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One-Year Technique Survival of Peritoneal Dialysis in a Semi-Urban Center in Northern Senegal: A Single-Center Retrospective Cohort Study (2021–2024)

(Survie technique de la dialyse péritonéale à un an dans un centre semi-urbain du nord du Sénégal : étude de cohorte rétrospective monocentrique (2021-2024))

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Summary

Introduction
Peritoneal dialysis (PD) represents a viable alternative to hemodialysis in resource-limited countries, but the data on its technical survival in sub-Saharan Africa remain scarce. This study aims to evaluate one-year technique survival in PD at a semi-urban center in northern Senegal.
Methods
A single-center retrospective cohort study, including all patients with stage 5D chronic kidney disease treated with PD between August 2021 and December 2024. Demographic, clinical, and event data (peritonitis, transfers) were collected via a standardized form. Technical survival, defined as continued peritoneal dialysis without a definitive transfer to hemodialysis, was estimated at 12 months using the Kaplan–Meier method (95% CI).
Results
Thirty-three patients were included (mean age: 46.8 ± 18.6 years; 57.6% women; rural origin: 60.6%). Hypertension was the leading cause of renal failure (33.3%), followed by glomerulonephritis (21.2%). The mean Charlson score was 3.5 ± 1.0. The predominant modality was CAPD (63.6%). The peritonitis rate was 0.59 episodes per patient-year (23 episodes over 38.8 patient-years). Seven patients (21.2%) experienced technical failure. One-year technical survival was estimated at 75.3% (95% CI: 60.7–93.5) using the Kaplan–Meier method. The median technical survival was not reached (median follow-up duration: 10.3 months). Technical failure was due to catheter malfunction (57.1%) or therapeutic failure of peritonitis (42.9%).
Conclusion
In this semi-urban setting in Senegal, one-year technical survival with PD is very encouraging, despite an early failure rate linked to mechanical and infectious complications as well as logistical constraints. These results support the strengthening of PD programs in sub-Saharan Africa, with a focus on optimizing the prevention of complications.

Keywords: Sub-Saharan Africa; peritoneal dialysis; chronic kidney disease; technical survival; Senegal.

Résumé

Introduction
La dialyse péritonéale (DP) représente une alternative viable à l'hémodialyse dans les pays à faibles ressources, mais les données sur sa survie technique en Afrique subsaharienne restent rares. Cette étude vise à évaluer la survie technique à un an en DP dans un centre semi-urbain au Nord du Sénégal.
Méthodes
Étude de cohorte rétrospective monocentrique incluant tous les patients atteints de maladie rénale chronique stade 5D traités par DP entre août 2021 et décembre 2024. Les données démographiques, cliniques et événements (péritonites, transferts) ont été recueillis via un formulaire standardisé. La survie technique définie par le maintien en dialyse péritonéale sans transfert définitif en hémodialyse, a été estimée à 12 mois par Kaplan-Meier (IC95%).
Résultats
Trente-trois patients ont été inclus (âge moyen : 46,8 ± 18,6 ans ; 57,6 % de femmes ; origine rurale : 60,6 %). L'hypertension artérielle était la cause principale d'insuffisance rénale (33,3 %), suivie des glomérulonéphrites (21,2 %). Le score de Charlson moyen était de 3,5 ± 1,0. La modalité dominante était la DPCA (63,6 %). Le taux de péritonite était de 0,59 épisode par année-patient (23 épisodes sur 38,8 années-patient). Sept patients (21,2 %) ont présenté un échec technique. La survie technique à un an était estimée à 75,3 % (IC 95 % : 60,7–93,5) selon la méthode de Kaplan-Meier. La médiane de survie technique n'a pas été atteinte (durée médiane de suivi : 10,3 mois). L'échec technique faisait suite à un dysfonctionnement du cathéter (57,1 %) ou à un échec thérapeutique d'une péritonite (42,9 %).
Conclusion
Dans ce contexte semi-urbain sénégalais, la survie technique en DP à un an est très encourageante, malgré un taux d'échec précoce lié aux complications mécaniques et infectieuses ainsi qu'aux contraintes logistiques. Ces résultats plaident pour un renforcement des programmes de DP en Afrique subsaharienne, avec une optimisation de la prévention des complications.

