

Long-Term Outcomes of Maintenance Peritoneal Dialysis Initiated During Infancy: A Temporally Aligned Comparative Study

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Abstract

Background: Infants requiring chronic peritoneal dialysis (PD) remain at high risk of mortality and dialysis-related complications. We compared long-term outcomes of infants initiating maintenance PD with those of temporally aligned older-child controls.

Methods: This retrospective single-center study included 45 children who initiated maintenance PD before 12 months of age and 45 temporally aligned controls. Clinical outcomes, PD-related complications, kidney transplantation, mortality, and five-year patient survival were compared. Exploratory analyses within the infant cohort evaluated survival by primary kidney disease and temporal changes in mortality.

Results: Infants had higher all-cause mortality than controls (35.6% vs. 2.2%, $p<0.001$), with five-year survival of 59.5% versus 97.7% ($p<0.001$). Peritoneal dialysis-associated peritonitis (PD peritonitis) and catheter failure rates were higher in infants ($p=0.007$ and $p<0.001$, respectively), whereas other PD-related complications did not differ between groups. During follow-up, 51.1% of infants and 66.7% of controls underwent kidney transplantation ($p=0.13$), and time from PD initiation to kidney transplantation did not differ between groups. Within the infant cohort, survival was better in patients with CAKUT than in those with non-CAKUT kidney disease ($p=0.012$), and crude mortality was lower in the contemporary era ($p=0.018$).

Conclusions: Infants initiating maintenance PD had substantially poorer five-year survival and higher peritonitis and catheter failure rates than temporally aligned controls. Nevertheless, transplantation was achieved in more than half, supporting PD as a viable bridge through this high-risk period. Exploratory findings further suggest that prognosis in infancy may vary according to underlying kidney disease and improve with contemporary care.

1. INTRODUCTION

End-stage kidney disease (ESKD) in infancy is a rare but devastating condition associated with substantial morbidity and mortality. Although kidney replacement therapy (KRT) during the first year of life is uncommon, infants account for a disproportionate burden of dialysis-related complications and death [1–3].

Peritoneal dialysis (PD) is generally the preferred KRT modality for infants with ESKD because it provides hemodynamic stability, avoids vascular access, and enables home-based treatment [4]. These advantages are particularly relevant in infants, given their limited vascular access options and cardiovascular vulnerability [5]. Outcomes have improved over time, with contemporary cohorts reporting substantially better survival than earlier eras; nevertheless, mortality remains higher than in older children, and peritonitis and catheter-related complications continue to contribute importantly to treatment burden [1, 3, 6, 7].

National and international registries have substantially improved our understanding of dialysis outcomes during infancy and have identified younger age and underlying kidney disease as important determinants of survival [1, 3, 7–10]. However, long-term single-center studies directly comparing infants with older children treated in the same setting remain limited. Such comparisons may help distinguish age-related risk from changes in practice over time. We therefore compared patient and PD characteristics, complications, kidney transplantation, mortality, and five-year survival between infants initiating maintenance PD and temporally aligned older-child controls treated at the same center over 27 years. We also examined survival by primary kidney disease, particularly congenital anomalies of the kidney and urinary tract (CAKUT), and temporal changes in mortality within the infant cohort.

2. MATERIALS AND METHODS

2.1 Study Design and Patients

This retrospective single-center comparative study reviewed all children who initiated maintenance PD at the Division of Pediatric Nephrology, Istanbul University-Cerrahpasa, Cerrahpasa Faculty of Medicine, between December 1998 and December 2025 (n = 220). All children who initiated PD before 12 months of age and remained on PD for at least 3 months were included in the infant group (n = 45).

For each infant, one older child who initiated maintenance PD after 12 months of age was selected as a temporally aligned control (n = 45). The control was the eligible patient whose PD initiation date was closest to that of the index infant and fell within a ± 12 -month window, with the same minimum PD duration criterion applied to both groups. The median interval between PD initiation dates for infant–control pairs was 5.8 months (IQR 3.0–10.6). This approach was used to align the temporal distribution of the control group with that of the infant cohort and thereby reduce potential confounding from secular changes in PD practice, technology, and overall patient management across the 27-year study period.

For analyses of temporal changes, patients were classified into two treatment eras according to the date of PD initiation: 1998–2012 and 2013–2025. Descriptive temporal comparisons, fixed-time-point mortality analyses and survival analyses according to primary kidney disease were performed within the infant group.

The study was approved by the Istanbul University-Cerrahpasa Non-Interventional Clinical Research Ethics Committee (04/02/2026- 1552162). The requirement for informed consent was waived due to the retrospective design.

