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ORIGINAL ARTICLE

Peritoneal dialysis technique survival at Tygerberg Hospital in Cape Town, South Africa

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ABSTRACT

Background: The use of peritoneal dialysis (PD) as a treatment modality for patients with end-stage renal disease (ESRD) has been declining in many countries over the past few years. One of the reasons is technique failure, which occurs more frequently than is the case with chronic haemodialysis. Identifying and addressing the causes of technique failure is important in order to maintain more patients on PD, especially in settings where there are limited resources for chronic haemodialysis and a "PD first" approach is followed.
Methods: In this retrospective study at Tygerberg Hospital in Cape Town, South Africa, we investigated 170 patients who were started on chronic ambulatory PD between January 2008 and July 2014, and determined rates of technique and patient survival. Demographic, clinical and laboratory data were assessed to identify risk factors for these outcomes.
Results: The median age of the patients was 36 years and the most common cause of ESRD was glomerulonephritis. Only one patient had diabetes mellitus. Technique survival at 1, 3 and 5 years was 80%, 54% and 39%, respectively, while patient survival was 90%, 82% and 63%. Patients started on PD during the second half of the study period had improved rates of technique survival. Peritonitis was the most common cause of technique failure. Increasing age and Black ethnicity were associated with increased likelihood of technique failure. Other clinical and social factors were not significantly associated with the occurrence of technique failure.
Conclusions: In our patients on PD, peritonitis, increased age and Black ethnicity were important factors associated with the development of technique failure. Concerted efforts are required to reduce peritonitis rates at our centre as this is the leading cause of technique failure.

Keywords: Peritoneal dialysis; technique failure; peritonitis; ESRD; South Africa.

INTRODUCTION

Patients with end-stage renal disease (ESRD) who are offered renal replacement therapy (RRT) may be treated with one of three RRT modalities, namely, kidney transplantation, haemodialysis (HD) or peritoneal dialysis (PD). For patients requiring chronic dialysis, PD allows treatment to be performed in the comfort of the home or workplace, better preserves residual renal function [1,2] and, in the first two years of dialysis, may result in better survival rates compared to HD for some groups of patients [3-5].

The global use of PD as a dialysis modality for ESRD has been estimated at 11% [6]. While the absolute numbers of PD patients have been increasing over the past few years, the proportion of all dialysis patients treated with this modality has, on average, been relatively stable in developing countries and significantly declining in developed countries [6].

Among the many reasons for the low utilisation of PD is "technique failure", which occurs more frequently with PD than is the case with HD. Technique failure has

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been variously defined as a switch from peritoneal dialysis to haemodialysis for a continuous period of more than thirty [7] or sixty days [8,9], or a permanent switch to haemodialysis [10-12]. It has also been defined as the cessation of PD due to a PD-related complication. This would include patients dying from PD-related causes (e.g., peritonitis) [13]. The lack of a generally accepted definition of technique failure has complicated the interpretation of reported outcomes. One aim of the on-going Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS) [14] is the establishment of consensus definitions for technique failure and other PD-related data, including the standardisation of the causes of technique failure. PDOPPS recommends examining and reporting cause-specific PD failure, in addition to composite endpoints such as those that combine death while on PD with technique failure.

Technique survival rates differ among countries, regions and centres, but results have generally been improving since the inception of PD over 40 years ago. For example, a large Korean cohort [15] reported a reduction in technique failure among patients initiating PD in 1993–2005 relative to 1981–1992, with an adjusted hazard ratio of 0.65 (95% CI 0.53–0.79). Similar data were reported from the US Renal Data System [16] where lower rates of technique failure occurred in the period 2002–2004 relative to 1996–1998 [hazard ratio 0.62 (0.59–0.64)]. The improvements in technique survival likely reflect advances in PD techniques as well as experience gained in the use of PD. The "flush before fill" technique, in particular, has improved technique survival by significantly reducing peritonitis rates [17].

The main causes of technique failure are similar in most centres, with peritonitis being the most common. Other reasons why patients may be transferred to HD include ultrafiltration failure, PD catheter-related problems (tunnel infection, leaks, herniation and catheter migration) and psycho-social factors such as burnout [12,18].

