failure rate at 1-, 2-, 3-, 4-, 5- and > 5 years after the time of insertion. In more than 70% of cases, technique failure occurred within the first two years of being on CAPD.

Main reasons for PD discontinuation

The reasons for continuation of PD are listed in Table 3. Peritonitis was the leading cause of technique failure, comprising 57.1% of cases, with the majority of participants having refractory bacterial peritonitis (67.3%). In 31.9% of patients, death was indicated as the reason for terminating PD.

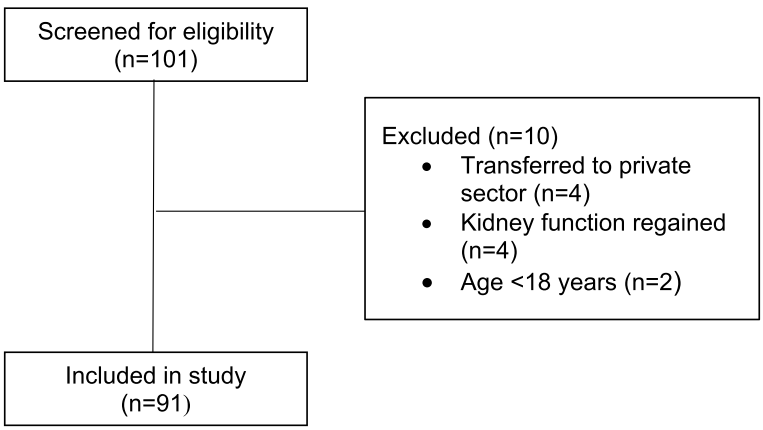

Fig. 1 Flow chart of study participant selection

Table 1 Sociodemographic characteristics of adult patients with ESKD with CAPD technique failure seen at Universitas Academic Hospital South Africa

Variable	n (%)
Sex (n = 91)	
Male	51 (56.0)
Female	40 (44.0)
Age group (n = 91)	
< 30 years	24 (26.4)
31–45 years	44 (48.3)
46–55 years	19 (20.9)
> 56 years	4 (4.4)
Marital status (n = 91)	
Single	51 (57.3)
Married	34 (38.2)
Divorced/separated	2 (2.3)
Widowed	2 (2.3)
Unknown	2 (2.3)
Highest level of education (n = 76)	
Primary school	22 (28.9)
Secondary school	50 (65.8)
Tertiary education	4 (5.3)
Employment status (n = 90)	
Employed	27 (30.0)
Unemployed	63 (70.0)
Type of dwelling (n = 87)	
Brick house	70 (80.5)
Informal house/dwelling	17 (19.5)
Number of persons living in the household with the participant (n = 87)	
1–5	75 (86.2)
6–10	12 (13.8)
Availability of running water (n = 89)	
Yes (in the house)	55 (62.5)
Yes (outside the house)	33 (37.5)
No	1 (1.1)
Availability of electricity (n = 88)	
Yes	87 (98.9)
No	1 (1.1)
Area of residence (n = 91)	
Urban	32 (35.2)
Rural	59 (64.8)

Patient survival

As shown in Table 4, 61 (67.0%) patients had demised during the study period, of which 29 (47.5%) were still undergoing PD at the time of death. The cause of death was not known in majority of the patients (70.5%) as they died at home. A small number (8.2%) of deaths were directly associated with PD-related peritonitis.

Table 2 Baseline clinical data of adult patients with ESKD with CAPD technique failure seen at Universitas Academic Hospital, South Africa