Mots-clés : Afrique subsaharienne ; Dialyse péritonéale ; Maladie rénale chronique ; Survie technique ; Sénégal

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Introduction

Chronic kidney disease is a major public health issue, affecting 10% of the global population, 78% of whom reside in resource-limited countries where access to renal replacement therapy remains limited [1]. A marked disparity is observed in the use of these treatments, with a prevalence of more than 632 patients treated per million inhabitants in high-income countries, compared to fewer than 108 patients treated per million inhabitants in very low-income countries [2].

In Senegal, official data from the Ministry of Health and Public Hygiene for the year 2024 indicate a prevalence of 55.72 patients treated per million inhabitants and that only 28.25% (1,003 patients out of 3,551) of chronic dialysis needs are met. Among these patients, 95.73% receive hemodialysis. The majority of patients not covered are on waiting lists, while a minority with financial resources or health insurance access care in the private sector. This situation reflects a limited and undiversified treatment offering, despite the burden of this disease in the country.

In this context, peritoneal dialysis (PD) represents a relevant therapeutic alternative, particularly in remote or semi-urban areas, due to its ability to be performed at home, its organizational flexibility, and its more modest infrastructure requirements compared to hemodialysis. Several comparative studies based on cost-utility analysis have shown that PD can offer highly satisfactory clinical outcomes [3–5].

Technical survival, defined as the patient remaining on PD without a permanent transfer to hemodialysis, is a key indicator of this modality's performance. It frequently exceeds 90% at one year in high-income countries, with variations attributable to age, comorbidities, local practices, and the incidence of infectious or mechanical complications [6]. However, data from resource-limited countries, and more specifically from West Africa, remain scarce.

Given the severe constraints on access to care and the underrepresentation of PD in renal replacement therapy policies, it is essential to document the actual outcomes of this technique in routine clinical practice. The objective of this study is to evaluate the one-year technique survival rate for peritoneal dialysis in a semi-urban center in northern Senegal, as well as to describe the main causes of technique failure and associated complications, in order to provide local data that may inform national strategies for the development of peritoneal dialysis.

Methods

Study Type and Setting

This is a retrospective, single-center, observational cohort study conducted at a peritoneal dialysis center located in a semi-urban area in Louga, 200 km north of Dakar in northern Senegal. The study included patients admitted to peritoneal dialysis between August 2021 and December 2024.

Study Population

All patients over the age of 18 (Adult Nephrology Unit) who initiated peritoneal dialysis at the center during the study period and were followed for at least one month after the procedure were included. A minimum follow-up of one month was required to ensure effective exposure

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to peritoneal dialysis and to limit the impact of early events that are not representative of the technique's performance. Patients whose start or end date for peritoneal dialysis was not clearly documented in the medical record were excluded.

Peritoneal Dialysis Modalities

All patients had a Tenckhoff catheter with a "Swan neck"–type subcutaneous route and a "Coiled"–type intraperitoneal segment. Catheter implantation was performed primarily via conventional surgery, with laparoscopy used only in exceptional cases.

Patients were treated with continuous ambulatory peritoneal dialysis (CAPD) or automated peritoneal dialysis (APD), depending on clinical indications and organizational constraints. The dialysis solutions used were standard solutions (based on 1.36%, 2.27%, and 3.86% glucose), with icodextrin used in some patients depending on their clinical profile. The average number of daily exchanges and the volume per exchange were individually tailored.

Data Collection

Data were collected from medical records and the center's registries. The variables collected included the following:
- Sociodemographic characteristics (age, sex, geographic origin, education level, payment method)
- Clinical data (initial kidney disease, comorbidities, Charlson score, body mass index)
- Biochemical parameters at the start of dialysis (hemoglobin, serum albumin, estimated glomerular filtration rate according to CKD-EPI, serum sodium, serum potassium)
- Technical characteristics of peritoneal dialysis (start and end dates, modality, type of solution, number and volume of exchanges)

Definitions

Technique survival was defined as the time interval between the initiation of peritoneal dialysis and the definitive transfer to hemodialysis for technical or infectious reasons. Censored events included: death, kidney transplantation, the end of the observation period, and transfer at the patient's request.

Technical failure was defined as a definitive transfer to hemodialysis, regardless of the cause.
Episodes of peritonitis were defined according to the diagnostic criteria recommended by the International Society for Peritoneal Dialysis (ISPD), including clinical, cytological, and microbiological criteria [7].