2.2 Data Collection and PD Characteristics

Demographic and clinical data were extracted from the medical records, including date of birth, sex, primary kidney disease, comorbidities, and anthropometric measurements. Both weight and height were noted at PD initiation and at the last available follow-up, and then body mass index (BMI) was calculated

as weight in kilograms divided by height in meters squared. Standard deviation scores (SDS) for height and BMI (according to height-age) were calculated using Turkish children's growth reference data [11].

PD-related data included the date of PD initiation, PD modality, catheter type and insertion technique, number of catheters used, catheter lifetime, infectious and mechanical complications, date and reason for PD discontinuation, date of kidney transplantation, date and cause of death, and date of the last follow-up.

Tenckhoff catheters, including single-cuff straight, single-cuff coiled, double-cuff straight, or double-cuff coiled configurations, were inserted laparoscopically, surgically, or percutaneously according to patient characteristics and center practice. Catheter lifetime was defined as the interval from insertion to removal, replacement, or last use. Catheter failure was defined as catheter removal or replacement because of loss of catheter function or a catheter-related complication, and catheter failure rates were expressed per 100 PD-months of cumulative PD exposure.

PD modalities included continuous cycling PD (CCPD), nocturnal intermittent PD (NIPD), and continuous ambulatory PD (CAPD). PD duration was defined as the interval from PD initiation to permanent discontinuation because of kidney transplantation, transfer to HD, death, or the last follow-up assessment for patients who remained on PD. Total follow-up duration was calculated from PD initiation to the last available clinical assessment, death, or loss to follow-up.

2.3 Dialysis-Related Complications

Infectious complications included peritonitis, exit-site infection, and tunnel infection. Definitions of all infectious complications were based on the contemporaneous ISPD recommendations in effect at the time of diagnosis. Peritonitis was defined as the presence of at least two of the following criteria: (1) clinical features consistent with peritonitis; (2) cloudy dialysis effluent with a white blood cell count > 100 cells/ μ L and > 50% polymorphonuclear cells; and (3) a positive dialysate culture. The peritonitis rate was calculated by dividing the total number of peritonitis episodes by the cumulative PD exposure time and was expressed as episodes per patient-year. Exit-site infection was defined by purulent drainage with or without surrounding erythema, and tunnel infection by tenderness, erythema, or swelling along the subcutaneous catheter tunnel, with or without ultrasonographic evidence of fluid collection.

Non-infectious complications included catheter malposition, subcutaneous dialysate leakage, hernia, hydrothorax, catheter dysfunction, and cuff extrusion.

2.4. Long-Term KRT Outcomes and Patient Status

The primary outcomes were all-cause mortality and receipt of kidney transplant during follow-up. The secondary outcomes, reasons for permanent PD discontinuation, were categorized as PD-related complications, transplantation, or death while receiving PD. Patient status at the end of follow-up was categorized as having a functioning kidney graft, receiving HD, remaining on PD, or deceased.

Kidney transplantation was recorded if performed at any time during follow-up, irrespective of subsequent graft failure, return to dialysis, or death. Age at transplantation and time from PD initiation to transplantation were recorded.

All-cause mortality was assessed from PD initiation through the end of available follow-up, irrespective of subsequent transfer to another center, transition to HD, or kidney transplantation. Deaths after transfer were included when vital status and date of death could be reliably confirmed from medical records, national health records, or communication with the receiving center or family; otherwise, patients were considered alive only through their last confirmed follow-up. For deceased patients, the date and cause of death and KRT modality at death were recorded.

2.5 Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics version 24.0 (IBM Corp., Armonk, NY, USA). Continuous variables are expressed as median and interquartile range (IQR) due to their non-normal distribution. Categorical variables are presented as numbers and percentages. Between-group comparisons of continuous variables were performed using the Mann-Whitney U test, whereas categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. Within the infant group, changes in anthropometric parameters between PD initiation and the last follow-up were assessed using paired analyses. Paired t-tests were used when the distribution of within-patient differences was normal, and Wilcoxon signed-rank tests were used otherwise. Incidence rate ratios (IRRs) with 95% confidence intervals (CI) were calculated assuming a Poisson distribution. The Kaplan–Meier graphs were created using R version 4.3.3.

2.6 Survival Analysis

Patient survival was evaluated from the date of PD initiation. The event of interest was death from any cause, and survival time was calculated from PD initiation to death or the last confirmed follow-up. Patients who remained alive were censored at the date of their last confirmed follow-up. Transfer to HD and kidney transplantation were not considered censoring events, and follow-up continued after these transitions when subsequent vital status was available.

Patient survival was estimated using the Kaplan–Meier method and compared using the log-rank test. The primary survival analysis compared the infant and control groups over the first five years after PD initiation, with follow-up administratively censored at five years. An additional exploratory survival analysis compared infants with CAKUT and non-CAKUT kidney disease using the entire available follow-up period. Given the limited number of deaths, multivariable survival modeling was not performed.