Variable	n (%)
Primary aetiology of CKD (n = 91)	
One primary etiology was documented as the most likely cause of CKD	
Hypertension	47 (51.7)
HIV-associated	18 (19.8)
Diabetes mellitus	11 (12.1)
Immune-mediated	8 (8.8)
Polycystic kidney disease	5 (5.5)
Obstructive uropathy	1 (1.1)
Chronic traditional medication use	1 (1.1)
Comorbidities (n = 91) *Some patients had more than one co-morbidity*	
Hypertension	88 (96.7)
HIV	23 (25.3)
Diabetes mellitus	11 (12.1)
Major depressive disorder	2 (2.2)
Chronic hepatitis B infection	1 (1.1)
Tuberous sclerosis complex	1 (1.1)
None	0 (0.0)
BMI at the time of PD insertion (n = 91)	
< 18.5 kg/m^2 (underweight)	14 (15.4)
18.5–24.9 kg/m^2 (normal weight)	51 (56.0)
25.0–29.9 kg/m^2 (overweight)	19 (20.9)
30.0–34.9 kg/m^2 (obese class 1)	5 (5.5)
35.0–39.9 kg/m^2 (obese class 2)	2 (2.2)
KRT prior CAPD initiation (n = 90)	
Acute HD (< 3 months)	78 (86.7)
Chronic HD (> 3 months)	10 (11.1)
No HD	2 (2.2)
Previous abdominal surgery (n = 90)	
Previous abdominal surgery	11 (12.2)
One previous Caesarian section	3 (3.3)
Two previous Caesarian sections	2 (2.2)
Caesarian section and appendectomy	1 (1.1)
Exploratory laparotomy	2 (2.2)
Appendectomy	2 (2.2)
Kidney transplantation	1 (1.1)
Response at initial CAPD assessment (n = 88)	
Willing to take CAPD	72 (81.8)
Reluctant to take CAPD	16 (18.2)
Method of CAPD catheter insertion (n = 91)	
Surgical	77 (84.6)
Percutaneous	14 (15.4)
Type of system used (n = 91)	
Adcock Ingram (Dianeal®)	79 (86.8)
Fresenius Medical Care (*stay·safe*®)	12 (13.2)

BMI body mass index, *CAPD* continuous ambulatory peritoneal dialysis, *CKD* chronic kidney disease, *HIV* Human immunodeficiency virus, *KRT* kidney replacement therapy, *PD* peritoneal dialysis, *HD* haemodialysis

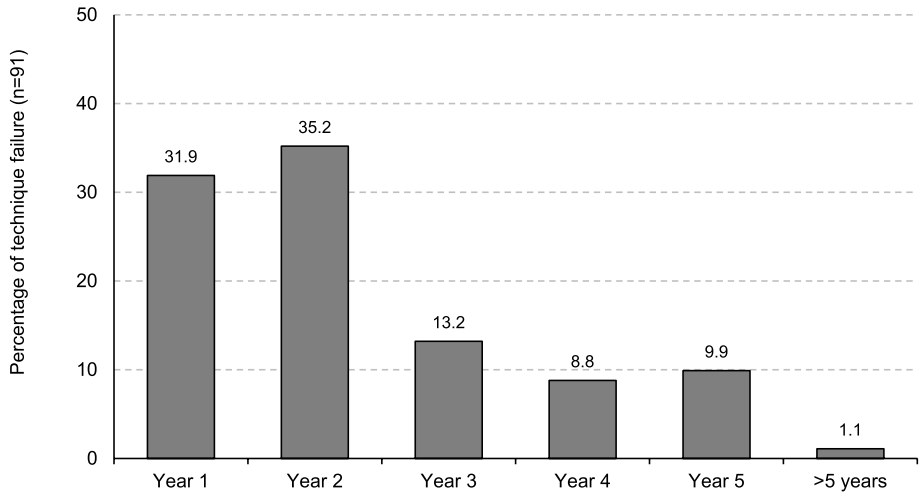

Fig. 2 Technique failure per year after initiation of continuous ambulatory peritoneal dialysis (CAPD)

Table 3 Main reasons for peritoneal dialysis discontinuation, peritoneal membrane characteristics and treatment non-compliance

Variable	n (%)
Main reasons for PD discontinuation (n = 91)	
Peritonitis	52 (57.1)
Fungal peritonitis	10 (11.1)
Pseudomonas peritonitis	4 (4.4)
Refractory bacterial peritonitis	35 (38.5)
Staphylococcus aureus with tunnel infection	2 (2.2)
Mycobacterium tuberculosis peritonitis	1 (1.1)
Mechanical causes	8 (8.8)
PD malfunction	3 (3.3)
Extraperitoneal leak (scrotum)	1 (1.1)
Extraperitoneal leak (thorax)	4 (4.4)
Membrane failure	2 (2.2)
Poor solute clearance	1 (1.1)
Encapsulating peritoneal sclerosis	1 (1.1)
Other	
Death	29 (31.9)
Peritoneal membrane characteristics (n = 27)	
Low transporter	2 (7.4)
Low-average transporter	7 (25.9)
High-average transporter	7 (25.9)
High transporter	11 (40.7)
Number of signed warnings[a] for poor compliance (n = 91)	
0 warning signs	79 (86.8)
1 warning sign	9 (9.9)
2 warning signs	2 (2.2)
4 warning signs	1 (1.1)