Follow-Up and Outcomes

Patients were followed from the initiation of peritoneal dialysis until the occurrence of technical failure, the end of the study period, or censoring. The causes of technical failure were documented and classified as infectious causes (peritonitis with treatment failure) or technical causes related to the catheter, loss of ultrafiltration, or inadequacy.

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Statistical Analyses

Quantitative variables were described by their mean and standard deviation, and qualitative variables by their frequencies and percentages.

Technique survival was estimated using the Kaplan–Meier method, with a calculation of 95% confidence intervals.

Comparisons between the failure and non-failure groups were performed using univariate analysis with appropriate nonparametric tests (Wilcoxon test for continuous variables, Fisher's exact test for categorical variables).

To identify factors associated with technical failure despite the small sample size, a penalized logistic regression using the Firth method was employed. Results are presented as odds ratios (OR) with their 95% confidence intervals. The threshold for statistical significance was set at $p < 0.05$. Statistical analyses were performed using R software version 4.5.2 (r-project.org).

Ethical Considerations

This retrospective cohort study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Individual informed consent was not required due to the retrospective and anonymized nature of the study.

Results

A total of 40 patients were evaluated for inclusion in the study. Of these, 7 were excluded due to missing data that did not allow for the determination of the start and/or end dates of peritoneal dialysis. The final analysis, thus, included 33 patients *(Figure 1)*.

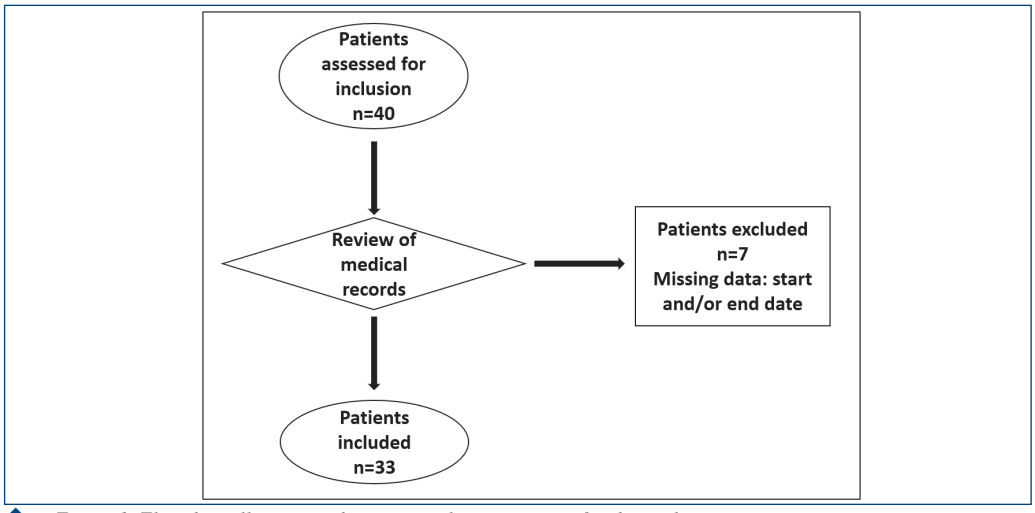

Figure 1. Flowchart illustrating the patient selection process for the study

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Population Characteristics

Table I. Demographic, clinical, and therapeutic characteristics of the patients

Variable	Value
Total number of patients	33
Age (years), mean (standard deviation)	46.8 (±18.6)
Gender, n (%)	
- Female	19 (57.6%)
- Male	14 (42.4%)
Geographic origin, n (%)	
- Rural	20 (60.6%)
- Urban	13 (39.4%)
Education level, n (%)	
- None	21 (63.6%)
- Elementary	5 (15.2%)
- Secondary	7 (21.2%)
Payment method, n (%)	
- Government	6 (18.2%)
- Self-payment	25 (75.8%)
- Insurance	1 (3%)
- Health insurance	1 (3%)
Initial kidney disease, n (%)	
- Hypertension	11 (33.3%)
- Glomerulonephritis	7 (21.2%)
- Polycystic kidney disease	4 (12.1%)
- Other / Unknown	11 (33.3%)
Charlson score, mean (standard deviation)	3.5 (±1)
Body mass index (kg/m²), mean (standard deviation)	20.9 (±3.3)
Serum albumin (g/L), mean (standard deviation)	39.4 (±8.6)
Hemoglobin (g/dL), mean (standard deviation)	7.5 (±1.6)
eGFR (ml/min/1.73 m²), mean (standard deviation)	4.5 (±2.3)
Dialysis modality, n (%)	
- CAPD	21 (63.6%)
- APD	12 (36.4%)
Type of solution, n (%)	
- Standard	25 (75.8%)
- With icodextrin	8 (24.2%)
Follow-up duration (months), median (IQR)	10 (6–25)
Number of peritonitis episodes, mean (standard deviation)	0.7 (±0.7)
Total number of peritonitis episodes	23
Technical failures, n (%)	7 (21.2%)