It is good clinical practice to evaluate any PD programme regularly and to compare outcomes with international standards and those reported at other centres within the same country. In our resource-limited setting, maximising the use of PD is particularly important as haemodialysis slots are limited and PD may be the only available form of renal replacement therapy. We recently investigated the quality of life of our patients on chronic dialysis and found that those on PD experienced a heavier symptom burden and more treatment-related limitations than those on HD [19]. The aim of the present study was to determine our PD technique survival rates at Tygerberg Hospital and to identify the causes and risk factors associated with this important outcome.

METHODS

We conducted a retrospective study at the Division of Nephrology, Tygerberg Hospital (Cape Town, South Africa). Tygerberg is a large public-sector teaching hospital which provides RRT to patients in the region, although the numbers are limited by resource constraints. There are approximately 70 patients on HD and 65 on PD. Only transplantable patients are accommodated on our RRT programme and PD is usually the first treatment modality.

All adult patients with ESRD starting PD at our centre between January 2008 and July 2014 were considered for inclusion in the study. The end date for observation was 31 October 2014, allowing for a minimum follow-up period of 3 months. Demographic, clinical and laboratory data were collected to assess technique survival rates and the risk factors for technique failure. This included information on access to running water, diabetes status, residual renal function and the occurrence of peritonitis. Laboratory tests done within the week prior to initiating dialysis were recorded. These tests were performed at the National Health Laboratory Service at Tygerberg Hospital on a Roche/Hitachi Cobas® c 501 system.

Definitions

Technique failure was defined as a switch to haemodialysis that was intended to be permanent, withdrawal from RRT due to inability to perform PD successfully, or any death directly related to an acute complication of PD (such as peritonitis with septicaemia). This definition is similar to that used in other studies [20]. We censored patients at recovery of renal function, kidney transplantation, transfer to another centre while on PD, death other than a PD-related death as described above, and at the end of the study while still on PD.

Distinct from technique failure was the probability of patients to "stay on PD". Failure events were a permanent switch to haemodialysis or death from any cause, with censoring events being kidney transplantation, recovery of renal function, transfer to another centre and remaining on PD at the end of the study. This analysis has been used in the paper on the NECOSAD study [12] and is useful when the aim is expanding the size of a PD programme and one needs to examine all the factors that lead to patients no longer continuing PD.

For patient survival, the failure events were death from any cause or withdrawal from RRT; patients were censored at kidney transplantation, recovery of renal function, permanent switch to haemodialysis, transfer to another centre and remaining on PD at the end of the study.

The initial RRT modality was the intended first dialysis modality and was the one recorded on day 91 of RRT. Patients who presented late and needed urgent haemodialysis but were then established on PD within 3 months had PD recorded as their initial modality.

Late presenters were patients who required RRT within 90 days of first being seen by a nephrologist; urgent start refers to patients who had ESRD on first presentation to our hospital and required dialysis during that admission.

Recovery of renal function was defined as the patient being independent of any form of RRT for more than three months.

Data management

Information was extracted from patient files and entered directly into REDCap (Research Electronic Data Capture) [21], a secure web application designed to support data capture for research studies. REDCap provides user-friendly, web-based case report forms, real-time data entry validation, audit trails and a data export mechanism in formats used by common statistical packages. Only authorised personnel were allowed access to the raw data, which was password-protected. Data were de-identified for further processing, including statistical analysis.

Statistical analysis

Stata (STATACORP, version 13, College Station, Texas, USA) was used for the statistical analysis. Patient and technique survival was assessed using proportions and survival analysis. The association with risk factors was assessed using chi-squared tests (and Fisher's exact test for small numbers). Logistic regression was also used to assess potential associations and multiple regression analysis performed on significant factors found at the bivariate level. A P-value of <0.05 represented statistical significance in hypothesis testing and 95% confidence intervals were also used. Kaplan-Meier curves were used to express technique survival and the log-rank test for testing the equality of survival functions.

Ethical aspects

A waiver of individual informed consent for this retrospective study was granted by the University of Stellenbosch Health Research Ethics Committee (reference #X14/10/021).