Temporal changes in mortality were explored separately within the infant cohort. To account for differences in follow-up duration between treatment eras (1998–2012 and 2013–2025), cumulative mortality was estimated at fixed time points of 2, 3, and 5 years after PD initiation as 1 minus the Kaplan–Meier survival estimate. The corresponding 95% confidence intervals were derived using

Greenwood standard errors. Between-era differences at each time point were assessed using a normal-approximation z-test based on pooled Greenwood standard errors.

3. RESULTS

3.1 Patient Characteristics

A total of 90 patients fulfilled the study criteria and were included in the final analysis, comprising 45 infants and 45 temporally aligned controls. There was no difference in sex distribution between the two groups (Table 1). At PD initiation, the median age was 0.3 years (IQR 0.02–0.64) in the infant group and 10.2 years (IQR 7.9–12.1) in the control group ($p < 0.001$).

Table 1. Baseline characteristics of the study cohorts

	Infant group (n= 45)	Control group (n= 45)	p-value
Demographic characteristics			
Male sex, n (%)	30 (66.7)	24 (53.3)	0.29
Age at PD initiation, years	0.3 (0.02;0.64)	10.2 (7.9;12.1)	<0.001
Age at the end of follow-up, years	8.2 (3.4;15.6)	19.9 (17;22)	<0.001
Primary kidney disease, n (%)			
CAKUT	22 (48.9)	18 (40)	0.019
Glomerular disease	9 (20)	10 (22.2)	
Cystic kidney disease	7 (15.6)	5 (11.1)	
Primary hyperoxaluria	5 (11.1)* ^a	0 (0.0)* ^b	
Cystinosis	0 (0)* ^a	5 (11.1)* ^b	
Other / Unknown	2 (4.4)	7 (15.6)	
Anthropometric characteristics			
Height-SDS at PD initiation	-1.56 (-2.59;0.76)	-2.4 (-3.22;-1.55)	0.013
BMI-SDS for height-age at PD initiation	-1.08 (-2.08;-0.43)	-0.41 (-1.10;0.54)	0.004
Height-SDS at the end of follow-up	-2.86 (-4.16;-1.33)	-2.3 (-3.19;-1.54)	0.26
BMI-SDS for height-age at the end of follow-up	-0.82 (-2.13;-0.44)	0.49 (-0.55;1.25)	0.002

Continuous data are presented as median (IQR;25th;75th percentile), and comparisons between the two groups were performed using the Mann–Whitney U test. Chi-square test or Fisher’s exact test were used to

compare categorical variables. *Different superscript letters (a, b) within a row indicate column proportions that differ significantly at the 0.05 level (Bonferroni-adjusted pairwise comparisons). P values <0.05 are given in bold.

PD, peritoneal dialysis; SDS, standard deviation score; CAKUT, congenital anomalies of the kidney and urinary tract.

As shown in Table 1, the distribution of primary kidney diseases differed significantly between the groups ($p = 0.019$). CAKUT was the most common underlying kidney disease in both groups (48.9% vs. 40.0%), while primary hyperoxaluria occurred exclusively in the infant group and cystinosis exclusively in the control group.

At PD initiation, the infant group had a higher height SDS but a lower BMI SDS for height-age than the control group ($p = 0.013$ and $p = 0.004$, respectively). At the end of follow-up, height SDS was comparable between groups, whereas BMI SDS remained lower in the infant group ($p = 0.002$). Within the infant group, height SDS decreased significantly from PD initiation to the end of follow-up ($p = 0.014$), while BMI SDS did not change significantly ($p = 0.09$). Anthropometric characteristics are presented in Table 1.

3.2. PD Characteristics and Complications

The distribution of PD modalities also differed between the groups ($p < 0.001$); CCPD was the predominant modality in the infant group (88.9% vs. 57.8%), whereas CAPD was more frequently used in the control group (35.6% vs. 4.4%). Median PD duration was comparable between the infant and control groups ($p = 0.59$) (Table 2).