The baseline characteristics of the 33 included patients are presented in *Table I*. The mean age was 46.8 years (± 18.6), with a slight predominance of females (57.6%). The majority of patients were from rural areas (60.6%) and had received no formal education (63.6%). Self-

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payment was the primary method of covering healthcare costs (75.8%). Hypertension was the predominant comorbidity, present in 97% of patients, while diabetes was uncommon (6.1%). Hypertension was also the most frequently reported cause of nephropathy (33.3%). The mean Charlson comorbidity score was 3.5 (± 1.0). The mean body mass index was 20.9 kg/m² (± 3.3), with 27.3% of patients being underweight. At the start of dialysis, patients had a mean eGFR of 4.5 ± 2.3 ml/min/1.73 m² and severe anemia (mean hemoglobin of 7.5 ± 1.6 g/dL).

Continuous Ambulatory Peritoneal Dialysis (CAPD) was the most commonly used modality (63.6%). The PD catheter was implanted in all patients, primarily via conventional surgery (97%). The majority of patients were treated with standard solutions (75.8%) and followed a regimen of an average of 4.2 (± 0.4) exchanges per day, with an exchange volume of 2.0 (± 0.1) liters.

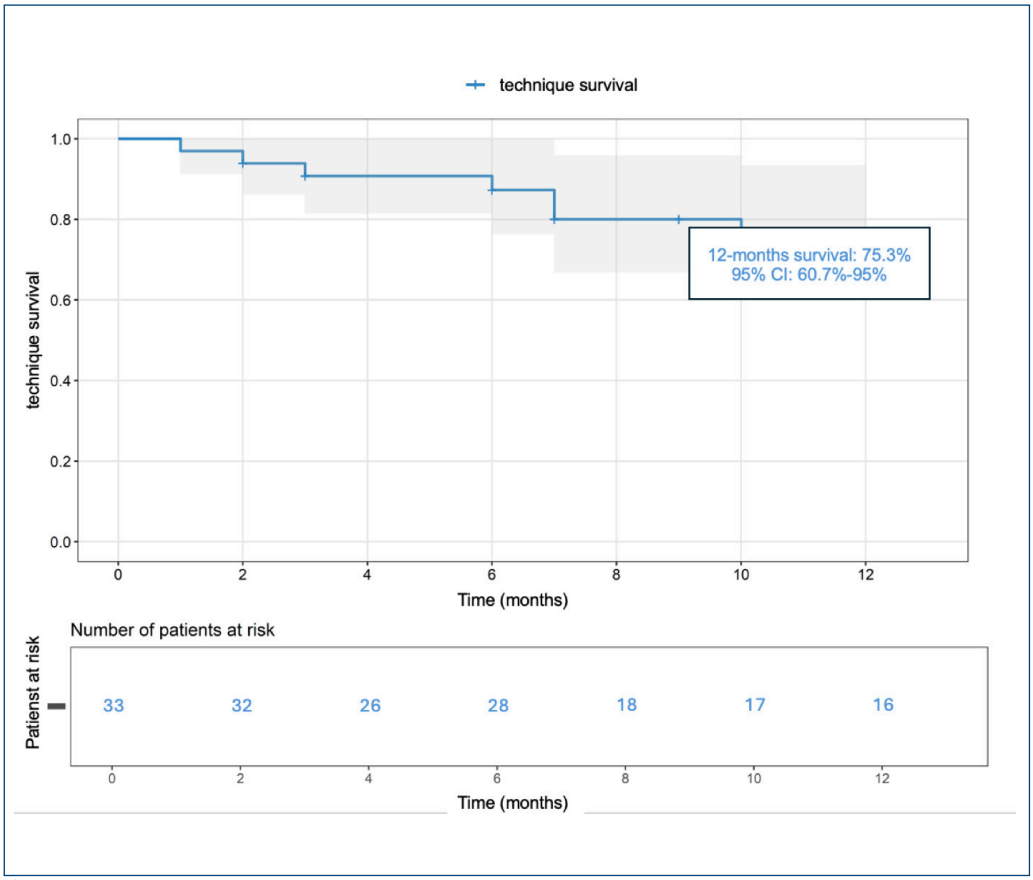

Figure 2. One-year technique survival curve (Kaplan–Meier) in peritoneal dialysis