RESULTS

During the study period, 172 patients were initiated on chronic ambulatory PD. Two of these patients were excluded because of missing records so that 170 were included in the study. The median follow-up period was 12.6 months (IQR 7.4–26.3 months, maximum 77.8 months). The outcomes of the patients are summarised in the study flow chart (Figure 1).

Approximately half of the participants were females (51.8%). The median age was 36 years (IQR 27–43 years). Most of the participants were of mixed ancestry (68.8%), had at least secondary school education, and lived in brick houses with access to running water (Table 1).

Glomerulonephritis was the most common cause of ESRD (69.4%). Most patients had been followed up for more than 3 months prior to initiating RRT and PD was the initial modality in 96%, with 74% of the Tenckhoff catheters inserted at the bedside by the nephrology team. Most of the patients (72%) used only one catheter during their time on peritoneal dialysis (Table 2).

Of the 170 patients enrolled, technique failure occurred in 53 (31.2%) during the follow-up period. Technique survival at 1, 2, 3 and 5 years was 80%, 61%, 54% and 39%, respectively, whereas patient survival was 90%, 86%, 82% and 63%, and "stay on PD" was 73%, 54%, 47% and 29% (Figure 2A–2C). The median technique survival was 39.9 months.

Peritonitis was the main cause of technique failure, accounting for 72% of the cases. Patients who experienced technique failure were older (42 vs. 33 years, P = 0.005) and, as expected, were more likely to have had episodes of peritonitis (Table 3). Having more than one PD catheter was not associated with technique failure. The technique failure rate was higher in the 89 patients started on PD in the first half of the study period as compared to the 81

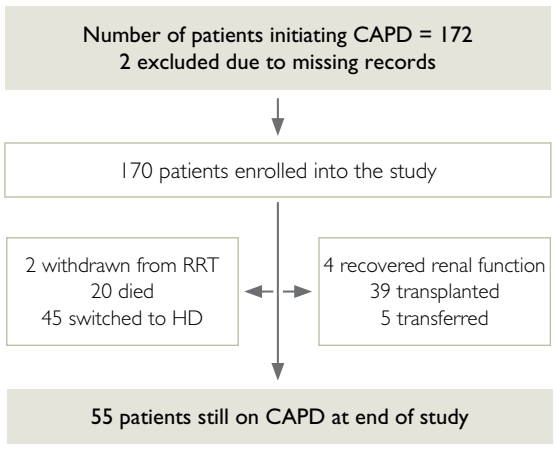

Figure 1. Study flow chart for the study period.

Table 1. Socio-demographic characteristics of study participants (n = 170).

	Frequency	%
Sex		
Female	88	51.8
Male	82	48.2
Ethnicity		
Mixed ancestry	117	68.8
Black	41	24.1
White	8	4.7
Indian	1	0.6
Unknown	3	1.8
Educational level		
≥ Secondary	87	51.2
≤ Primary	41	24.1
Unknown	42	24.7
Type of dwelling		
Brick house	113	66.5
Informal backyard dwelling*	11	6.5
Other informal dwelling**	8	4.7
Unknown	38	22.3
Running water		
Yes	113	66.5
No	19	11.2
Unknown	38	22.3

* An informal dwelling (or "shack") is defined by Statistics South Africa [33] as a makeshift structure not approved by a local authority and not intended as a permanent dwelling. These dwellings are typically built with materials such as wood, corrugated iron, cardboard and plastic. When erected in the backyard of a property, the occupants usually rely on the bathroom facilities and water supply of the main house.

** An informal dwelling in an informal/squatter settlement on land which has not been surveyed or proclaimed as residential, or on a farm.

Table 2. Clinical characteristics of study participants (n = 170).

	Frequency	%
Primary renal disease		
Glomerulonephritis	118	69.4
ESRD cause unknown	22	12.9
Malignant hypertension	14	8.2
Polycystic kidney disease	11	6.5
Other	5	3.0
Late presenter		
No	58	34.1
Yes	23	13.5
Unknown	89	52.4
Urgent start		
No	62	36.5
Yes	27	15.9
Unknown	81	47.6
Initial RRT modality		
Peritoneal dialysis	163	95.9
Haemodialysis	4	2.3
Kidney transplant	3	1.8
Catheter insertion method		
Percutaneous bedside	125	74.0
Surgical	31	18.0
Unknown	14	8.0
Number of catheters		
1	122	71.8
≥2	48	28.2
Peritonitis		
No	64	37.6
Yes	63	37.1
Unknown	43	25.3

beginning in the second half (43% vs. 19%, P = 0.001). Multivariate regression analysis of baseline factors revealed that patients starting PD in the earlier years of the study, older patients and Black patients had an increased risk of technique failure at two years (Table 4 and Figure 3).

