APCN✕TSN 2025
23rd Asian Pacific Congress of Nephrology
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23rd Asian Pacific Congress of Nephrology

Dec. 5 Fri. ▷ Dec. 7 Sun. 2025
TaiNEX 2, Taipei Taiwan

Impact of Diabetes on Clinical Features and Outcomes of Peritoneal Dialysis-associated Peritonitis

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Introduction

- End-stage kidney disease (ESKD) continues to rise worldwide, with diabetes mellitus remaining the leading cause.[1]

- Diabetic patients face specific challenges in kidney replacement therapy due to higher rates of cardiovascular disease, autonomic neuropathy, and increase vulnerability to infections.[2]

- Peritoneal dialysis (PD) is often preferred in this group as it avoids the hemodynamic fluctuations associated with hemodialysis.[3]

1. Koye et al. The Global Epidemiology of Diabetes and Kidney Disease. Adv Chronic Kidney Dis. 2018
2. Cotovio P et al. Peritoneal Dialysis in Diabetics: There Is Room for More. Int J Nephrol. 2011
3. Kuriyama S. Peritoneal dialysis in patients with diabetes: Are the benefits greater than the disadvantages? Perit Dial Int. 2007

Introduction

- Diabetes is associated with impaired immune function, weakened host defenses, and delayed symptom recognition from neuropathy. These factors may influence both the clinical presentation and outcomes of PD-related peritonitis.[4]

- Concerns remain that diabetic PD patients may experience higher complication rates – including peritonitis, hospitalization, technique failure, catheter loss, and mortality.[5]

4.Berbudi A et al. Type 2 Diabetes and its Impact on the Immune System. Curr Diabetes Rev. 2019
5.Joshi N et al. Infections in Patients with Diabetes Mellitus. N Engl J Med. 1999

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Primary Outcome

- To assess medical cure outcomes in PD-associated peritonitis among patients with diabetes compared with those without diabetes.

Secondary Outcomes

- To compare the causative organisms and clinical features of peritonitis among diabetes and non-diabetes.

- To evaluate relapsing or recurrent peritonitis, PD-associated catheter removal, hospitalization and death.

Definitions

- Medical Cure

  - Complete resolution of peritonitis together with none of the following complications: relapse/recurrent peritonitis, catheter removal, transfer to haemodialysis for ≥ 30 days or death.[6]

- Relapsing peritonitis

  - Peritonitis episode that occurs within 4 weeks of completion of antibiotic therapy of a prior episode with the same organism or one sterile (culture negative) episode.[6]

- Recurrent Peritonitis

  - Peritonitis episode that occurs within 4 weeks of completion of therapy of a prior episode but with a different organism.[6]

- Peritonitis-associated death

  - Death occurring within 30 days of peritonitis onset or death during hospitalisation due to peritonitis.[6]

6.Li PKT, Chow KM, Cho Y, et al. ISPD peritonitis guideline recommendations: 2022 update on prevention and treatment.

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Study Design and Methods

- **Design:** Retrospective, cohort, single-center at Singapore General Hospital

- **Population:** All episodes of peritonitis in PD patients between 2013 to 2024

- **Data collection**: Demographics, presence of cardiovascular disease, etiology of kidney failure, clinical presentation, imaging utilization, and peritonitis-related outcomes

Study Design and Methods

- **Statistical methods**
  - Categorical variables
    - Frequency
    - Chi-squared test
  - Continuous variables (normally distributed)
    - Student's t-test
  - Continuous variables (non-normally distributed)
    - Wilcoxon rank-sum test
  - Peritonitis outcomes
    - Multilevel mixed-effects logistic regression models
    - P values < 0.05 – statistically significant