Table 2
Peritoneal dialysis (PD) characteristics, PD-related complications, and reasons for permanent PD discontinuation

	Infant group (n = 45)	Control group (n = 45)	p-value
PD characteristics			
PD modality, n (%)			
CCPD	40 (88.9)	26 (57.8)	< 0.001
CAPD	2 (4.4)	16 (35.6)	
NIPD	3 (6.7)	3 (6.7)	
PD duration, months	32.0 (21.9;45.9)	23.1 (8.4;43.3)	0.59
Catheter lifetime, months	14.7 (7.4–30.5)	22.8 (8.7–39.9)	0.15
Catheter failure rate, failures/100 PD-months	2.66	0.97	< 0.001
PD-related complications			
Peritonitis			
Peritonitis rate, episodes/patient-year	0.67	0.42	0.007
Patients with ≥ 1 peritonitis episode, n (%)	34 (75.6)	26 (57.8)	0.07
Catheter-related infections			
Exit-site infection, n (%)	10 (22.2)	8 (17.7)	0.58
Tunnel infection, n (%)	3 (6.7)	1 (2.2)	0.61
Mechanical complications			
Hernia, n (%)	10 (22.2)	7 (15.6)	0.42
Catheter malposition, n (%)	6 (13.3)	3 (6.7)	0.29
Subcutaneous leakage, n (%)	9 (20)	5 (11.1)	0.24
Hydrothorax	1 (2.2)	1 (2.2)	1.00
Continuous data are presented as median (IQR;25th percentile;75th percentile) and were analyzed by the Mann–Whitney U test for two groups. Chi-square test or Fisher’s exact test were used for categorical variables, where appropriate. *Different superscript letters (a, b) within a row indicate column proportions that differ significantly at the 0.05 level (Bonferroni-adjusted pairwise comparisons)			
PD, peritoneal dialysis; CCPD, continuous cycling peritoneal dialysis; CAPD, continuous ambulatory peritoneal dialysis; NIPD, nocturnal intermittent peritoneal dialysis.			

	Infant group (n = 45)	Control group (n = 45)	p-value
PD characteristics			
Catheter dysfunction	2 (4.4)	0 (0)	0.15
Cuff extrusion	2 (4.4)	0 (0)	0.15
Reasons for permanent PD discontinuation, n/N (%)			
PD-related complications	11/41 (26.8) ^{*a}	16/41 (39) ^{*b}	< 0.001
Kidney transplantation	17/41(41.5)	24/41 (58.5)	
Death while receiving PD	13/41 (31.7) ^{*a}	1/41 (2.4)	
Continuous data are presented as median (IQR;25th percentile;75th percentile) and were analyzed by the Mann–Whitney U test for two groups. Chi-square test or Fisher’s exact test were used for categorical variables, where appropriate. *Different superscript letters (a, b) within a row indicate column proportions that differ significantly at the 0.05 level (Bonferroni-adjusted pairwise comparisons)			
PD, peritoneal dialysis; CCPD, continuous cycling peritoneal dialysis; CAPD, continuous ambulatory peritoneal dialysis; NIPD, nocturnal intermittent peritoneal dialysis.			

Median catheter lifetime did not differ between the infant and control groups ($p = 0.15$), whereas the catheter failure rate was significantly higher in the infant group (2.66 vs. 0.97 failures per 100 PD-months; IRR 2.74, 95% CI 1.52–4.93, $p < 0.001$) (Table 2).

The peritonitis rate was significantly higher in the infant group than in the control group (0.67 vs. 0.42 episodes per patient-year; IRR 1.59, 95% CI 1.14–2.23, $p = 0.007$). At least one episode of peritonitis occurred more frequently in the infant group, although this difference did not reach statistical significance (75.6% vs. 57.8%, $p = 0.07$). Exit-site infection, tunnel and non-infectious catheter-related complications were also comparable between groups (Table 2).

3.3. Long-term KRT Outcomes and Patient Status

As shown in Table 2, the distribution of reasons for permanent PD discontinuation differed significantly between the groups ($p < 0.001$). Kidney transplantation was a more frequent reason for PD discontinuation in the control group than in the infant group (58.5% vs. 41.5%), whereas death while receiving PD was markedly more frequent in the infant group (31.7% vs. 2.4%). Transition to HD was comparable between the infant and control groups (17.1% vs 24.4%, $p = 0.59$).

During total follow-up, 23 infants (51.1%) and 30 controls (66.7%) underwent kidney transplantation; this difference was not statistically significant ($p = 0.13$). Among transplanted patients, age at transplantation was significantly lower in the infant group than in the control group ($p < 0.001$), but the interval from PD initiation to kidney transplantation did not differ between the two groups (Table 3). At the end of follow-up, 21 infants (46.7%) and 30 controls (66.7%) had a functioning kidney graft, four

infants (8.9%) and 10 controls (22.2%) were receiving HD, while four patients in each group (8.9%) remained on PD.

