

Technique Failure in Peritoneal Dialysis: A Comparative Study of Diabetic and Non-Diabetic Patients in Northern Hunan Province, China

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Abstract

Objective

To compare the risk of technique failure and clinical outcomes between diabetic and non-diabetic peritoneal dialysis (PD) patients in northern Hunan province, China, and to identify independent predictors for individualized intervention.

Methods

This retrospective study enrolled 550 patients (aged ≥ 18 years, dialysis > 3 months) who initiated PD at Yiyang Central Hospital from January 2009 to December 2024. Patients were divided into diabetes mellitus (DM) ($n = 205$) and non-diabetes mellitus (NDM) ($n = 345$) groups. The primary endpoint was technique failure (transfer to hemodialysis or death). Cox regression was used to identify risk factors, and Kaplan-Meier analysis with log-rank tests compared survival rates, with subgroup analyses performed.

Results

At the end of follow-up, among the 155 patients remaining on PD, 44 (22.9%) had DM, and 111 (32.2%) did not have DM ($p = 0.007$). Among the 265 deceased patients, 111 (54.2%) had DM, and 154 (44.6%) did not have DM ($p = 0.033$). Cardiovascular disease was the main cause of death in both DM and NDM patients. There was a statistically significant difference in the cause of death between the two groups in terms of infection ($p < 0.041$). Multivariate Cox regression analysis revealed that age (HR = 1.022), systolic blood pressure (HR = 1.006), serum albumin (HR = 0.975), history of diabetic kidney disease (HR = 1.511), and comorbid chronic obstructive pulmonary disease (COPD) (HR = 2.447) were all independent predictors of technique failure (all $P < 0.05$). Subgroup analyses showed that low albumin (< 25.0 g/L, < 35.0 g/L), older age (≥ 58 years, ≥ 70 years), high systolic blood pressure (≥ 148 mmHg), and COPD significantly increased technique failure risk in NDM patients, whereas these associations were not statistically significant within the DM subgroup for albumin, age, or blood pressure.

Conclusion

Diabetes mellitus substantially elevates the risk of PD technique failure. Independent risk factors encompass older age, higher systolic blood pressure, low serum albumin levels, a history of diabetic kidney disease, and comorbid COPD. Therefore, interventions targeting patients with these risk factors are important for improving long-term outcomes.

1. Introduction

With population aging and the rising prevalence of diabetes mellitus (DM), chronic kidney disease (CKD) has become a global public health issue. According to the latest data released by the Chinese Society of Nephrology of the Chinese Medical Association in 2024, the total number of peritoneal dialysis (PD) patients in the Chinese mainland reached 156,000 patients, with an increase of 23,500 cases compared to 2023 within just one year^[1]. In China, the prevalence of adult DM is 12.4%, and approximately 30%–40% of DM patients develop CKD and progress to End-Stage Renal Disease (ESRD). However, the awareness and screening rates for diabetic kidney disease (DKD) in China are only 26% and 55.3% respectively^[2].

Patients with DM and kidney disease are often older, have poor vascular condition, and experience hemodynamic instability, making long-term hemodialysis (HD) access difficult. PD has greater technical feasibility, better cost-effectiveness, higher patient satisfaction, and better preservation of residual kidney function^[3, 4]. However, technique failure has been an important reason for the relatively low PD retention rate worldwide. Technical failure is defined as a composite endpoint of transfer to HD due to catheter-related complications, refractory peritonitis, ultrafiltration failure, or death^[5, 6]. Therefore, identifying PD patients at high risk of technique failure is important in clinical practice and helps clinicians provide appropriate advice.

Several foreign studies have confirmed that technique survival in elderly PD patients is relatively lower, and diabetes itself is an independent risk factor for PD technique failure^[7, 8]. An Australia and New Zealand cohort study involving 8,279 PD patients demonstrated that patients with type 2 diabetes and diabetic nephropathy had the highest risk of technique failure (adjusted HR = 1.45)^[9]. Another study of 16,748 patients also identified age > 70 years, diabetes, or vascular disease as independent risk factors for early technique failure^[10]. However, there are inconsistencies in diabetes-related research across different provinces. A Shanghai study involving 210 elderly PD patients (81 with diabetes) demonstrated that diabetes did not significantly predicted mortality and technique survival^[11]. In contrast, study in Jilin province showed that the diabetic group significantly predicted all-cause mortality but not technical^[12]. In addition, most previous studies lacked specific focus on technical failure in DM and NDM receiving PD treatment in northern Hunan province, China, and the sample sizes were relatively small, failing to identify specific indicator thresholds.

Therefore, this study aims to investigate the clinical outcomes and detailed grouping of risk factors for technical failure between PD patients with DM and those without in northern Hunan province, China, providing evidence for individualized clinical decision-making and early intervention, improving long-term treatment adherence and prognosis.

2. Materials and methods

2.1 Study design and population

This study initially included 1,126 patients who underwent their first PD in the Department of Nephrology, Yiyang Central Hospital, Hunan Province, between January 2009 and December 2024. Inclusion criteria were age > 18 years and dialysis duration > 3 months. Exclusion criteria were: (1) recovery of renal function without need for further treatment; (2) age < 18 years at PD initiation; (3) survival < 90 days; (4) incomplete data, loss to follow-up, non-cooperation, or transfer to another dialysis center; and (5) kidney transplantation. All patients were followed up via telephone or medical records until the end of the study in December 2025. A total of 550 PD patients were enrolled in the final analysis. Of these, 155 remained on PD, 265 died, and 130 transitioned to HD (Fig. 1). Our current study has been registered in the Chinese Clinical Trial Registry (ChiCTR2500107548) on August 13, 2025. The study protocol complied with the principles of the Declaration of Helsinki and was approved by the Scientific Research Ethics Committee of Yiyang Central Hospital. Because this was a retrospective study and patient information was protected and accessible only to the researchers, written informed consent was waived.

2.2 Data collection

Clinical and laboratory data were obtained from the medical records department, the JIAHE Electronic Medical Record system (v6.1), and the Weining Health system (5.6.2403). Baseline data were collected from the patient's hospitalization of peritoneal dialysis catheterization in the nephrology department. Demographic characteristics and laboratory data included age, sex, residential region, dialysis vintage, systolic blood pressure (SBP), diastolic blood pressure, glomerular filtration rate (GFR), serum creatinine, serum urea, serum sodium, serum potassium, serum calcium, serum phosphate, serum albumin, parathyroid hormone, C-reactive protein (CRP), hemoglobin, white blood cell count, platelet count, absolute lymphocyte count, platelet-to-lymphocyte ratio (PLR), blood glucose, hemoglobin A1c (HbA1c), triglycerides, total cholesterol, low-density lipoprotein, high-density lipoprotein, and cardiac ejection fraction. Disease characteristics included primary kidney disease (chronic glomerulonephritis, Diabetic kidney disease (DKD), hypertensive nephropathy, polycystic kidney disease, obstructive nephropathy, pulmonary interstitial fibrosis) and comorbidities (diabetes mellitus, hypertension, cardiovascular disease, chronic heart failure [New York Heart Association (NYHA) class III–IV], gastrointestinal bleeding, cerebrovascular disease, chronic obstructive pulmonary disease (COPD).