PD Peritoneal Dialysis

[a] Non-compliant patients are addressed and have to sign a warning

Table 4 Outcomes and causes of death among patients on chronic ambulatory peritoneal dialysis

Outcome and cause of death	n (%)
Survival (*n* = 91)	
Alive at time of data collection	30 (33.0)
Dead at time of data collection	61 (67.0)
Death with functioning PD catheter	29 (47.5)
Death after modality change	32 (52.5)
Cause of death (n = 61)	
Cardiovascular	1 (1.6)
Cerebrovascular	3 (4.9)
PD-related infection	5 (8.2)
Severe adult respiratory syndrome	3 (4.9)
Sepsis	2 (3.3)
Severe aortic regurgitation with infective endocarditis	1 (1.6)
Defaulted dialysis sessions	1 (1.6)
Pedestrian-vehicle accident	1 (1.6)
Suicide by hanging	1 (1.6)
Cause of death unknown[a]	43 (70.5)

PD peritoneal dialysis

[a] These patients died at home and their hospital records did not contain information of cause of death

Two-thirds (67.2%) of patients died in the first year after PD insertion (median 0 months; range 0–54 months) (Fig. 3). Approximately a fifth of the patients' PD technique survived more than 5 years ($n = 18/91$; 19.8%). The median technique survival time in those patients with technique survival beyond 5 years was 6.3 years (range: 5–7.6 years).

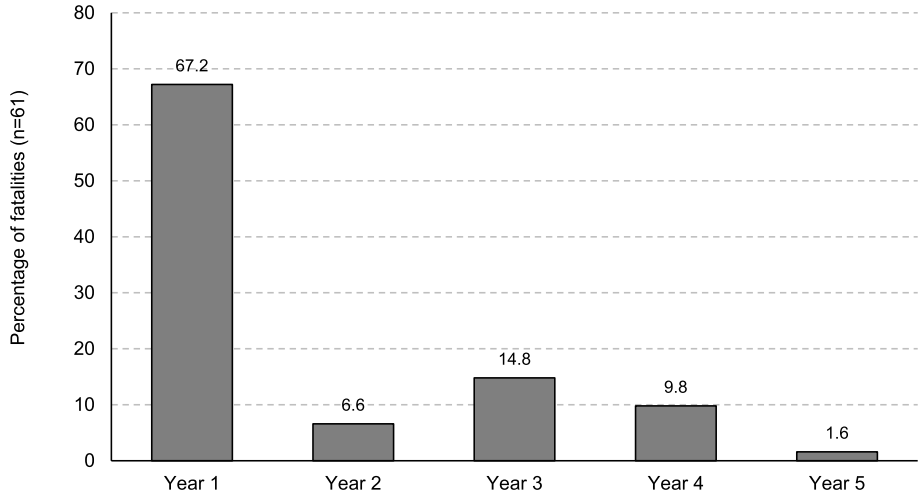

Fig. 3 Mortality rate per year following initiation of continuous ambulatory peritoneal dialysis (CAPD)

Laboratory data

Laboratory data at the time of PD initiation and the latest available data before technique failure are shown in Table 5. The majority of patients (69.2%) had serum albumin levels ranging between 20 g/L and 35 g/L (median 29 g/L) at the time of starting PD. However, at the time of technique failure, 53.8% of the patients' albumin levels were below 20 g/dL, with a median of 19 g/L. Haemoglobin levels were below 10 g/dL in 69.2% of patients at the time of PD catheter insertion (median 9 g/dL). Similar values were measured close to the time of PD discontinuation (68.1%). Most patients had ferritin levels ranging between 200 µg/L and 800 µg/L at the start of PD (50.5%) and close to technique failure (60.4%), with a median ferritin level of 445 µg/L and 516 µg/L at termination and discontinuation, respectively.

Association of clinical characteristics with technique failure

Younger age was associated with an increased likelihood of technique failure. A large proportion ($n=79$; 86.8%) of the participants were on the Dianeal® system, while the remainder were on the *stay·safe*® system (Fresenius Medical Care; Waltham, MA, USA). A statistically significant increased likelihood of technique failure was observed in patients on the Dianeal® system ($p=0.04$, Fischer's exact test). The remaining sociodemographic and clinical variables had no statistically significant association with PD technique failure.