Table 3
Kidney replacement therapy (KRT) outcomes and patient status at the end of follow-up

	Infant group (n = 45)	Control group (n = 45)	p-value
Kidney transplantation during follow-up			
Patients undergoing kidney transplantation, n (%)	23 (51.1)	30 (66.7)	0.13
Age at transplantation, years	3.3 (2.6;4.8)	13.6 (11.3;15.8)	< 0.001
Time from PD initiation to transplantation, months	38.5 (25.3;53.9)	23.8 (15.1;60.2)	0.13
Patient status at the end of follow-up, n (%)			
Functioning kidney graft	21 (46.7)	30 (66.7)	< 0.001
Receiving HD	4 (8.9)	10 (22.2)	
Receiving PD	4 (8.9)	4 (8.9)	
Deceased	16 (35.6)	1 (2.2)	
KRT modality at the time of death, n/N (% of deaths)			
Receiving PD	13/16 (81.3)	1/1 (100)	< 0.001
Receiving HD	3/16 (18.7)	0 (0)	
After kidney transplantation	0 (0)	0 (0)	
Continuous data are presented as median (IQR;25th percentile;75th percentile) and were analyzed by the Mann–Whitney U test for two groups. Chi-square test or Fisher’s exact test was used for categorical variables, where appropriate.			
PD, peritoneal dialysis; HD, hemodialysis; KRT, kidney replacement therapy.			

3.4. Mortality and Survival

Overall all-cause mortality during follow-up was significantly higher in the infant group than in the control group [16/45 (35.6%) vs. 1/45 (2.2%), $p < 0.001$]. Among the 16 deaths in the infant group, 13 occurred while patients were receiving PD and three after transition to HD. No deaths occurred after kidney transplantation. The median age at death was 2.41 years (IQR 1.46–3.07). The leading identified causes of death were cardiac failure (n = 5), sepsis (n = 3), pneumonia (n = 2), aspiration and hemorrhage in one each, while the cause remained undetermined in four patients. The single death in the control group occurred while receiving PD and was attributed to pneumonia.

At five years after PD initiation, the Kaplan–Meier estimated survival probabilities were 59.5% in the infant group and 97.7% in the control group. Five-year patient survival differed significantly between the groups (log-rank $p < 0.001$) (Fig. 1).

Within the infant cohort, Kaplan–Meier analysis demonstrated significantly better survival in patients with CAKUT than in those with non-CAKUT kidney disease over the entire follow-up period (log-rank $p = 0.012$) (Fig. 2).

3.5. Temporal Changes within the Infant Cohort

In exploratory analyses, baseline characteristics were generally comparable between infants treated during 1998–2012 and those treated during 2013–2025. PD duration was significantly shorter in the contemporary era [22.1 (IQR 12–27) vs. 41.2 (IQR 32–88.8) months, $p = 0.014$]. Kidney transplantation rates were similar between the two eras (50% vs 52.6%). Infants treated during 2013–2025 tended to undergo transplantation at a younger age [2.8 (IQR 2.3–3.3) vs. 4.4 (IQR 2.7–7.8) years, $p = 0.052$] and after a shorter interval from PD initiation to transplantation [27.7 (IQR 22.2–40.6) vs. 41.2 (IQR 32.0–88.8) months, $p = 0.055$], although neither difference reached statistical significance. Crude all-cause mortality was significantly lower among infants treated during 2013–2025 than among those treated during 1998–2012 [3/19 (15.8%) vs. 13/26 (50.0%), $p = 0.018$] (**Supplementary Table S1**).

Fixed-time-point analyses similarly showed lower cumulative mortality in the contemporary era, with estimates of 12.6% vs. 23.7% at 2 years, 21.3% vs. 44.3% at 3 years, and 21.3% vs. 49.4% at 5 years. The largest absolute difference was observed at five years ($p = 0.065$; **Supplementary Table S2**).

4. DISCUSSION

This long-term single-center study shows that infants initiating maintenance PD are at a much higher risk than older children with PD performed at the same time in the same center. This higher risk is primarily associated with poorer survival rates, greater peritonitis and catheter failure rates. Exploratory analyses demonstrate prognostic differences according to the underlying kidney disease and the era of treatment. Furthermore, the proportion of infants who undergo kidney transplantation underscores the importance of PD in supporting these patients through childhood.

The most notable finding of the present study was the substantially poorer survival among infants initiating maintenance PD, with five-year survival of 59.5% compared with 97.7% in controls. This finding is consistent with previous reports of approximately four- to five-fold higher mortality in infants receiving KRT than in older children [2, 6], and with registry data identifying younger age at dialysis initiation as an independent mortality risk factor [3]. The causes of death in our infant cohort were also comparable with those reported in previous pediatric dialysis cohorts, with cardiovascular and infectious causes predominating [1, 5, 12].