Technical Survival

The technique survivalanalysis using the Kaplan–Meier method is presented in *Figure 2*. Over a median follow-up of 10.3 months, one-year technique survivalwas estimated at 75.3% (95% CI: 60.7–93.5%). The median technique survivalhad not been reached at the end of the study follow-up.

Causes of Technical Failure

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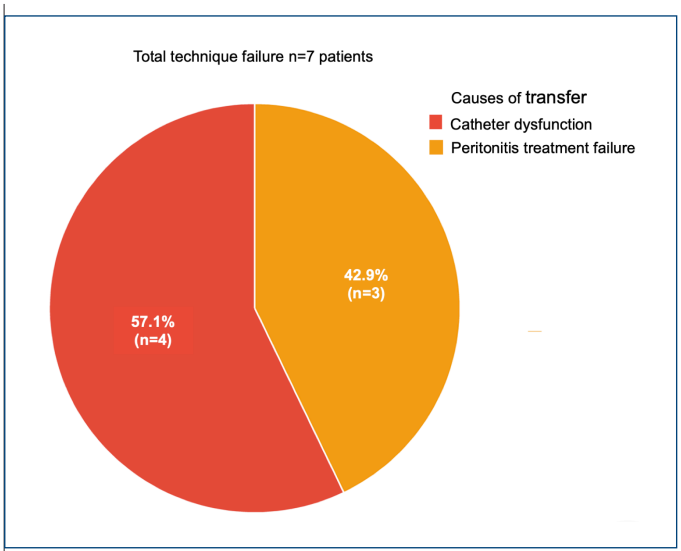

Figure 3. Distribution of the causes of transfer to haemodialysis among cases of technical failure

Among patients who experienced technical failure (permanent transfer to hemodialysis), the causes were divided into two main categories. Technical problems related to the catheter (malfunction, migration, or obstruction) were the most common cause, accounting for 57.1% (n=4) of failures. Peritonitis, where treatment failure led to transfer, accounted for 42.9% (n=3) of cases *(Figure 3)*.

Peritonitis During Follow-Up

During follow-up, 23 episodes of peritonitis were observed in 33 patients, corresponding to an overall rate of 0.59 episodes/patient-year, calculated over 38.8 patient-years of follow-up *(Figure 4)*.

The distribution of episodes by subtype showed a predominance of culture-negative peritonitis,