Association of variables with reason for PD catheter removal

Associations between sociodemographic, clinical and laboratory variables and technique failure were

Table 5 Laboratory data of patients on continuous ambulatory peritoneal dialysis at time of initiation and at last visit before technique failure

Variable	Before initiating CAPD	Before technique failure
	n (%)	n (%)
Albumin (n = 91)		
< 20 g/L	9 (9.9)	49 (53.8)
20–35 g/|L	63 (69.2)	40 (44.0)
> 35 g/L	19 (20.9)	2 (2.2)
Haemoglobin (n = 91)		
< 10 g/dL	63 (69.2)	62 (68.1)
10–12 g/dL	23 (25.3)	18 (19.8)
> 12.1 g/dL	5 (5.5)	11 (12.1)
Ferritin (n = 91)		
< 200 µ/mL	25 (27.5)	13 (14.3)
200–800 µ/mL	46 (50.5)	55 (60.4)
> 800 µ/mL	20 (22.0)	23 (25.3)
HIV status (n = 91)	23 (25.3)	–
Positive	23 (25.3)	–
Negative	68 (74.7)	–
CD4 count (n = 23)		
< 150 cells/mm^3	0 (0)	–
150–300 cells/mm^3	3 (13.0)	–
301–600 cells/mm^3	15 (65.2)	–
> 600 cells/mm^3	5 (21.7)	–
HIV viral load (n = 23)		
Lower than detectable limit	21 (91.3)	–
57 copies/mL	1 (4.3)	–
268 copies/mL	1 (4.3)	–

CAPD chronic ambulatory peritoneal dialysis, *HIV* human immunodeficiency virus, *CD* cluster of differentiation

determined by Fisher's exact test. Younger age, higher BMI, and type of CAPD system were associated with technique failure (p-values 0.03, 0.03 and 0.04, respectively). There was a suggestion that a lower BMI at PD insertion and lower albumin levels at the time of removal were associated with peritonitis as a reason for PD catheter removal. Moreover, patients with higher BMI were more likely to discontinue CAPD due to mechanical complications compared to patients who discontinued PD due to infectious complications ($p=0.03$).

Discussion

In keeping with international and local studies, we noted a similar median duration of PD, with most patient failing in the first two years after PD catheter insertion, with similar patient survival [14, 15, 18–20, 22].

Bacterial peritonitis was the leading cause of technique failure, which was similar to several studies conducted both locally and internationally [18–20, 22–26]. The fungal peritonitis rate of 11% in this cohort is concerning and warrants further investigation and consideration of antifungal prophylaxis as recommended by the International Society for Peritoneal Dialysis (ISPD) guidelines [16].

Death was the second most common reason for PD discontinuation. Most deaths occurred at home and the cause was unknown. Chronic kidney disease increases the risk of death and cardiovascular disease, with cardiovascular events being a leading cause of death in this population [27]. Access to healthcare remains a challenge in rural parts of South Africa, especially in the public healthcare sector which caters for approximately 71% of the population [28]. This may explain the high proportion of deaths that occurred at home with undocumented causes. The low proportion of failure due to mechanical causes of technique failure has been shown in another study in South Africa [19].

In this study, patients' age and the type of PD system used were the only two parameters that showed a significant in influencing the likelihood of PD technique failure, regardless of the unequal distribution of the PD systems among patients. Younger patients tended to have an increased likelihood of technique failure than older patients. This may be due to better mental adjustment and acceptance of the chronic illness diagnosis by older patients. However, it is important to note that the median age of this cohort was 40 years, which represented a younger population group resulting from selection bias due to the provincial rationing policy not offering KRT to diabetics above the age of 50 and all adults above the age of 60 years [29]. This result was contrary to other South African data where a significant association between older age and technique failure was noted [19]. Small numbers make it challenging to generalise findings.

The type of PD system appeared to have influenced the risk of technique failure. By design, the *stay·safe*® system is a closed system with minimum contact points that, in theory, should minimise contamination risk and infection complications. This might explain the lower likelihood of technique failure in this group. It is important to note that the larger proportion of the study population was on the Dianeal® system because the *stay·safe*® system was only introduced in 2018 in this center. During the study period, the patients on the *stay·safe*® system were few and had a shorter dialysis vintage with a technique failure rate of 42%. This finding was different from an Australian study which showed that patients on the *stay·safe*® system were more likely to have PD technique failure than those put on Dianeal® [30]. These observational findings need further investigation as our study was not powered to compare the two systems.