Twenty patients died during follow-up, with cardiovascular disease (8 cases) and infection (6 cases) being the main causes of death. Six other patients died at home and their causes of death were not ascertained. There were no deaths among the 45 patients with technique failure during the first 90 days following their transfer to haemodialysis.

DISCUSSION

Our technique survival rates were lower than those reported by Isla et al. from the Limpopo province of South Africa [22] and from China and Canada [11,23,24], but are similar to those reported from the USA [16] and Mexico [25] (Table 6). Most of these studies, including ours, reported survival in patients starting PD (from day 0). However, the Mexican study [25] included only patients who had been established on PD for one month and one of the studies from China [24] included only patients who had been on PD for three months. We considered it

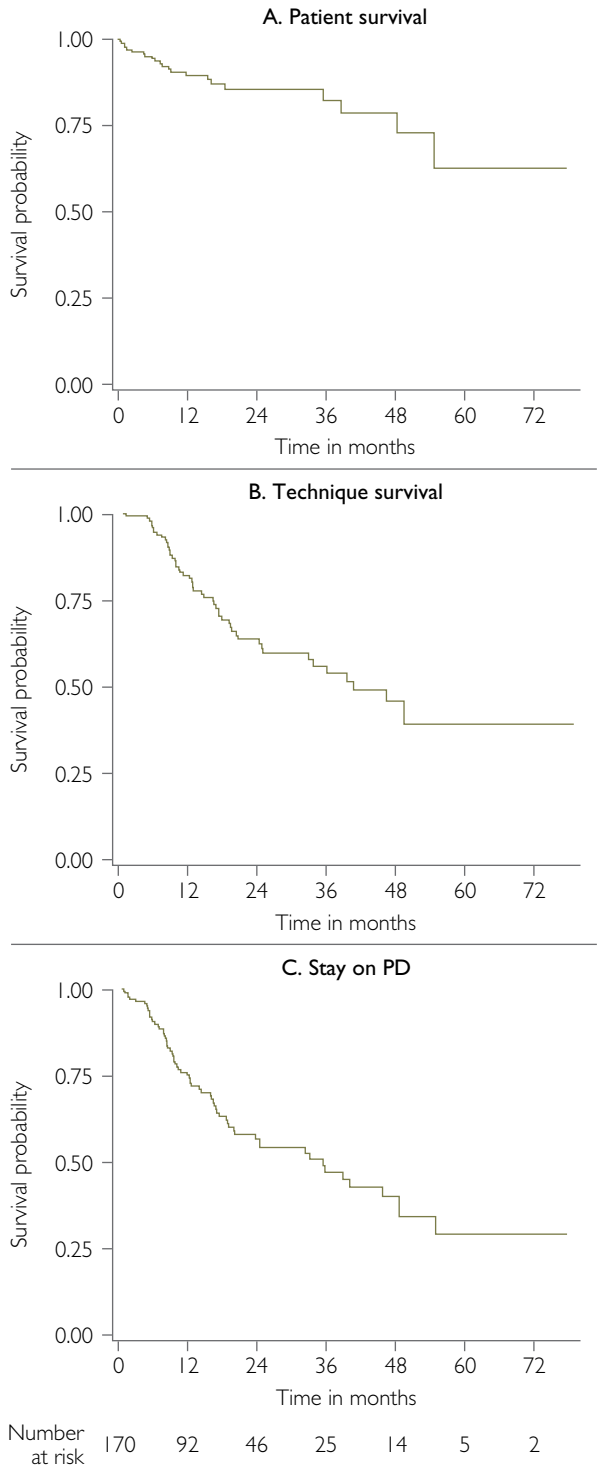

Figure 2A-2C. Patient survival, technique survival and "Stay on PD" for study participants.
Failure events for patient survival included death and cessation of all RRT, and patients were censored at kidney transplantation, recovery of renal function, permanent switch to HD, transfer to another centre, and at the end of the study. Failure events for technique survival included a switch to HD, withdrawal from RRT due to inability to perform PD successfully, and death directly related to an acute complication of PD. Censoring events included other deaths, recovery of renal function, transplantation, transfer to another centre, and reaching the end of the study on PD. For "stay on PD" the failure events were a switch to HD and death from any cause, with censoring events being transplantation, recovery of renal function, transfer to another centre, and reaching the end of the study.

important to include the first few months on PD as positive interventions made during this period may improve overall outcomes.

Technique failure was usually defined as a switch to HD, with transplantation and death as censoring events. The NECOSAD study [13] specified a permanent switch to HD as defining technique failure and the US study [16] defined it by a switch for longer than two months. Our study considered deaths directly related to acute complications of PD as technique failure whereas the study by Cueto-Manzano et al. [25] considered all deaths as technique failure.

Peritonitis was the most common cause of technique failure, in keeping with many other studies [25-28]. This may explain our lower technique survival rate as compared to the Chinese and Canadian studies where the rates of peritonitis were low. Our patients were mostly switched to HD following recurrent episodes of peritonitis or upon finding a "frozen abdomen" with multiple adhesions on attempting to reinsert the PD catheter. Two patients developed encapsulating peritoneal sclerosis and were switched to HD.