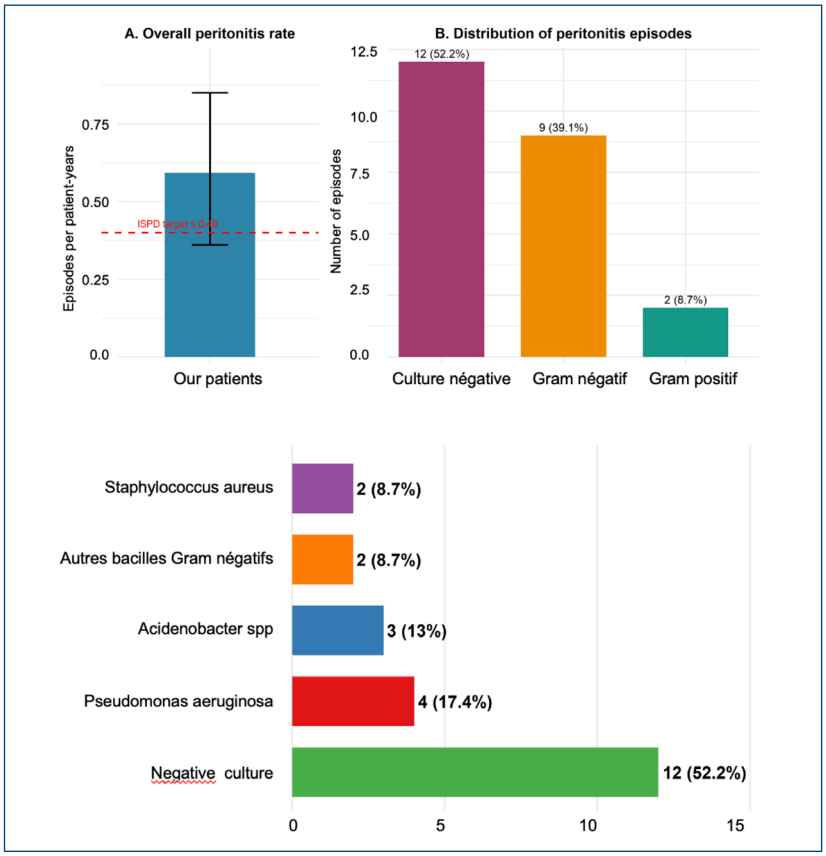

Figure 4. Distribution of the 23 episodes of peritonitis over 38.8 patient-years in 33 patients

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accounting for 52.2% of episodes (n=12), followed by Gram-negative peritonitis (39.1%, n=9), while Gram-positive infections were less frequent (8.7%, n=2).

The specific incidence rates were estimated at 0.31 episodes per patient-year for culture-negative peritonitis, 0.23 episodes per patient-year for Gram-negative infections, and 0.05 episodes per patient-year for Gram-positive infections. Among the identified organisms, Gram-negative infections were dominated by Pseudomonas aeruginosa and Acinetobacter spp., while Staphylococcus aureus was the most commonly isolated Gram-positive organism.

The overall rate observed in our cohort (0.59 episodes/patient-year) was higher than the target recommended by the International Society for Peritoneal Dialysis (ISPD), set at ≤ 0.40 episodes/patient-year [7].

Factors Associated with Technical Failure

We analyzed the baseline characteristics of the 7 (21.2%) patients who experienced treatment failure. *Table II* presents the demographic and clinical characteristics according to event status. No statistically significant differences were observed between the groups in univariate analysis.

Firth's penalized logistic regression model yielded stable estimates despite the small sample size. No factor reached the threshold for statistical significance ($p<0.05$). However, non-significant associations were observed: secondary education (OR=4.92; 95% CI: 0.78–45.6; p=0.091) and the DPCA modality (OR=3.21; 95% CI: 0.52–25.4; p=0.211) were associated with an increased risk of failure. Similarly, each additional year of age was associated with a 6% increase in risk

Table II. Baseline characteristics of patients by event status

Variable	Not a failure, n=26.	Failure, n=7.
Total number of patients	26	7
Age (years), mean (standard deviation)	45.4 (±19.2)	51.7 (±16.5)
Gender, n (%)		
- Female	16 (61.5%)	3 (42.9%)
- Male	10 (38.5%)	4 (57.1%)
Geographic origin, n (%)		
- Rural	16 (61.5%)	4 (57.1%)
- Urban	10 (38.5%)	3 (42.9%)
Education level, n (%)		
- None	18 (69.2%)	3 (42.9%)
- Elementary	4 (15.4%)	1 (14.3%)
- Secondary	4 (15.4%)	3 (42.9%)
Dialysis modality, n (%)		
- CAPD	16 (61.5%)	5 (71.4%)
- APD	10 (38.5%)	2 (28.6%)
Payment method, n (%)		
- Government	5 (19.2%)	1 (14.3%)
- Self-payment	20 (76.9%)	5 (71.4%)
Charlson score, mean (standard deviation)	3.5 (±1)	3.7 (±1.3)

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(OR=1.06; 95% CI: 0.99–1.15; p=0.115). *Figure 5* visually presents these associations in the form of a forest plot.