In addition to age, underlying kidney disease may also contribute to differences in survival. CAKUT accounted for nearly half of the infant cohort, consistent with previous reports [13–15], and was

associated with better survival than non-CAKUT disease. This finding is consistent with registry data showing more favorable outcomes in young children with CAKUT [3, 14–17]. These findings suggest that underlying disease spectrum may contribute to heterogeneity in survival among infants receiving maintenance PD, although the present study was not powered to determine its independent effect.

Crude mortality was lower in infants treated during 2013–2025 than in those treated during 1998–2012, despite similar transplantation rates. Previous studies have also reported improvements in survival over time among pediatric dialysis populations. In a large USRDS analysis spanning 1990–2010, Mitsnefes et al. found that each 5-year increment in the calendar year of dialysis initiation was associated with a 20% reduction in adjusted mortality risk among children younger than 5 years [17]. Carey et al. similarly demonstrated better dialysis and overall survival among infants treated in a more recent era [18], while a recent nationwide study from Türkiye found that treatment in an earlier era was independently associated with higher mortality among pediatric dialysis patients [10]. Importantly, in our cohort, the lower crude mortality was not explained solely by shorter follow-up, as cumulative mortality remained lower when the two eras were compared at standardized 2-, 3-, and 5-year time points. Although these differences did not reach statistical significance, they suggest a favorable temporal trend in survival.

Peritonitis remains a major PD-related complication in children and an important contributor to morbidity and technique failure, as emphasized by pediatric registry data and current ISPD recommendations [19–21]. In our cohort, infants had higher peritonitis and catheter failure rates than controls, consistent with previous report of an increased peritonitis burden in this age group [6]. In contrast, exit-site infections, tunnel infections, and individual non-infectious mechanical complications were comparable between age groups. These findings suggest that the excess PD-related complication burden in infancy is driven mainly by peritonitis and catheter failure rather than by a generalized increase across all PD-related complications.

Growth impairment is an important long-term concern in children who initiate dialysis during infancy. Previous studies have highlighted the marked growth impairment in this population, although relatively stable height SDS and improvement in BMI SDS during PD have also been reported [4, 21]. In our cohort, height SDS declined significantly over follow-up, while BMI SDS showed no significant improvement. By the end of follow-up, the initial difference in height SDS between infants and controls was no longer evident, while BMI SDS remained lower in infants. These findings should be interpreted cautiously because the final anthropometric assessment was not limited to the PD period.

Kidney transplantation in very young children may be limited by patient and vascular size [5]. Nevertheless, more than half of our infants underwent kidney transplantation, consistent with previously reported rates of 39–68% in the Italian Registry and NAPRTCS cohorts [6, 18], while the ESPN/ERA-EDTA Registry reported a 5-year transplantation rate of 70.2% [3]. Similarly, Alexander et al. [15] reported that 65.5% of children initiating KRT before 2 years of age underwent transplantation, although access was lower among those starting KRT at the youngest ages. In our cohort, infants underwent transplantation

at a younger age than the older group, while time from PD initiation to transplantation was comparable between the groups.

Several limitations should be considered. The retrospective, single-center design may limit the generalizability of our findings, and changes in PD practices over the nearly three decades of observation may have influenced outcomes. The requirement for at least three months of PD treatment may have introduced selection bias by excluding patients who died or discontinued PD very early after initiation. In addition, the distribution of primary kidney diseases differed between infants and controls, and residual confounding by underlying disease cannot be excluded. Vital status could be ascertained after transfer when reliable information was available, but detailed post-transfer clinical data were not uniformly available. In addition, although mortality differed markedly between the groups, the limited number of events precluded robust multivariable survival analyses. Exploratory analyses of primary kidney disease and treatment era within the infant cohort were constrained by the small sample size and, for the temporal comparison, by the decreasing number of patients at risk at later fixed time points. Nevertheless, the temporally aligned control design and long-term longitudinal follow-up are important strengths of the study.

5. CONCLUSIONS

Infants initiating maintenance PD experienced substantially poorer five-year survival and higher peritonitis and catheter failure rates than temporally aligned controls, whereas most other PD-related complications were comparable between groups. Despite this high-risk clinical course, more than half of the infants ultimately underwent kidney transplantation, supporting maintenance PD as a feasible bridge to transplantation. Exploratory analyses suggested better long-term survival among infants with CAKUT and lower mortality in infants treated in the contemporary era, although the temporal trend requires confirmation in larger cohorts.

Abbreviations

Peritoneal dialysis-associated peritonitis, PD peritonitis

BMI, body mass index;

CAKUT, congenital anomalies of the kidney and urinary tract;

CAPD, continuous ambulatory peritoneal dialysis;

CCPD, continuous cycling peritoneal dialysis;

CI, confidence interval;

ESKD, end-stage kidney disease;

ESPN/ERA-EDTA, European Society for Paediatric Nephrology/European Renal Association–European Dialysis and Transplant Association.