Demographic and Baseline Data of Study Population

Variables	All patients	Patients with Diabetes	Patients without Diabetes	P value
	(n=376)	(n=187)	(n=189)	
Age	62.5±14	64.7±13	60.3±14	0.002
Gender, male	190(51)	102(55)	88(47)	0.12
Race				0.005
Chinese	309(82)	142(76)	167(88)	
Malay	51(14)	36(19)	15(8)	
Indian	12(3)	8(4)	4(2)	
Others	4(1)	1(0.5)	3(2)	
Cardiovascular disease	141(38)	97(52)	44(23)	0.03
Primary renal disease				< 0.001
Diabetes mellitus	180(48)	180(93)	0(0)	
Hypertension	70(19)	3(2)	67(37)	
Chronic Glomerulonephritis	97(26)	6(3)	91(50)	
Polycystic Kidney Disease	10(3)	1(0.5)	9(5)	
Others	19(5)	3(1.5)	16(8)	
Modality of PD (CAPD)	100(27)	45(24)	55(29)	0.27
On Welfare Support	156(42)	88(47)	68(36)	0.03
Time to First Peritonitis (months)	15.1	14.4	15.8	0.20

Presentation Symptoms of of Peritonitis Episodes

Variables	Diabetes	Non-diabetes	P value
	(n=312)	(n=379)	
Presenting symptoms			
Fever	64 (23)	102 (30)	0.04
Cloudy effluent	194 (69)	250 (74)	0.14
Abdominal pain	206 (73)	275 (81)	0.01
Hypotension	25 (9)	37 (11)	0.38
Effluent cell counts on presentation	12±76	8.32±11	0.36
Abdominal imaging for peritonitis	151 (48)	204 (54)	0.16

Causative Organisms of Peritonitis Episodes

Variables	Diabetes	non-Diabetes	P value
	(n=312)	(n=379)	
Causative organisms			0.06
Gram-positive	125 (40)	120 (32)	
Gram-negative	89 (29)	142 (37)	
Culture-negative	44 (14)	56 (15)	
Polymicrobial organisms	35 (11)	46 (12)	
Fungal/Mycobacterial	19 (6)	15 (4)	

Multivariable Logistic Regression of Medical Cure

Variables	OR	95% CI	P value
Diabetes Mellitus	1.36	0.53 – 3.50	0.52
Age	1.00	0.99 – 1.02	0.57
Race			0.25
Chinese	1.0	Reference	
Malay	0.82	0.46 – 1.46	0.50
Indian	0.79	0.24 – 2.58	0.70
Others	0.25	0.06 – 1.01	0.05
Cardiovascular disease	1.16	0.76– 1.78	0.43
On Welfare Support	10.96	0.67 – 1.48	0.84
Primary renal disease			0.31
Diabetes mellitus	1.0	Reference	
Hypertension	1.95	0.70 – 5.41	0.20
Chronic Glomerulonephritis	1.25	0.48 – 3.26	0.64
Polycystic Kidney Disease	0.93	0.26 – 3.30	0.91
Others	2.50	0.70 – 8.92	0.16
Causative organisms			< 0.001
Gram-positive	1.0	Reference	
Gram-negative	0.54	0.33 – 0.87	0.01
Culture-negative	1.04	0.53 – 2.05	0.91
Polymicrobial	0.20	0.11 – 0.35	<0.001
Fungal/Mycobacterial	0.02	0.004 – 0.05	<0.001

Multivariable Logistic Regression of Relapsing and Recurrent PD-associated Peritonitis

Variables	OR	95% CI	P value
Diabetes Mellitus	1.14	0.28 – 4.63	0.86
Age	0.99	0.97 – 1.02	0.51
Race			0.17
Chinese	1.0	Reference	
Malay	0.83	0.35 – 1.99	0.68
Indian	0.57	0.07 – 5.02	0.62
Others	6.65	1.14 – 38.8	0.04
Cardiovascular disease	1.15	0.61– 2.16	0.67
On Welfare Support	0.92	0.50 – 1.67	0.78
Primary renal disease			0.87
Diabetes mellitus	1.0	Reference	
Hypertension	0.87	0.19 – 3.94	0.20
Chronic Glomerulonephritis	0.75	0.18 – 3.21	0.70
Polycystic Kidney Disease	1.55	0.25 – 9.55	0.64
Others	1.23	0.23 – 6.61	0.81
Causative organisms			0.02
Gram-positive	1.0	Reference	
Gram-negative	1.54	0.76 – 3.15	0.23
Culture-negative	1.10	0.43 – 2.79	0.84
Polymicrobial	1.05	0.37 – 2.97	0.92
Fungal/Mycobacterial	5.71	1.98 – 16.44	0.001