Discussion

Summary of Key Findings

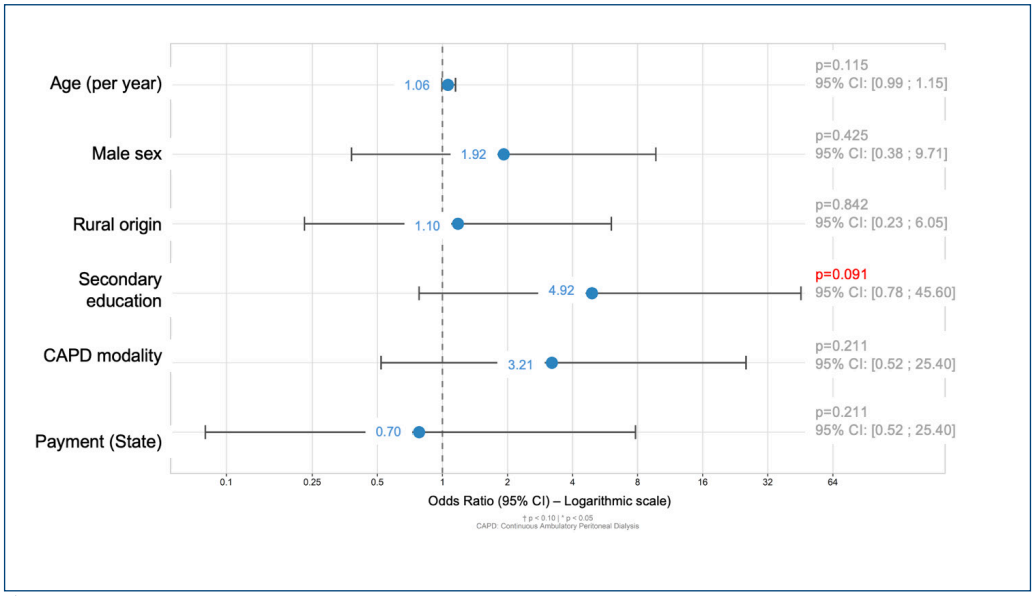

Figure 5. Factors associated with the risk of technical failure in peritoneal dialysis (Forest plot)

In our cohort of 33 patients on peritoneal dialysis in a semi-urban center in northern Senegal, the mean age was 46.8 years, with a predominance of women (57.6%) and a majority of rural origin (60.6%). One-year technique survivalwas estimated at 75.3% (95% CI: 60.7–93.5%), with the median survival not yet reached at the end of the median follow-up of 10.3 months. The peritonitis rate was 0.59 episodes per patient-year, with a predominance of negative cultures (52.2%) and Gram-negative bacteria (39.1%). Seven patients (21.2%) experienced technical failure, primarily due to catheter malfunction (57.1%) or therapeutic failure of peritonitis (42.9%). No significant differences were observed in univariate analysis between the failure and non-failure groups, although trends toward increased risk were noted for age, secondary education level, and CAPD modality in penalized multivariate analysis.

Comparison with the Literature

According to international data compiled by the International Peritoneal Dialysis Society, one-year technique survivalgenerally exceeds 90% in high-income countries. The survival rate of 75.3% observed in our cohort is lower than this standard, but comparable to data from low- and middle-income countries (70–86%). For example, a retrospective Tunisian cohort study reported a one-year technique survivalrate of 70% in patients as young as ours, with a mean age of 46.47 years [8], while other studies in South Africa, Mexico, and India reported one-year survival rates of 79.5%, 82%, and 86.4%, respectively [9, 10, 11]. In certain national settings, notably in Thailand and South Africa, a gradual improvement in outcomes has been reported, with rates

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reaching 94.8% over the 2013–2016 period and 85% in 2015, highlighting the transformative impact of national programs supporting peritoneal dialysis [12, 13].

Technical failure in our cohort was primarily related to catheter malfunctions (57.1%) and peritonitis (42.9%), which is consistent with the literature in low- and middle-income countries, where catheter-related mechanical problems account for up to 42.4% of failures during the first three months and infections contribute to 25.4% of definitive transfers to hemodialysis, often due to logistical constraints and limited surgical expertise [14].

The observed peritonitis rate (0.59 episodes per patient-year) is slightly above the standards recommended by the International Society for Peritoneal Dialysis (ISPD), which aim for a rate of <0.40 episodes per patient-year and a percentage of patients without peritonitis of >80% per year [7]. This rate remains, however, very satisfactory compared to data reported to date in Africa, where the rate generally varies between 0.33 and 2.8 episodes per patient-year, with a frequently high proportion of culture-negative peritonitis, approaching 50%, and a predominance of Gram-negative bacteria linked to environmental factors in certain series [15]. The high rate of culture-negative peritonitis (52.2%) in our series exceeds the ISPD target of <15–20% [7]. This suggests shortcomings in the practices of collecting and culturing dialysis fluids and calls for enhanced local microbiology training.