2.3 Patients' follow-up

According to the 2020 DM criteria, patients exhibiting typical symptoms of diabetes and meeting any one of the following criteria can be diagnosed: (1) HbA1c $\geq 6.5\%$; (2) fasting plasma glucose ≥ 7.0 mmol/L; (3) 2-hour plasma glucose ≥ 11.1 mmol/L during an oral glucose tolerance test (OGTT); (4) random plasma glucose ≥ 11.1 mmol/L^[11]. Based on the presence of DM, all enrolled patients were divided into a DM group (including any patient with diabetes, regardless of whether DKD was diagnosed) and a NDM group. Based on technical survival status, patients were categorized into a technical survival group and a technical failure group (including death and transfer to HD) (Fig. 1). Causes of death were recorded and classified as cardiovascular disease, cerebrovascular disease, infection (including peritonitis and non-peritonitis infection), other causes, cancer, or unknown. Reasons for transfer to HD included

peritonitis, catheter mechanical complications, ultrafiltration failure, personal intention, cancer, pleuroperitoneal fistula, or unknown. Cox regression analysis was employed to identify risk factors, and the overall survival rates and technical survival rates were compared between DM and NDM patients. Subgroup analyses were also conducted for risk factors associated with technical failure.

2.4 Statistical analysis

Normally distributed continuous variables were expressed as mean $\pm$ standard deviation (SD); non-normally distributed continuous variables were expressed as median (interquartile range). T-test was used for parametric data, and Mann-Whitney U test for non-parametric continuous data. Categorical variables were presented as frequencies (percentages), and comparisons were made using the chi-square test or Fisher's exact test. Variables with $P < 0.05$ in univariate Cox regression analysis were entered into a multivariate Cox proportional hazards model, and results were presented as hazard ratios (HR) with 95% confidence intervals (CI). Survival curves and survival time were estimated using the Kaplan-Meier method, and differences in survival rates were tested by the log-rank test. Kaplan-Meier survival analysis was used to compare patient survival and technical survival between DM and NDM patients. Subgroup analyses for technical survival were performed based on albumin, age, systolic blood pressure, and presence or absence of COPD. All analyses were conducted using SPSS software (version 27.0) and GraphPad Prism 10. All tests were two-tailed, and $P < 0.05$ was considered statistically significant.

3. Results

3.1 Patients' characteristics

In this retrospective study, 1126 patients who received PD treatment for the first time in our center were included. After screening according to exclusion criteria, 550 patients were included in the analysis (Fig. 1). The average age of all patients was 58.00 (49.00, 68.00) years, including 273 males (49.64%). During the follow-up period, 395 patients (71.82%) experienced PD technique failure, among whom 199 were males (50.4%). Compared with the technique survival group, patients in the technique failure group had the following characteristics: older age [60.00 (51.00, 70.00) years vs. 55.05 ± 12.12 years, $p < 0.001$], shorter dialysis duration [34.00 (18.00, 53.00) months vs. 43.00 (29.00, 61.00) months, $p < 0.001$], and higher SBP [150.00 (140.00, 160.00) mmHg vs. 142.43 ± 19.11 mmHg, $p < 0.001$]. Laboratory test results showed that patients in the technique failure group had lower levels of creatinine, urea, phosphorus, serum albumin, hemoglobin, high-density lipoprotein, and cardiac ejection fraction, while white blood cell count, blood glucose, and total cholesterol levels were higher, with statistically significant differences ($p < 0.05$). There were significant differences in the distribution of primary diseases (chronic glomerulonephritis, diabetic kidney disease) and comorbidities (diabetes, heart failure, cardiovascular disease) between the two groups ($p < 0.05$), but no significant differences in other demographic indicators and laboratory test results. The baseline characteristics of patients are detailed in Table 1.

Table 1
Baseline characteristics of technical survival in Peritoneal Dialysis Patients.

Characteristics	All PD patients (n = 550)	Technical survival group (n = 155)	Technical failure group (n = 395)	P value
Demographic data				
Age, years	58.00 (49.00,68.00)	55.05 ± 12.12	60.00 (51.00,70.00)	0.001^{***}
Male, n(%)	273 (49.64)	74 (47.8)	199 (50.4)	0.578
Mountainous area, n (%)	360 (65.45)	108 (69.7)	252 (63.8)	0.192
Lake district, n (%)	190 (34.55)	47 (30.3)	143 (36.2)	
Dialysis vintage, months	37.00 (23.00,56.00)	43.00 (29.00,61.00)	34.00 (18.00,53.00)	0.001^{***}
Systolic BP, mmHg	148.00 (136.00,160.00)	142.43 ± 19.11	150.00 (140.00,160.00)	0.001^{***}
Diastolic BP, mmHg	80.00 (75.00,89.00)	79.00 (75.00,87.00)	80.00 (75.00,90.00)	0.481
Laboratory data				
GFR, mL/min/1.73m ²	4.82 (3.70,6.40)	4.54 (3.60,5.90)	5.50 (3.80,6.57)	0.053
Creatinine, µmol/L	826.50 (678.80,1043.00)	876.00 (695.00,1075.20)	803.00 (650.00,1021.00)	0.029[*]
Urea, mmol/L	27.67 (20.91,34.97)	29.28 (22.85,37.21)	26.97 (20.02,34.35)	0.006^{**}
Sodium, mmol/L	141.20 (138.68,143.85)	141.30 (138.20,143.60)	141.00 (138.70,144.00)	0.958
Potassium, mmol/L	4.70 (4.13,5.35)	4.70 ± 0.83	4.73 (4.15,5.38)	0.376
Calcium, mmol/L	1.94 (1.75,2.10)	1.94 ± 0.32	1.94 (1.75,2.08)	0.263
Phosphorus, mmol/L	2.09 (1.75,2.30)	2.11(1.81,2.50)	1.97 (1.72,2.21)	0.003^{**}
PD, Peritoneal Dialysis; SBP, systolic blood pressure; DBP, diastolic blood pressure; PTH, Parathyroid Hormone; CRP, C-reactive protein; WBC, white blood cell count; PLR, platelet-to-lymphocyte ratio; HbA1c, Hemoglobin A1c; TG, Triglyceride; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TC, Total Cholesterol; COPD, Chronic Obstructive Pulmonary Disease.				
*p < 0.05. **p < 0.01. ***p < 0.001.				