There was a high unemployment rate in this cohort, and this reflects a national challenge that is compounded by the increased risk of job loss due to ill health. However, similar to another South African studies, socio-economic or sociodemographic factors did not influence technique survival [18, 19]. These findings suggest that the role of socio-economic background in disqualifying patients to access PD in settings where KRT is rationed, might not be justified in the South African context. Interestingly, non-compliance was not a major factor contributing to technique failure, supporting local data [19]. However, a USA-based study showed poor compliance to be associated with an increased risk of technique failure [31].

The high proportion of patients was noted to have received haemodialysis before PD catheter insertion reflected late presentation with indications of acute KRT, although it did not influence PD technique failure, irrespective of the duration of haemodialysis before initiating CAPD. Koc et al. found that patients who received HD prior to PD had a higher mortality rate [32], which could possibly explain the high mortality rate during the first year after initiating CAPD in our study. This observation warrants further investigation.

Comorbidities, including HIV and aetiology of CKD was not associated with reasons for PD discontinuation in this study. This contrasts with a South African study that showed that patients with diabetes mellitus had a poor survival rate [33]. A quarter of the study participants were HIV-positive, although HIV seropositivity had no influence on PD discontinuation or increased risk for death, which was similar to the findings reported by Sunnyraj et al. [33]. Similarly, body mass index (BMI) as classified by the WHO [21] did not have any impact on the reason for PD discontinuation. However, in our

centre, patients with a BMI exceeding 35 kg/m [2] do not qualify for KRT [27]. In other studies, BMI did influence technique survival [34, 35].

At the time of data collection, 61 (67.0%) patients had demised, of which 29 (47.5%) died while still on PD. PD-related peritonitis was directly linked to mortality in 8.2% of cases, significantly less than data from Taiwan, where peritonitis was responsible for 41% of deaths [36], whereas no mortality was related to PD peritonitis in a Dutch study [37].

Strengths and limitations

There were limitations in this study, including the small sample size, retrospective nature of data collection and missing data. Because of the retrospective nature of the study, incomplete records could not be avoided. However, a strength of this study is that its observations represent findings of all PD technique failure for the whole Free State Province public health sector over a reasonable time of five years. The authors acknowledge that this is a highly selected population due to pre-treatment vetting and assessment that poses patient to have a better outcome when treated with KRT.

Conclusion

Peritoneal dialysis-associated peritonitis is the primary cause of technique failure, followed by sudden, unexpected death occurring at home. Preventive measures need to be adhered to in order to avoid high rates of peritonitis.

Abbreviations

BMI	Body mass index
CAPD	Continuous ambulatory peritoneal dialysis
CKD	Chronic kidney disease
EPS	Encapsulating peritoneal sclerosis
ESKD	End-stage kidney disease
Hb	Haemoglobin
HD	Haemodialysis
HIV	Human immunodeficiency virus
IQR	Interquartile range
ISPD	International Society for Peritoneal Dialysis
KRT	Kidney replacement therapy
NHLS	National Health Laboratory Service
PD	Peritoneal dialysis
SARR	South African Renal Registry
UAH	Universitas Academic Hospital
WHO	World Health Organization

Acknowledgements

Dr. Daleen Struwig, medical writer/editor, Faculty of Health Sciences, UFS, for technical and editorial preparation of the article.

Authors' contributions

TBS: principal investigator; conceptualisation and study design; ethics approval application; data collection; drafting of the manuscript. CB: co-supervisor; research methodology; design of the data collection sheet; editing of the article. NvZ: co-supervisor; assistance with protocol preparation; editing of the article. CvR: statistical analysis of data; reviewing the article. FBB: study supervisor; editing of the article.

Funding

The study was self-funded.

Data availability

Data are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Health Sciences Research Ethics Committee (HSREC) of the University of the Free State (UFS-HSD2021/1450/2501) and the Free State Province Department of Health. Each patient file was allocated a study number used in data collection to anonymise patient data. Due to the retrospective nature of the study, informed consent was not required.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 19 April 2024 Accepted: 23 December 2024
Published online: 02 January 2025

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