HD, hemodialysis;

IQR, interquartile range;

IRR, incidence rate ratio;

ISPD, International Society for Peritoneal Dialysis;

KRT, kidney replacement therapy;

NAPRTCS, North American Pediatric Renal Trials and Collaborative Studies;

NIPD, nocturnal intermittent peritoneal dialysis;

PD, peritoneal dialysis;

SDS, standard deviation score;

USRDS, United States Renal Data System

Declarations

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Authorship

RG, SS and NC researched literature and conceived the study. RG, EKY, SS, AA and GP were involved in protocol development, gaining ethical approval and data analysis. RG wrote the first draft of the manuscript. SS, LS and SC critically reviewed and revised the manuscript for important intellectual content. **NC contributed to the finalization of the manuscript and critically revised it for important intellectual content.** All authors reviewed and approved the final version of the manuscript.

Informed consent to participate

Informed consent was not sought for the present study because it was waived by the ethics committee due to the retrospective design of the study.

Informed consent for publish

Informed consent to publish was not sought for the present study because the manuscript contains no identifiable individual patient information or images.

Conflicting interests

The authors declares that there is no conflict of interest.

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Trial registration

Not applicable.

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Figures

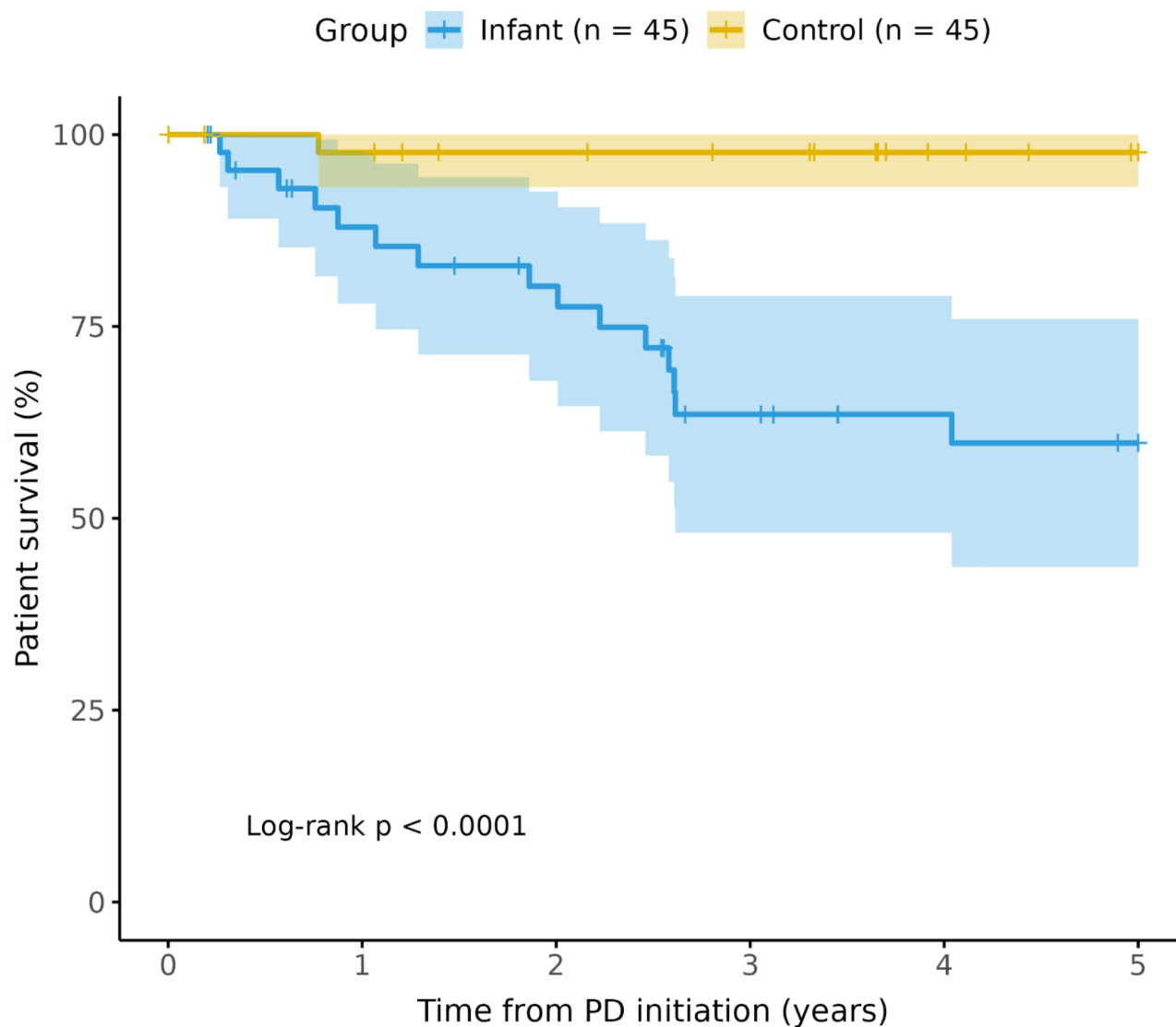


Figure 1. Kaplan-Meier estimates of five-year patient survival in the infant and control groups

See image above for figure legend.