Characteristics	All PD patients (n = 550)	Technical survival group (n = 155)	Technical failure group (n = 395)	P value
Demographic data				
Serum Albumin, g/L	37.40 (34.00,40.50)	38.80 (35.30,41.20)	36.90 (33.70,40.10)	0.001^{***}
PTH, pg/mL	283.60 (209.95,370.35)	312.45 (198.20,446.40)	269.80 (211.90,339.40)	0.053
CRP, mg/L	7.43 (3.16,14.32)	6.73 (1.68,16.19)	7.43 (5.31,12.98)	0.055
Hemoglobin, g/L	75.00 (66.00,87.00)	79.30 ± 16.55	75.00 (65.00,85.00)	0.023[*]
WBC, ×10 ⁹ /L	6.21 (4.99,7.90)	5.85(4.83,7.50)	6.37 (5.07,8.05)	0.030[*]
Platelets, ×10 ⁹ /L	164.00 (123.00,203.00)	162.00 (126.00,203.00)	164.00 (123.00,202.00)	0.915
Lymphocyte count, ×10 ⁹ /L	0.99 (0.73,1.29)	0.94 (0.73,1.29)	1.00 (0.72,1.30)	0.872
PLR	159.61 (121.48,217.48)	159.84 (122.76,210.67)	159.46(118.56,222.86)	0.987
HbA1c, %	6.05 (5.98,6.05)	6.05 (5.60,6.10)	6.05 (6.05,6.05)	0.183
Blood Glucose, mmol/L	8.33 (6.39,8.33)	6.93 (5.63,8.50)	8.33 (6.80,8.33)	0.001^{***}
TG, mmol/L	1.61 (1.14,2.08)	1.47 (1.08,2.09)	1.64 (1.15,2.07)	0.647
HDL, mmol/L	1.53 (1.18,2.66)	3.05 (1.46,4.34)	1.40 (1.11,1.70)	0.001^{***}
LDL, mmol/L	2.50 (1.90,2.97)	2.39 (1.81,2.84)	2.54 (1.92,2.98)	0.195
TC, mmol/L	3.78 (2.05,4.92)	1.63 (1.09,4.00)	4.07 (3.41,5.05)	0.001^{***}
Ejection Fraction, (%)	61.00 (56.00,65.00)	63.00 (58.88,67.00)	61.00 (57.00,65.00)	0.001^{***}
Primary renal disease, n (%)				
Chronic glomerulonephritis	232 (42.2%)	82 (52.9%)	150 (38.0%)	0.002^{**}
PD, Peritoneal Dialysis; SBP, systolic blood pressure; DBP, diastolic blood pressure; PTH, Parathyroid Hormone; CRP, C-reactive protein; WBC, white blood cell count; PLR, platelet-to-lymphocyte ratio; HbA1c, Hemoglobin A1c; TG, Triglyceride; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TC, Total Cholesterol; COPD, Chronic Obstructive Pulmonary Disease.				
*p < 0.05. **p < 0.01. ***p < 0.001.				

Characteristics	All PD patients (n = 550)	Technical survival group (n = 155)	Technical failure group (n = 395)	P value
Demographic data				
Diabetic kidney disease	187 (34.0%)	37 (23.9%)	150 (38.0%)	0.002**
Hypertensive nephropathy	72 (13.1%)	14 (9.0%)	58 (14.7%)	0.077
Polycystic kidney disease	7 (1.3%)	2 (1.3%)	5 (1.3%)	1.000
Obstructive nephropathy	47 (8.5%)	19 (12.3%)	28 (7.0%)	0.051
Gouty nephropathy	5 (0.9%)	1 (0.6%)	4 (1.0%)	1.000
Comorbidity, n (%)				
Diabetes mellitus	205 (37.3%)	44 (28.3%)	161 (40.8%)	0.007**
High blood pressure	496 (90.2%)	138 (89.0%)	358 (90.6%)	0.570
Heart failure	300 (54.5%)	58 (37.4%)	242 (61.3%)	0.001***
Cardiovascular disease	367 (66.7%)	80 (51.6%)	287 (72.7%)	0.001***
Digestive tract hemorrhage	13 (2.4%)	4 (2.6%)	9 (2.3%)	0.764
Cerebrovascular disease	44 (8.0%)	11 (7.1%)	33 (8.4%)	0.625
COPD	9 (1.6%)	1 (0.6%)	8 (2.0%)	0.456
PD, Peritoneal Dialysis; SBP, systolic blood pressure; DBP, diastolic blood pressure; PTH, Parathyroid Hormone; CRP, C-reactive protein; WBC, white blood cell count; PLR, platelet-to-lymphocyte ratio; HbA1c, Hemoglobin A1c; TG, Triglyceride; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TC, Total Cholesterol; COPD, Chronic Obstructive Pulmonary Disease.				
*p < 0.05. **p < 0.01. ***p < 0.001.				

3.2 Patients'outcomes

Among the 550 patients, 205 (37.3%) had DM. At the end of follow-up, 155 patients (28.2%) remained on PD, 265 patients (48.2%) died, and 130 patients (23.6%) transferred to hemodialysis (HD). Among the 155 patients remaining on PD, 44 (22.9%) had DM, and 111 (32.2%) did not have DM ($p = 0.007$). Among the 265 deceased patients, 111 (54.2%) had DM, and 154 (44.6%) did not have DM ($p = 0.033$). There was a

statistically significant difference in the cause of death between the two groups in terms of infection ($p < 0.041$). The causes of death in DM patients were cardiovascular disease (46.0%), cerebrovascular disease (9.9%), infection (14.4%), other causes (18.9%), tumor (0%), and unknown (10.8%). The causes of death in NDM patients were cardiovascular disease (34.4%), cerebrovascular disease (10.4%), infection (24.7%), other causes (14.3%), tumor (2.6%), and unknown (13.6%). Cardiovascular disease was the main cause of death in both DM and NDM patients. Other causes (advanced age, gastrointestinal bleeding, economic problems, malnutrition, etc.) were the secondary cause of death in DM patients, while infection was the secondary cause of death in NDM patients. No significant differences were observed between the two groups in the reasons for transfer to HD, including peritonitis, catheter mechanical problems (catheter displacement, thrombosis, catheter blockage, puncture site injury), ultrafiltration failure, personal reasons, cancer, thoracoabdominal fistula, and unknown reasons (Table 2).

Table 2
Outcomes of patients.

Characteristics	All PD patients (n = 550)	DM group (n = 205)	NDM group (n = 345)	P value
Outcomes, n (%)				
Stay on PD	155 (28.2%)	44 (22.9%)	111 (32.2%)	0.007**
Death	265 (48.2%)	111 (54.2%)	154 (44.6%)	0.033*
Transferred to HD	130 (23.6%)	50 (22.9%)	80 (23.2%)	0.748
Causes of death, n (%)				
Cardiovascular disease	104 (39.2%)	51 (46.0%)	53 (34.4%)	0.058
Cerebrovascular disease	27 (10.2%)	11 (9.9%)	16 (10.4%)	0.899
Infection	54 (20.4%)	16 (14.4%)	38 (24.7%)	0.041*
Others	43 (16.2%)	21 (18.9%)	22 (14.3%)	0.313
Cancer	4 (1.5%)	0 (0)	4 (2.6%)	-
Unknown	33 (12.5%)	12 (10.8%)	21 (13.6%)	0.492
Causes of switch to HD, n (%)				
Peritonitis	33 (25.4%)	13 (26.0%)	20 (25.0%)	0.899
Catheter complications	21 (16.1%)	7 (14.0%)	14 (17.5%)	0.598
Ultrafiltration failure	24 (18.5%)	7 (14.0%)	17 (21.3%)	0.300
Personal intention	35 (26.9%)	13 (26.0%)	22 (27.5%)	0.851
Cancer	3 (2.3%)	0 (0)	3 (3.7%)	-
Thoracoabdominal fistula	11(8.5%)	7 (14.0%)	4 (5.0%)	0.073
Unknown	3 (2.3%)	3 (6.0%)	0 (0)	-
DM, Diabetes Mellitus; PD, Peritoneal Dialysis; HD, Hemodialysis. *p < 0.05. **p < 0.01. ***p < 0.001.				