Mechanical complications were rarely a cause of technique failure. Most of our patients had their first Tenckhoff catheter inserted percutaneously at the bedside. Subsequent catheters were inserted by the surgical team in theatre. This was also done for first catheters in patients with previous abdominal surgery. There was no difference in technique survival based on the method of catheter insertion, and we recommend continuing bedside insertion for all suitable patients.

Although our population of patients on RRT is relatively young, we still observed an association of increasing age with technique failure as has been reported by others [29]. Black ethnicity was another risk factor for technique failure; this has also been reported previously [7,30]. For example, in US studies the worst outcomes were seen in African-Americans [7,30]. Poor compliance was more common in this population group [31] and was suggested as a reason for higher rates of technique failure [7,30]. In our study non-compliance did not emerge as a major issue and it was unclear why our Black patients did so poorly. We speculate that the home environment may have contributed, based on our impression that Black patients tended to have poor family support and often lacked privacy for exchanging their bags at home. There usually was no separate room available for the purpose and this increases the risk of contamination

Table 3. Comparison of potential risk factors in patients who experienced technique failure with those who did not.

	Technique failure (n = 53)	No technique failure (n = 117)	P-value	HR	95% CI
Later vs. earlier PD period*					
Early	38 (71.7)	51 (43.6)	0.001	R	
Later	15 (28.3)	66 (56.4)		0.30	0.15-0.61
Age, years (IQR)	42 (31–47)	33 (25–42)	0.005	1.05	1.01– 1.08
Haemoglobin, g/dL (IQR)	7.5 (6.1–8.2)	7.4 (6.5–8.6)	0.710	0.95	0.79– 1.15
Albumin, g/L (SD)	34.2 (6.0)	34.0(6.2)	0.598	1.01	0.95– 1.06
Follow-up, months (IQR)	11 (7–18)	13 (6–28)	0.744		
Male	29 (54.7)	53 (45.3)	0.255		
Ethnicity					
Mixed ancestry, White, Indian	35 (68.6)	91 (78.4)	0.174	R	
Black	16 (31.4)	25 (21.6)		1.66	0.79– 3.48
Educational level					
≥ Secondary	30 (75.0)	57 (64.8)	0.250	R	
≤ Primary	10 (25.0)	31 (35.2)		1.63	0.70– 3.77
Dwelling					
Brick house	35 (85.4)	78 (85.7)	0.923	R	
Wendy house	3 (7.3)	8 (8.8)		0.84	0.21– 3.34
Shack	3 (7.3)	5 (5.5)		1.33	0.30– 5.91
Running water inside home					
Yes	35 (85.4)	78 (85.7)	0.958	R	
No	6 (14.6)	13 (14.3)		0.97	0.34–2.78
Initial RRT modality					
Peritoneal dialysis	51 (96.2)	112 (95.7)	0.461		
Haemodialysis	2 (3.8)	2 (1.7)			
Kidney transplant	0 (0.0)	3 (2.6)			
Method of catheter insertion					
Bedside	40 (85.1)	85 (78.0)	0.306	R	
Surgical	7 (14.9)	24 (22.0)		0.62	0.25–1.56
Late presentation					
No	14 (26.4)	44 (37.6)	0.130		
Yes	5 (9.4)	18 (15.4)			
Unknown	34 (64.2)	55 (47.0)			
Urgent start					
No	16 (30.2)	46 (39.3)	0.425		
Yes	8 (15.1)	19 (16.2)			
Unknown	29 (54.7)	52 (44.4)			
Number of catheters					
1	34 (64.1)	88 (75.2)	0.138	R	
≥2	19 (35.9)	29 (24.8)		1.70	0.84– 3.42
Peritonitis					
No	2 (4.9)	62 (72.1)	<0.001	R	
Yes	39 (95.1)	24 (29.5)		50.38	11.27– 225.11