Specifics of the Senegalese Context

In our cohort, the prevalence of self-financing of care illustrates a socioeconomic barrier often described in low and middle-income countries, where high costs of consumables and lack of public coverage limit sustainable access to peritoneal dialysis [16]. Studies conducted in similar settings have shown that the lack of adequate training for healthcare providers and logistical barriers related to supply can hinder the optimal use of peritoneal dialysis and increase the risk of treatment interruptions or infectious complications [17].

Several studies suggest that health literacy and educational level significantly influence clinical outcomes in patients with chronic kidney disease. A systematic review has shown that low health literacy is associated with higher rates of hospitalizations, missed dialysis sessions, and mortality [18]. Furthermore, multicenter analyses have indicated that educational levels may be associated with different risks of cardiovascular events and mortality in these patients [19]. Finally, a recent study shows that delayed management of anemia (hemoglobin <9 g/dL) in non-dialysis patients with chronic kidney disease is associated with an increased risk of cardiovascular events and mortality, underscoring the importance of early intervention [20]. This severe anemia at baseline reflects delayed management of kidney disease and may constitute a risk factor for peri- and post-related morbidity and mortality, particularly during catheter placement. Early-onset anemia is also associated with reduced survival in peritoneal dialysis [20].

The low prevalence of diabetes observed in our cohort appears consistent with local epidemiology. According to the STEPS survey conducted in 2024 by the Senegalese Ministry of Health and Public Hygiene, the prevalence of diabetes in the Louga region is estimated at 5.8% [21].

Clinical Implications

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The importance of surgical expertise is underscored by the predominance of catheter malfunctions as a cause of early failure, arguing for the widespread adoption of advanced laparoscopic techniques (with omentopexy or fixation) or enhanced training for surgeons, as recommended in the ISPD guidelines to minimize rates of migration and obstruction [7, 22]. Patient education, tailored to low educational levels and rural backgrounds, must include simplified protocols and home visits to minimize infections, with evidence of effectiveness in programs, such as "PD First" or "retraining" interventions that significantly reduce peritonitis [7, 16]. Targeted prevention of peritonitis through pre-procedural antibiotic prophylaxis and monitoring of serum potassium levels (hypokalemia being a modifiable risk factor) aligns with the 2022 updates to the ISPD guidelines, which further emphasize reducing negative cultures through improved microbiological identification [7].

Limitations

The small sample size of 33 limits statistical power and prevents the robust identification of risk factors in multivariate analysis, despite the use of Firth's penalized regression. The results cannot be generalized to other settings in Senegal or sub-Saharan Africa, where practices vary, due to the single-center design. The retrospective nature of the study is subject to several biases: selection bias (only patients who started PD at the center and were followed for at least one month are included, effectively excluding patients who died or were transferred early), information bias (data extracted from medical records may be incomplete), and potential underreporting of minor complications. The failure to account for competing risks, particularly death and kidney transplantation, constitutes a methodological limitation of this study. This approach could lead to an overestimation of technical survival, as these events prevent the occurrence of the event of interest. Finally, the limited statistical power for univariate and multivariate analyses prevents definitive conclusions from being drawn regarding certain observed results, such as the association with age or dialysis modality.

Outlook

A multicenter study in Senegal and West Africa would allow these results to be validated in a larger sample and identify region-specific factors. A longer follow-up, beyond 12 months, would assess median technique survivaland the long-term impact of infectious complications. An approach focused on quality of care, including annual audits of peritonitis rates and continuing education, aligned with ISPD recommendations [7], could optimize PD programs in resource-limited settings.

Conclusion

Despite major structural constraints, peritoneal dialysis demonstrates acceptable one-year technique survivalin our setting. Improving the prevention of technical and infectious complications could sustainably strengthen the viability of PD in semi-urban settings in sub-Saharan Africa.

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Authors' Contributions

Mr. Sarr: Study design and conception, data collection, statistical analysis, interpretation of results, drafting of the original manuscript, revision and approval of the final version.A. Niang: Critical review of the manuscript, validation of results, and approval of the final version for publication.

Ethics Statement

This retrospective cohort study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Individual informed consent was not required due to the retrospective and anonymized nature of the study.

Artificial intelligence statement

The entire manuscript, from study design and data collection to statistical analysis, interpretation of results, and scientific writing, was produced by the authors. AI was used solely to generate the R scripts from the collected data, which were then used to create the figures.

Competing interest

The authors declare that they have no conflicts of interest related to this work

Data availability

Anonymised data are available from the corresponding author upon reasonable request.

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