Multivariable Logistic Regression of Peritonitis-related Catheter Removal

Variables	OR	95% CI	P value
Diabetes Mellitus	0.67	0.24 – 1.81	0.43
Age	0.98	0.96 – 1.00	0.01
Race			0.26
Chinese	1.0	Reference	
Malay	1.16	0.64 – 2.11	0.62
Indian	1.33	0.40 – 4.38	0.64
Others	3.40	0.98 – 16.25	0.05
Cardiovascular disease	0.97	0.61 – 1.50	1.53
On Welfare Support	1.08	0.71 – 1.64	0.71
Primary renal disease			0.70
Diabetes mellitus	1.0	Reference	
Hypertension	0.65	0.22 – 1.93	0.44
Chronic Glomerulonephritis	0.91	0.33 – 2.51	0.86
Polycystic Kidney Disease	0.86	0.22 – 3.34	0.82
Others	0.52	0.14 – 1.92	0.33
Causative organisms			<0.001
Gram-positive	1.0	Reference	
Gram-negative	1.70	1.03 – 2.82	0.04
Culture-negative	0.67	0.31 – 1.45	0.31
Polymicrobial	4.06	2.17 – 7.61	<0.001
Fungal/Mycobacterial	37.07	13.93 – 98.62	<0.001

Multivariable Logistic Regression of Peritonitis-related Hospitalization

Variables	OR	95% CI	P value
Diabetes Mellitus	0.88	0.29 – 2.60	0.81
Age	0.99	0.98 – 1.01	0.51
Race			0.99
Chinese	1.0	Reference	
Malay	1.01	0.52 – 1.98	0.98
Indian	1.13	0.29 – 4.37	0.86
Others	1.26	0.16 – 9.89	0.82
Cardiovascular disease	1.09	0.67 – 1.77	0.73
On Welfare Support	1.07	0.68 – 1.70	0.77
Primary renal disease			0.40
Diabetes mellitus	1.0	Reference	
Hypertension	0.86	0.27 – 2.75	0.80
Chronic Glomerulonephritis	1.24	0.41 – 3.75	0.71
Polycystic Kidney Disease	1.68	0.30 – 9.32	0.55
Others	2.96	0.62 – 14.07	0.17
Causative organisms			0.002
Gram-positive	1.0	Reference	
Gram-negative	2.27	1.37 – 3.77	0.002
Culture-negative	1.34	0.73 – 2.47	0.34
Polymicrobial	2.36	1.14 – 4.92	0.02
Fungal/Mycobacterial	8.84	1.89 – 41.48	0.006

Multivariable Logistic Regression of Peritonitis-related Mortality

Variables	OR	95% CI	P value
Diabetes Mellitus	1.46	0.71 – 2.30	0.31
Age	1.06	1.03 – 1.09	<0.001
Cardiovascular disease	0.80	0.38 – 1.65	0.54
Causative organisms			0.002
Gram-positive	1.0	Reference	
Gram-negative	1.55	0.54 – 4.48	0.42
Culture-negative	1.59	0.43 – 5.86	0.49
Polymicrobial	5.57	1.98 – 15.70	0.001
Fungal/Mycobacterial	6.01	1.67 – 21.64	0.006

Discussion

💡 Strength

- This study provides a direct comparison of clinical presentations and outcomes of peritonitis between diabetic and non-diabetic patients on peritoneal dialysis.
- Findings indicate outcomes of peritonitis are largely comparable between both groups.

⚠️ Limitations

- Single center, retrospective cohort study
- Limited generalizability to other populations

Conclusion

- Diabetes itself is not independently associated with worse peritonitis outcomes in our cohort.

- Although overall outcomes were comparable between diabetic and non-diabetic groups, heightened clinical vigilance remains essential, due to atypical or delayed symptoms in diabetic patients.

- Future prospective studies are needed to further clarify the impact of diabetes on PD-related peritonitis and to guide tailored clinical strategies.