3.3 Predictors of technical mortality in PD patients

To further investigate the risk factors for technique failure (death or transfer to HD) in PD patients, univariate and multivariate Cox regression analyses were applied. The results of univariate Cox regression analysis demonstrated that age, male, SBP, GFR, creatinine, phosphorus, serum albumin, PTH, CRP, blood glucose, chronic glomerulonephritis, diabetic kidney disease, heart failure, cardiovascular disease, cerebrovascular disease, and COPD were significant risk factors for technique failure (Table 3). Variables with statistical significance in the final model included: age (HR = 1.022, [CI]: 1.013–1.031, $p <$

0.001), systolic blood pressure (HR = 1.006, 95% CI: 1.001–1.011, $p = 0.018$), serum albumin (HR = 0.975, 95% CI: 0.960–0.991, $p = 0.002$), history of diabetic kidney disease (HR = 1.511, 95% CI: 1.224–1.864, $p < 0.001$), and comorbid COPD (HR = 2.447, 95% CI: 1.199–4.997, $p = 0.014$). From a clinical practice perspective, for each 1-year increase in age, the risk of technique failure increases by 2.2%; for each 1 mmHg increase in systolic blood pressure, the risk increases by 0.6%; and for each 1 g/L decrease in serum albumin level, the risk increases by 2.5%. Patients with a history of diabetic kidney disease have a 1.51-fold higher risk of technique failure than those without, while patients with comorbid COPD have a 2.45-fold higher risk than those without comorbidities (Table 4).

Table 3
Cox model analysis of independent risk factors for technique mortality in PD patients.

Characteristics	HR (95% CI)	p value
Demographic data		
Age,years	1.027 (1.018–1.036)	0.001 ^{***}
Male,n(%)	0.794 (0.651–0.968)	0.022 [*]
Mountainous Area, n(%)	1.161 (0.946–1.426)	0.154
Dialysis vintage, months		
Systolic BP, mmHg	1.009 (1.004–1.013)	0.001 ^{***}
Diastolic BP, mmHg	1.001 (0.998–1.003)	0.461
Laboratory data		
GFR, mL/min/1.73m ²	1.073 (1.030–1.118)	0.001 ^{***}
Creatinine, µmol/L	0.999 (0.999-1.000)	0.001 ^{***}
Urea, mmol/L	1.001 (0.998–1.005)	0.386
Sodium, mmol/L	1.008 (0.985–1.031)	0.507
Potassium, mmol/L	1.095 (0.985–1.217)	0.094
Calcium, mmol/L	0.895 (0.637–1.257)	0.520
Phosphorus, mmol/L	0.792 (0.660–0.950)	0.012 [*]
Serum Albumin, g/L	0.967 (0.953–0.982)	0.001 ^{***}
PTH, pg/mL	0.999 (0.999-1.000)	0.030 [*]
CRP, mg/L	1.004 (1.001–1.008)	0.005 ^{**}
Hemoglobin, g/L	1.001 (0.995–1.007)	0.817
WBC, ×10 ⁹ /L	1.031 (0.996–1.067)	0.084
Platelets, ×10 ⁹ /L	1.001 (1.000-1.002)	0.080
Lymphocyte Count, ×10 ⁹ /L	1.113 (0.968–1.279)	0.132
PLR	1.000 (0.999–1.001)	0.668
HbA1c, %	1.064 (0.904–1.252)	0.457
*p < 0.05. **p < 0.01. ***p < 0.001.		

Characteristics	HR (95% CI)	p value
Blood Glucose, mmol/L	1.063 (1.014–1.114)	0.010*
TG, mmol/L	1.031 (0.943–1.128)	0.498
HDL, mmol/L	0.994 (0.909–1.087)	0.895
LDL, mmol/L	1.033 (0.947–1.126)	0.463
TC, mmol/L	1.023 (0.964–1.087)	0.454
Ejection Fraction (%)	0.981 (0.962–1.000)	0.053
Primary disease [n(%)]		
Chronic glomerulonephritis	0.660 (0.538–0.810)	0.001***
Diabetic kidney disease	1.732 (1.408–2.130)	0.001***
Hypertensive nephropathy	1.086 (0.822–1.436)	0.560
Polycystic kidney disease	0.572 (0.235–1.392)	0.218
Obstructive nephropathy	0.794 (0.541–1.167)	0.241
Gouty nephropathy	0.961 (0.358–2.578)	0.937
Comorbidity [n(%)]		
High blood pressure	0.947 (0.674–1.331)	0.755
Heart failure	1.260 (1.028–1.544)	0.026*
Cardiovascular disease	1.353 (1.084–1.689)	0.008**
Digestive tract hemorrhage	1.174 (0.66–2.274)	0.635
Cerebrovascular disease	1.632 (1.138–2.341)	0.008***
COPD	2.954 (1.463–5.966)	0.003*
*p < 0.05. **p < 0.01. ***p < 0.001.		

Table 4
Multivariate Cox regression analysis of predictors of technique mortality in PD patients.

Characteristics		Univariate Cox regression		Multivariate Cox regression	
		HR (95%CI)	p value	HR (95%CI)	p value
Age, years	1 year	1.011 (0.995–1.027)	0.192	1.022 (1.013–1.031)	0.001^{***}
Male, n(%)	-	0.870 (0.615–1.230)	0.430		
Systolic BP, mmHg	1 mmHg	1.005 (0.997–1.012)	0.221	1.006 (1.001–1.011)	0.018[*]
GFR, mL/min/1.73m ²	1 mL/min/1.73m ²	0.966 (0.853–1.093)	0.581		
Creatinine, µmol/L	1µmol/L	1.000 (0.998–1.001)	0.480		
Phosphorus, mmol/L	1 mmol/L	0.952 (0.699–1.296)	0.753		
Serum Albumin, g/L	1 g/L	0.977 (0.951–1.003)	0.083	0.975 (0.960–0.991)	0.002[*]
PTH, pg/mL	1 pg/mL	1.001 (1.000–1.002)	0.190		
CRP, mg/L	1 mg/L	1.002 (0.998–1.007)	0.286		
Blood Glucose, mmol/L	1 mmol/L	1.021 (0.963–1.082)	0.485		
Chronic glomerulonephritis	-	1.609 (0.896–2.891)	0.111		
Diabetic kidney disease	-	2.717 (1.640–4.501)	0.001^{***}	1.511 (1.224–1.864)	0.001^{***}
Heart failure	-	0.840 (0.561–1.257)	0.396		
Cardiovascular disease	-	1.327 (0.858–2.053)	0.203		
Cerebrovascular disease	-	1.376 (0.839–2.257)	0.205		
COPD	-	4.791 (1.430–16.046)	0.011[*]	2.447 (1.199–4.997)	0.014[*]
*p < 0.05. **p < 0.01. ***p < 0.001.					

3.4 Kaplan-Meier curves for technical survival

In this study, Kaplan-Meier survival curves and Log-rank tests were used to analyze and compare the differences in survival rates between the DM and NDM group. The results showed that the overall survival rate and technique-related survival rate of the NDM group were significantly higher than those of the DM group ($p < 0.001$) (Fig. 2A-B). These results indicate that diabetes mellitus is an important risk factor affecting long-term technique survival rate.

In addition, we evaluated the effects of different serum albumin levels (35.0 g/L, 30.0 g/L, 25.0 g/L), age groups (58 years old, 75 years old), SBP levels, COPD and DM status on technique survival. The results showed that the technique survival rate of the serum albumin ≥ 35.0 g/L group was significantly higher than that of the < 35.0 g/L group in the overall population ($p = 0.002$) and the NDM subgroup ($p = 0.005$), but there was no statistically significant difference in the DM subgroup ($p = 0.795$) (Fig. 3A-C). When 30.0 g/L was used as the cut-off value, there was no significant difference in the overall population ($p = 0.411$), NDM subgroup ($p = 0.534$) or DM subgroup ($p = 0.782$) (Fig. 3D-F). Only within the NDM subgroup did patients with serum albumin ≥ 25.0 g/L show a significantly better survival rate ($p = 0.031$) (Fig. 3G-H). For age and SBP, in both the overall and NDM populations, younger patients (< 58 years or < 75 years) and those with SBP < 148 mmHg exhibited significantly superior technique survival ($p < 0.003$) (Fig. 4A-E, Fig. 5A-B). Nevertheless, these associations were not statistically significant within the DM subgroup ($p > 0.05$) (Fig. 4C, 4F, Fig. 5C). Non-COPD patients consistently showed significantly higher technique survival rates than COPD patients across the overall population, NDM subgroup, and DM subgroup ($p = 0.001$, $p = 0.040$, and $p = 0.001$, respectively) (Fig. 5D-F).