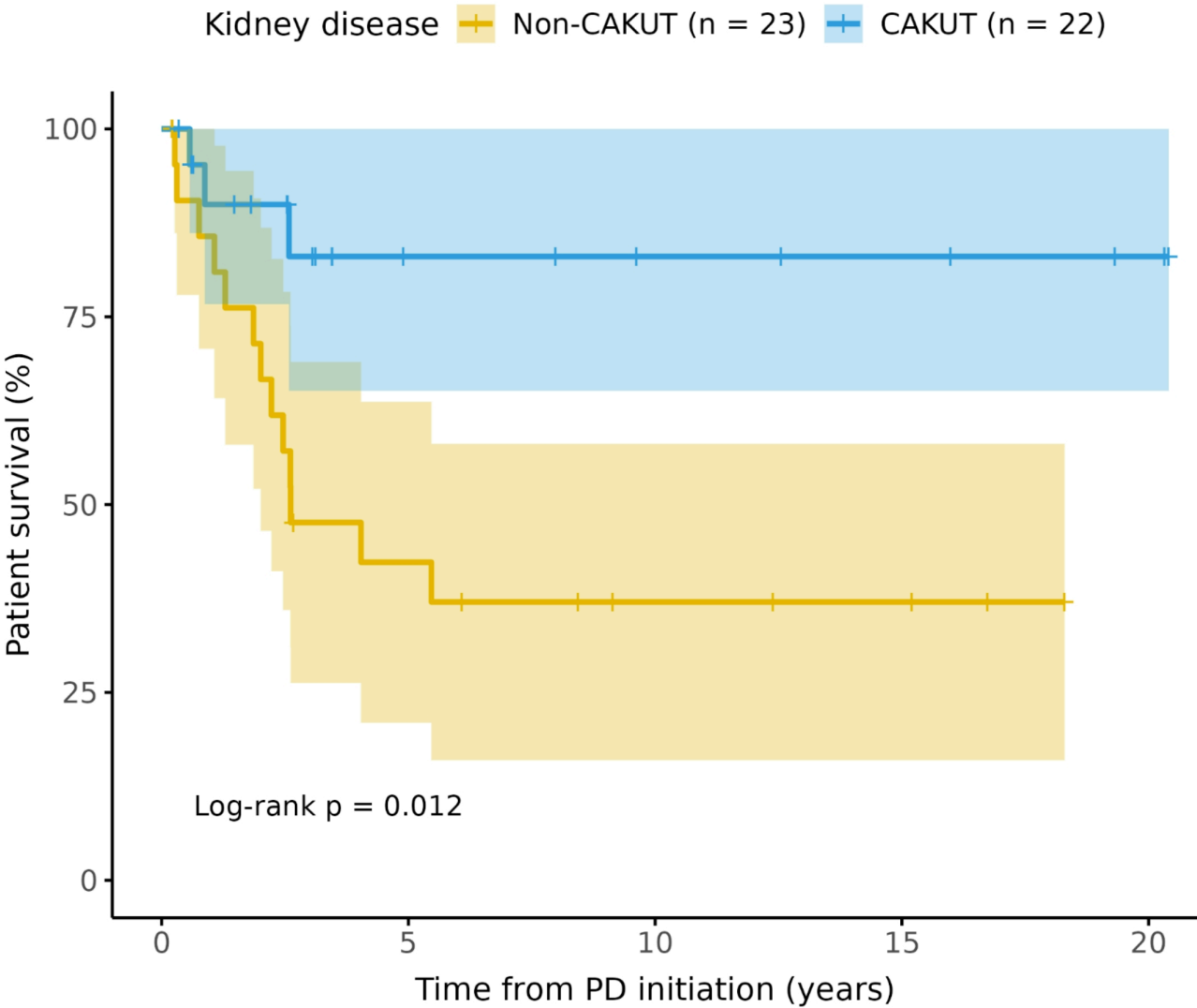


Figure 2. Kaplan-Meier estimates of patient survival according to underlying kidney disease (CAKUT vs. non-CAKUT) within the infant group.

Figure 2

See image above for figure legend.

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