HR, hazard ratio; CI, confidence interval; R, reference group. * Starting PD in the second half of the study period (16/04/2011–31/07/2014) vs. the first half (01/01/2008–15/04/2011).

Table 4. Multivariate analysis of baseline factors associated with technique failure at two years after commencement of PD.

	HR	95% CI	P-value
Period starting PD*	0.38	0.17–0.84	0.017
Increasing age	1.07	1.03–1.12	<0.001
Black ethnicity	3.10	1.33–7.23	0.009

* Starting PD in the second half of the study period (16/04/2011–31/07/2014) vs. the first half (01/01/2008–15/04/2011).

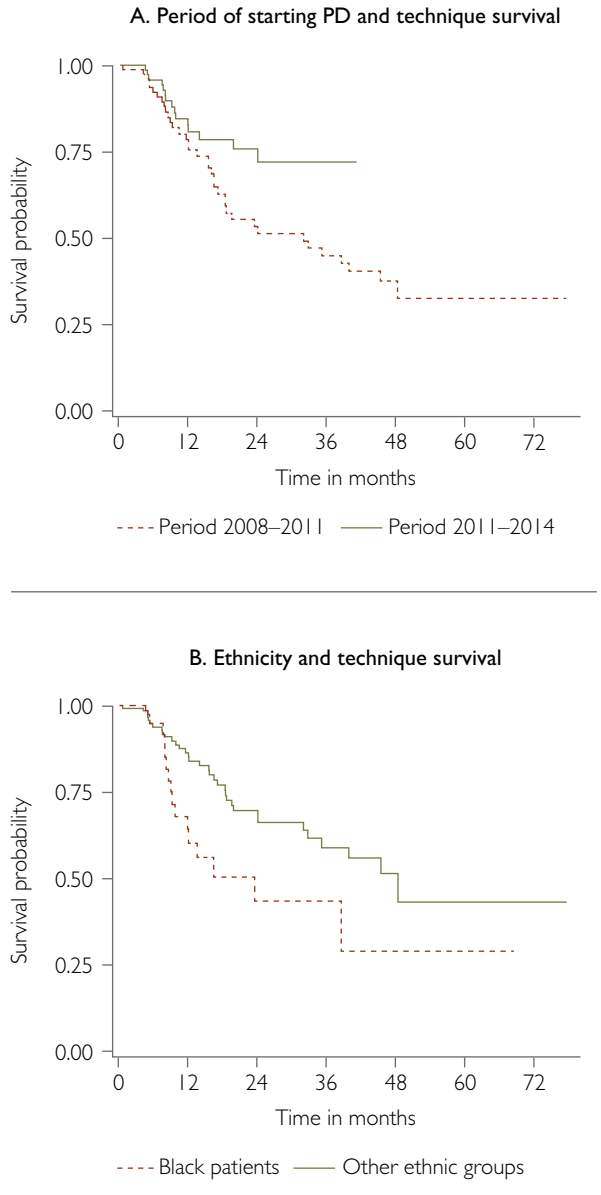

Figure 3. Association of period of starting PD and ethnicity with technique survival.
Patients who began PD in the first half of the study period had reduced technique survival compared to those starting in later years (P = 0.028, log-rank test). Black ethnicity was also associated with reduced technique survival (P = 0.020, log-rank test).