4. Discussion

In this study, we comprehensively compared clinical outcomes and technique failure risk factors between DM and NDM patients on PD. Although diabetes has long been recognised as a predictor of PD failure^[13, 14], systematic investigations into whether classic prognostic factors—age, blood pressure, serum albumin, and comorbidities—operate differently in these two populations remain scarce, especially in northern Hunan province, China. Our data indicated that diabetic PD patients fared significantly worse in terms of both overall and technique survival. Notably, age, SBP, serum albumin, and COPD predicted technique failure only in NDM individuals, with no such associations observed within the DM subgroup. This pattern suggests that the metabolic and vascular derangements inherent to diabetes may overshadow the prognostic value of these individual markers. Consequently, our findings argue against a uniform risk assessment approach and support the adoption of diabetes tailored management strategies for PD patients.

In our cohort, technique survival and overall survival were both significantly inferior in diabetics compared with non-diabetics PD patients ($p < 0.001$), corroborating a wealth of earlier evidence. A Portuguese study reported worse patient survival among diabetics, closely echoing the poorer outcomes we observed^[15]. Likewise, an Australian-New Zealand cohort of 8,279 PD patients identified the highest risks of technique failure and death in those with type 2 diabetes and DKD^[13]. These results conducted across

geographically and ethnically diverse populations, and consistently confirm that diabetes is a strong negative prognostic indicator in PD survival rate.

Cardiovascular disease accounted for the largest share of deaths in both groups, but its proportion was higher in DM (46.0%) than in NDM (34.4%). Consistent with previous reports, cardiovascular events are the leading mortality cause in PD, because diabetes accelerates atherosclerosis and microvascular damage, thereby increasing the risks of heart failure, myocardial infarction and sudden death^[13, 14]. Infection ranked second among NDM decedents (24.7%) but was relatively less frequent in DM (14.4%), and this intergroup difference was statistically significant ($p = 0.041$). This does not mean that infection is inconsequential in diabetic patients, rather, cardiovascular mortality is so pronounced that it relegates infection to a lower relative position. In fact, multiple studies have shown that diabetes not only increases the risk of PD associated peritonitis but also worsens its severity^[16, 17, 31]. Diabetics have higher cardiovascular mortality and infection susceptibility. It can be attributed to the combined effects of diabetes-related metabolic disorders, immune impairment, and multiple coexisting comorbidities. Hence, infection remains a clinically important issue that demands ongoing surveillance.

One of the most striking observations in our study is that traditional risk factors (advancing age, elevated SBP, low serum albumin and COPD) were independent predictors of technique failure in the whole cohort. Nevertheless, these associations disappeared in the DM subgroup when patients were divided into DM and NDM groups. A plausible explanation is that diabetic patients are already burdened with chronic inflammation, protein energy wasting, autonomic neuropathy and extensive vascular damage. These coexisting conditions collectively determine the disease prognosis, thereby reducing the discriminative power of individual factors. Subgroup analyses reinforced this view: higher serum albumin (≥ 35.0 g/L) was protective for technique survival in the overall population ($p = 0.002$) and in NDM patients ($p = 0.005$), but not in the DM subgroup. Applying a cut off of 25.0 g/L, we found that only NDM patients with albumin ≥ 25.0 g/L enjoyed significantly better survival ($p = 0.031$). Prior work from Zhongshan Hospital, Guangzhou, has identified reduced albumin as a common feature in elderly patients and a robust predictor of survival^[18]. Similarly, a Suzhou based study noted that baseline albumin was significantly lower in elderly PD patients who died during follow up than in survivors, and hypoalbuminemia independently predicted mortality risk^[19]. Diabetics have a more complex metabolic milieu, persistent inflammatory state, and protein energy depletion, all of which can diminish the prognostic value of a single albumin measurement. These considerations point to the need for dynamic albumin monitoring and interpretation that accounts for diabetes status, as well as individualised nutritional interventions^[20].

The influence of age and blood pressure may also be diminished, as diabetes itself subjects patients to a significantly higher baseline risk.^[21, 22] Our subgroup analyses indicated that each additional year of age raised the technique failure hazard by 2.2%. Patients younger than 58 or 75 years, and those with SBP below 148 mmHg showed significantly better technique survival in the overall cohort and among NDM. However, these benefits were not statistically evident in the DM subgroup. A Suzhou study on elderly PD patients reported that those aged ≥ 75 years had significantly higher mortality and technique failure rates than those aged 65–74 years^[19]. International data similarly show that dialysis initiation after age 75 is

linked to poorer survival, with age and comorbidity burden substantially influencing treatment decisions and outcomes in elderly patients with ESRD^[22, 23]. The 2024 KDIGO guidelines emphasise blood pressure control to reduce cardiovascular risk and slow disease progression in CKD^[24]. Shamspour et al. identified hypertension as a key determinant of PD outcomes^[21]. In diabetic patients, the cumulative burden of diabetes-related comorbidities may reduce the additional prognostic effect of age. The diminished impact of blood pressure in this population may stem from higher baseline cardiovascular risk, more advanced vascular lesions and a greater prevalence of autonomic dysfunction. All these factors may influence the association between blood pressure and clinical outcomes. Taken together, for diabetic PD patients, a comprehensive management encompassing strict control of blood glucose and blood pressure, cardiovascular risk reduction, and nutritional support is more appropriate than focusing narrowly on single indicators such as albumin or blood pressure.

COPD stood out as a particularly strong risk factor for technical failure in our study (HR = 2.447, 95% CI 1.199–4.997, $p = 0.014$), conferring a 2.45 fold higher risk of technique failure compared with patients without COPD. Subgroup analyses consistently showed that non-COPD patients had superior technique survival across all strata. This finding underscores the critical importance of thorough comorbidity assessment before PD initiation, given the well documented adverse effect of COPD on survival in dialysis populations^[22,25]. The mechanisms linking COPD to technique failure are likely multifaceted, involving chronic systemic inflammation, impaired respiratory mechanics that affect intra abdominal pressure and peritoneal fluid exchange, malnutrition, and increased vulnerability to infections.

This study has several limitations. Firstly, the retrospective, single center design may introduce selection bias and residual confounding. Secondly, we lacked detailed data on glycaemic control and serial HbA1c measurements, despite previous studies have already shown that linking glycaemic control to technique failure in diabetic PD patients^[26]. Thirdly, the generalisability of our results to other settings or populations requires confirmation, as PD outcomes vary considerably across regions^[27, 28, 29]. Future prospective, multicentre studies with richer data collection will be essential to validate our findings.