Table 5. Causes of peritoneal dialysis technique failure (n = 53).

	Frequency	%
Peritonitis	38	71.6
Death due to PD-related infection	6	11.3
Tunnel infection	2	3.8
Withdrawn due to non-compliance	2	3.8
Encapsulating peritoneal sclerosis	2	3.8
Calciphylaxis	1	1.9
Abdominal hernia	1	1.9
Recurrent outflow failure	1	1.9

during the procedure and of patients deferring their exchanges. Interestingly, a study conducted in Limpopo that predominantly included Black South Africans reported good technique survival rates despite the poor socio-economic circumstances of their patients [22].

In our study, too, educational status, housing and access to running water did not seem to influence technique survival. This is similar to the findings of Isla et al. [22] and Katz et al. [27] in other studies performed in South Africa. In Brazil the large BRAZPD cohort study also reported that economic status was not associated with either patient or technique survival [32].

Other factors, such as sex, and haemoglobin and albumin levels, that have been reported to be associated with technique failure were not independently associated with this outcome in our patients. As we had only one diabetic patient, we could not examine the association of diabetes with technique failure.

The technique survival rates at our centre appear to be increasing. There was a clear improvement in technique survival when comparing cohorts of patients who started in the early years of the study and those beginning PD more recently.

Our study had several limitations. We have reported data from a single centre, which necessarily limited the sample size, and the retrospective study design meant that we had to contend with missing data. We were therefore not able to adequately examine the impact of late presentation or of an urgent start to RRT on technique survival. Many of the patients had missing data on these potential risk factors and this was often the case for the patients who started PD early in the study period, when technique failure rates were highest.

Table 6. Summary of selected studies reporting technique survival (%) in peritoneal dialysis. Most studies included all patients starting PD (from day 0) and defined technique failure as a switch to HD, with transplantation and death as censoring events. Two studies ([12] and the present investigation) specified a permanent switch to HD and one [34] a switch for longer than two months. The present study included deaths directly related to acute complications of PD (such as peritonitis with septicaemia) as technique failure. The study by Cueto-Manzano [25] included only patients who had been on PD for at least one month and considered all deaths as technique failure. The study by Zhang [24] included only patients who had been on PD for at least three months.

Study	Country	Cohort	N	Age	*DM (%)	1 yr	2 yr	3 yr	5 yr
Present study, 2017	South Africa	2008–2014	170	36.0 ± 11.0	0.6	79.5	61.0	53.8	39.1
Isla, 2014 [22]	South Africa	2007–2012	152	36.8 ± 11.4	9.9	83.3	71.7	—	62.1
Zhang, 2014 [24]	China	2004–2011	712	52.0 ± 19.3	15.7	95.1	—	87.7	79.6
Fang, 2008 [11]	Canada	2000–2004	256	58.8 ± 17.8	27.7	92.0	88.0	85.0	73.0
Cueto-Manzano, 2001 [25]	Mexico	1985–1997	627	45.2 ± 18.2	36.8	82.0	—	61.0	40.0
Kolesnyk, 2010 [12]	Netherlands	1997–2007	709	52.6 ± 11.1**	6.4**	87.0	76.0	66.0	–
Weinhandl, 2016 [34]	USA	2006–2010	4201	54.6 ± 15.0	49.2	72.9	63.0	55.9	

* DM, percentage of diabetic patients. The present study included only one diabetic patient. **Estimated from data on patients in the first 3 months of PD from medians and ranges according to the method of Wan et al. [35].

CONCLUSIONS

In our cohort, peritonitis was the most important direct cause of technique failure whereas increasing age and Black ethnicity were independently associated risk factors. Further studies are required to investigate the reasons for the increased rates of technique failure in our Black patients and concerted efforts are needed to reduce the peritonitis rates in our PD programme.

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Conflict of interest

None to declare.

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