In summary, this study demonstrates that diabetes is associated with markedly inferior technique and overall survival in PD patients. Age, SBP, serum albumin, DKD and coexisting COPD are independent risk factors for technique failure. The prognostic significance of albumin, age, and blood pressure appears to be attenuated in diabetics, suggesting that diabetes related factors may eclipse these conventional predictors. Our results highlight the need for comprehensive risk stratification and individualised care in diabetic PD patients^[20]. Close cardiovascular monitoring, nutritional support to maintain albumin levels, optimisation of blood pressure and active management of comorbidities such as COPD are all crucial for improving outcomes in this high risk group^[24, 30]. In future studies, we will use larger sample sizes, detailed glycemic control data, and dynamic albumin levels to further elucidate the mechanisms underlying poorer outcomes in diabetic patients undergoing PD and to develop targeted intervention strategies^[26, 31].

Declarations

CRediT authorship contribution statement

Yuan Xia: Study design, Data acquisition, Statistical analysis Manuscript drafting. Haojun Fu and Ling Guo: Data acquisition, Statistical analysis, Data interpretation. Jie Zhou, Zhong Peng, and Zixu Tang: Data acquisition, Statistical analysis. Ning Gao, Jing Qin, and Wei Long: Data acquisition. Zhangxiu He: Study concept, Study design, Data acquisition, Statistical analysis, Data interpretation, Critical revision of the manuscript.

Conflict of interest

The authors declare they have no conflicts of interest.

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Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Figures

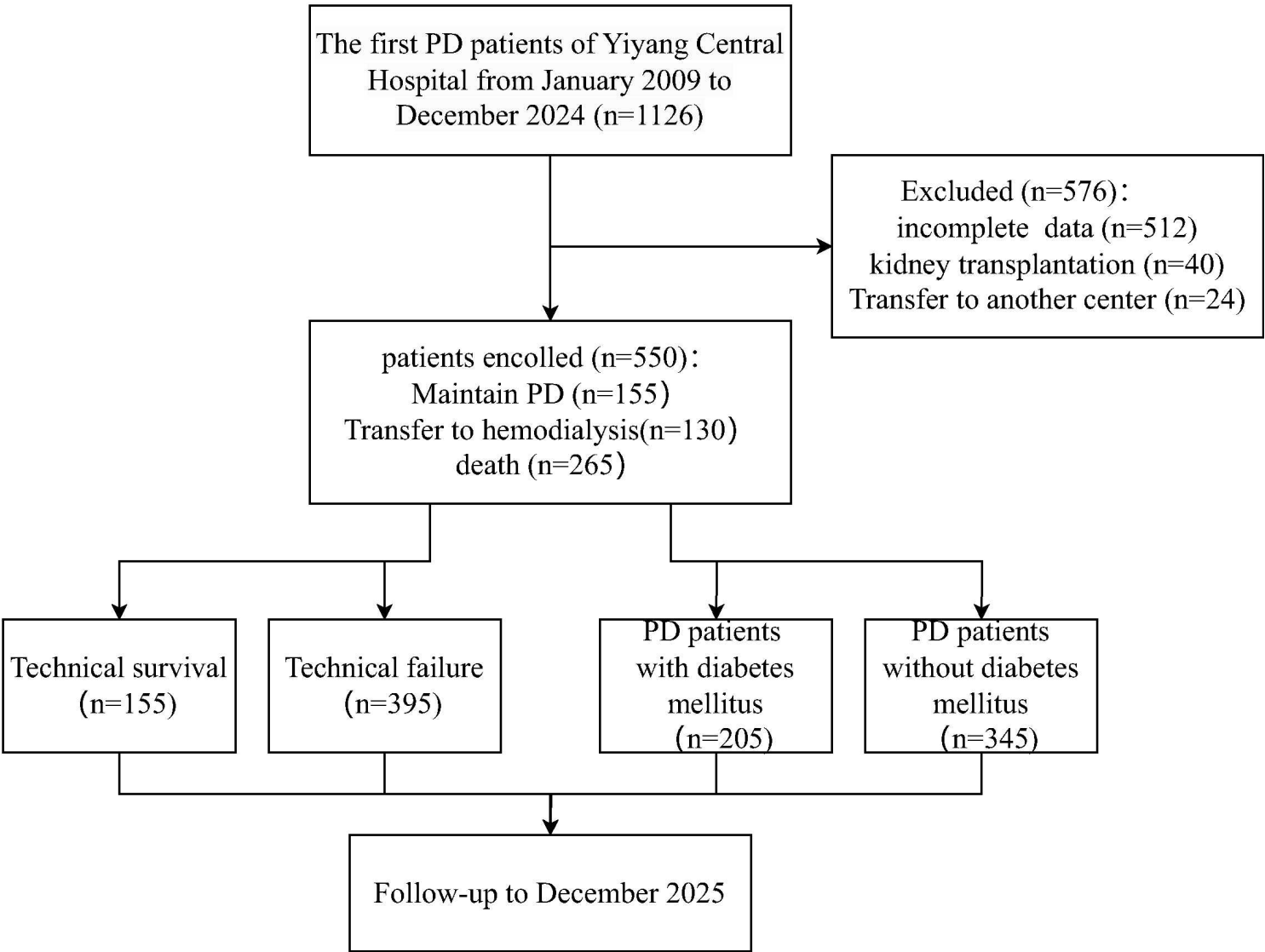


Figure 1

Flowchart of patient enrollment and outcomes. A total of 1,126 PD patients at Yiyang Central Hospital from January 2009 to December 2024 were initially screened. After excluding 576 patients (incomplete data, n=512; kidney transplantation, n=40; transfer to another center, n=24), 550 patients were enrolled. Among them, 155 maintained PD, 130 transferred to hemodialysis, and 265 died. Of the 550 patients, 205 had diabetes mellitus and 345 did not.

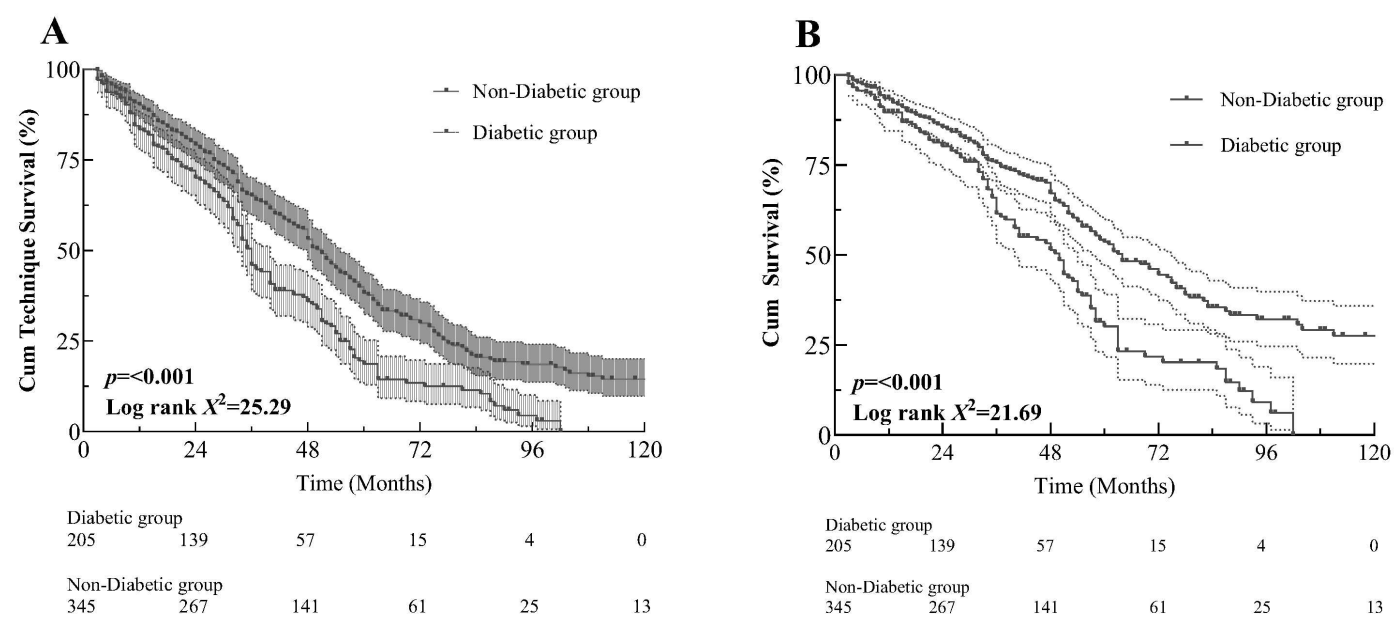


Figure 2

Kaplan-Meier survival curves comparing clinical outcomes between diabetic and non-diabetic PD patients. (A) Cum Technical Survival; (B) Cum Survival. Patients with diabetes mellitus showed significantly lower technical survival and survival compared to those without diabetes. Each panel presents the log-rank χ^2 and p value, with the number of patients at risk at 0, 12, 24, 48, 72, and 96 months tabulated below.

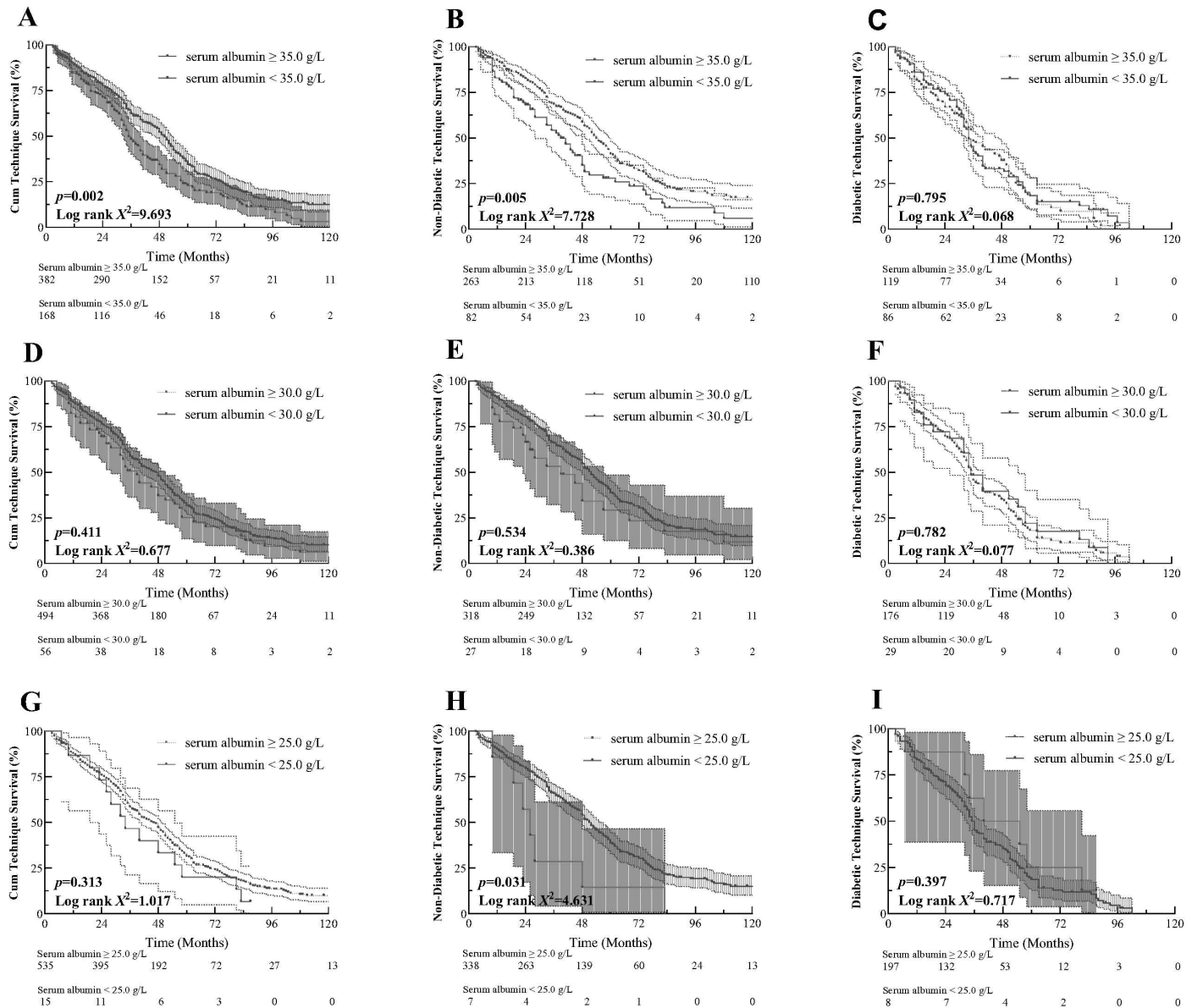


Figure 3

Kaplan-Meier survival curves for PD patients stratified by different serum albumin levels. (A-C) Stratified by serum albumin ≥ 35.0 vs. < 35.0 g/L for (A) Cum Technical Survival, (B) Non-Diabetic Technique Survival and (C) Diabetic Technique Survival; (D-F) Stratified by serum albumin ≥ 30.0 vs. < 30.0 g/L for (D) Cum Technical Survival, (E) Non-Diabetic Technique Survival and (F) Diabetic Technique Survival; (G-I) Stratified by serum albumin ≥ 25.0 vs. < 25.0 g/L for (G) Cum Technical Survival, (H) Non-Diabetic Technique Survival and (I) Diabetic Technique Survival. Each panel presents the log-rank χ^2 and p value, with the number of patients at risk at 0, 12, 24, 48, 72, and 96 months tabulated below.

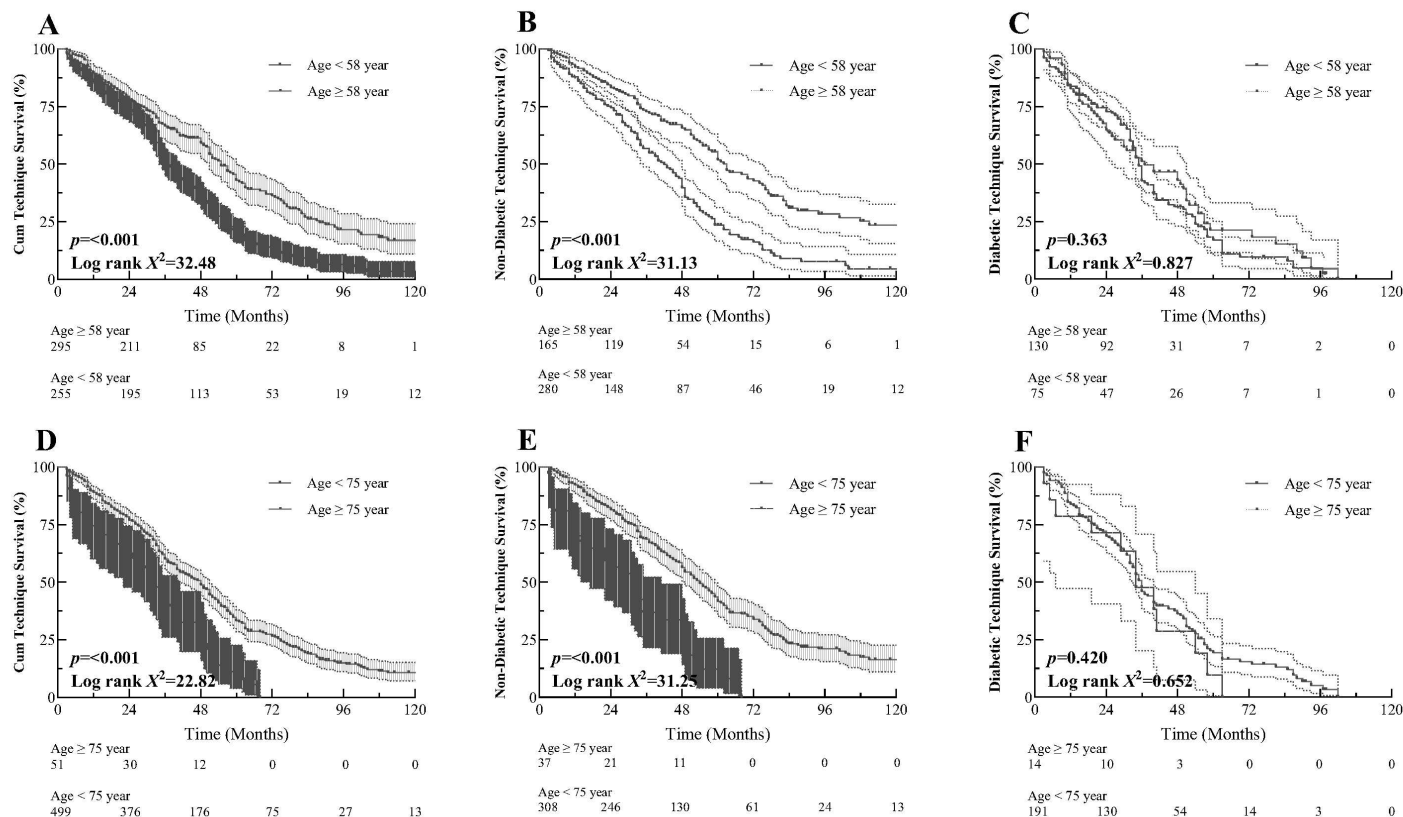


Figure 4

Kaplan-Meier survival curves for PD patients stratified by age levels. (A-C) Stratified by age ≥ 58 years vs. < 58 for (A) Cum Technical Survival, (B) Non-Diabetic Technique Survival and (C) Diabetic Technique Survival; (D-F) Stratified by age ≥ 75 years vs. < 75 for (D) Cum Technical Survival, (E) Non-Diabetic Technique Survival and (F) Diabetic Technique Survival. Each panel presents the log-rank χ^2 and p value, with the number of patients at risk at 0, 12, 24, 48, 72, and 96 months tabulated below. The age cutoff of 58 years was determined based on the median age of the cohort.

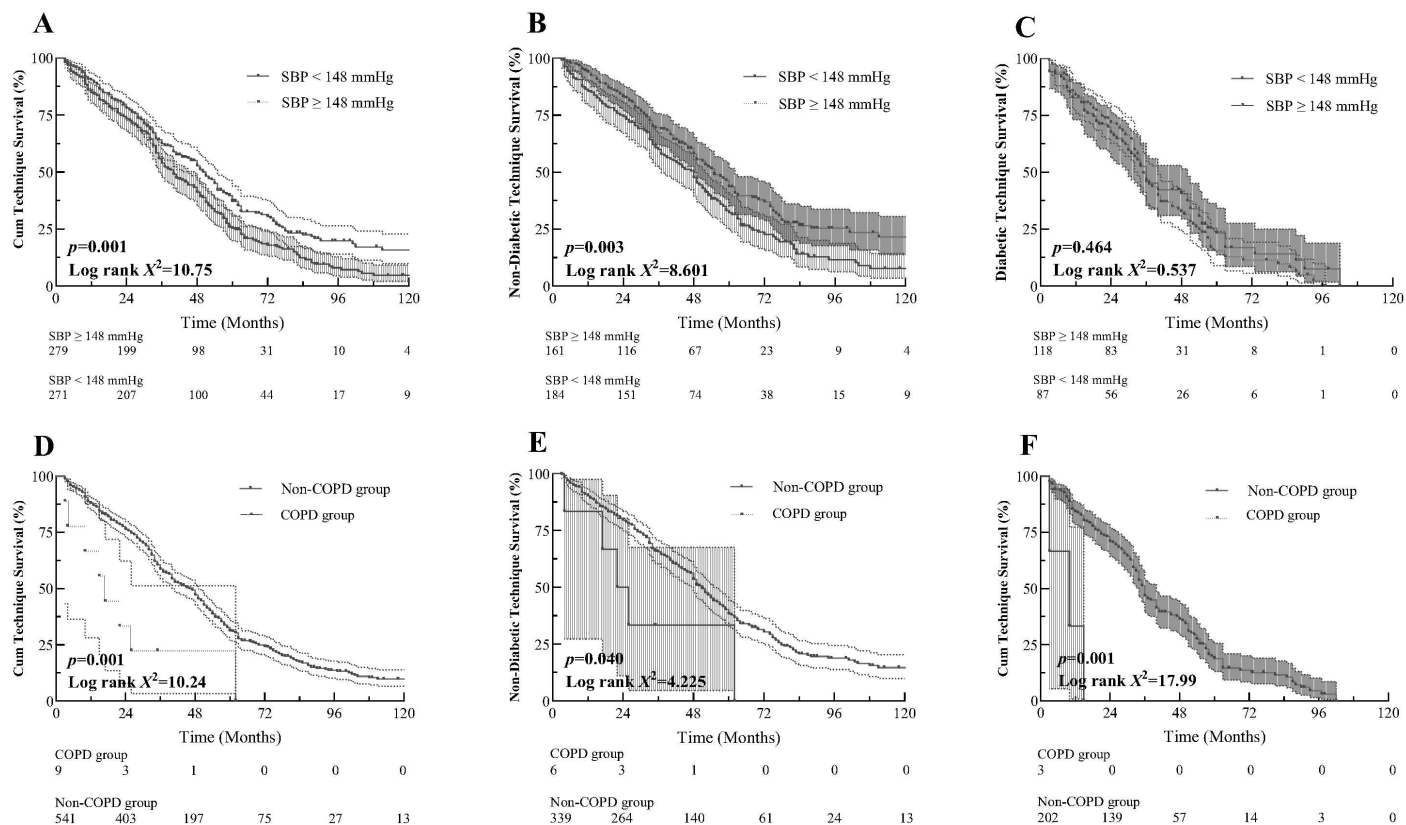


Figure 5

Kaplan-Meier survival curves for PD patients stratified by systolic blood pressure (SBP) and COPD status. (A) Cum Technical Survival by SBP < 148 vs. ≥ 148 mmHg; (B) Non-Diabetic Technique Survival; (C) Diabetic Technique Survival; (D) Cum Technical Survival by COPD vs. Non-COPD; (E) Non-Diabetic Technique Survival ; (F) Diabetic Technique Survival. Each panel presents the log-rank χ^2 and p value, with the number of patients at risk at 0, 12, 24, 48, 72, and 96 months tabulated below. The SBP cutoff of 148 mmHg was determined based on the median baseline SBP level of the cohort. COPD, chronic obstructive pulmonary disease.