



Shaping Tomorrow's Nephrology: Insight-Driven Kidney Care

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Long-Term Effects of Combined Super High-Flux and Medium-Flux Dialysis on Middle-Molecule Levels and Sleep Quality in Maintenance Hemodialysis: A Prospective Longitudinal Cohort Study

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Objectives : Super high-flux (SHF) dialyzers enhance the clearance of middle-molecule solutes, but their long-term use is often limited by cost and availability. This study evaluated the effects of combined SHF and medium-flux (MF) dialyzers on middle-molecule levels and sleep quality in patients undergoing maintenance hemodialysis.

Methods : A prospective longitudinal study was conducted in 60 maintenance hemodialysis patients (30 combined SHF–MF and 30 MF alone). The combined SHF–MF group received six SHF (Elisio HX19, Nipro, Japan) and six MF (Elisio 17M, Nipro, Japan) sessions monthly, whereas the MF group received 12 MF sessions. Pre-dialysis hematological parameters and middle-molecule concentrations were measured quarterly, while sleep quality and pruritus were evaluated at baseline and at study completion using the Pittsburgh Sleep Quality Index (PSQI) and the 5-D Itch Scale. Multivariate linear mixed-effects models were applied to examine longitudinal changes and between-group differences across time points.

Results : The overall mean age was 55.0 ± 15.2 years, and 60% were male. Longitudinal interactions for hematological parameters and parathyroid hormone levels between groups were not significant. β_2 -microglobulin levels were significantly lower in the combined SHF–MF group than in the MF-alone group at 6 months ($\beta = -7.45$, 95% CI: -10.91 to -3.99, $p < 0.001$) and 9 months ($\beta = -4.09$, 95% CI: -7.55 to -0.63, $p = 0.022$). Combined SHF–MF dialyzers were associated with a significant reduction in PSQI at 9 months compared with MF ($\beta = -2.43$, 95% CI: -4.53 to -0.34, $p = 0.027$), whereas 5-D Itch Scale did not change significantly within and between groups.

Conclusions : Combined SHF–MF dialyzers were associated with lower middle-molecule levels and potentially improved sleep quality in maintenance hemodialysis patients, suggesting a feasible approach for resource-limited settings.

table 1.jpg



Table 1. Baseline characteristics

Variables	General	Combined super high-flux	Medium-flux	p
Sample size, n	60	30	30	
Age, years	55.0 ± 15.2	56.1 ± 13.9	53.9 ± 16.4	0.576
Male, n (%)	36 (60.0)	19 (63.3)	17 (56.7)	0.278 ^b
Body mass index, kg/m ²	22.29 ± 2.23	22.42 ± 2.20	22.16 ± 2.28	0.657
Primary renal disease, n (%)				0.134 ^a
Diabetes	7 (11.7)	3 (10.0)	4 (13.3)	
Glomerulonephritis	15 (25.0)	11 (36.7)	4 (13.3)	
Hypertension	19 (31.7)	9 (30.0)	10 (33.3)	
Pyelonephritis	5 (8.3)	3 (10.0)	2 (6.7)	
Polycystic kidney disease	1 (1.7)	1 (3.3)	0 (0.0)	
Others	13 (21.7)	3 (10.0)	10 (33.3)	
Comorbidity				
Hypertension, n (%)	50 (83.3)	24 (80.0)	26 (86.7)	0.729 ^a
Diabetes, n (%)	9 (15.0)	4 (13.3)	5 (16.7)	1.000 ^a
Vascular access, n (%)				0.886 ^a
Arteriovenous fistula	57 (95.0)	29 (96.7)	28 (93.3)	
Arteriovenous graft	3 (5.0)	1 (3.3)	2 (6.7)	
Dialysis vintage, years	4 (2–8.25)	3.5 (2–12.5)	4.75 (2.25–6.75)	0.988
Blood flow rate, mL/min	234.17 ± 14.88	232.33 ± 15.69	236.00 ± 14.04	0.344
Dialysate flow rate, mL/min	450	450	450	
PSQI score	10 (6.75–12)	10 (8–12)	8.5 (6–12)	0.305
5-D Itch Scale score	9.12 (0–11)	10 (0–11.5)	7.25 (0–10.69)	0.167

Footnotes: ^a Fisher's exact test, ^b Chi-square test. **Abbreviations:** MCO, medium cut-off; PSQI, Pittsburgh Sleep Quality Index.

table 1.jpg



Table 2. Linear mixed-effects model for middle-molecule levels

Variables	Parathyroid hormone			B2-microglobulin		
	β (Estimate)	95% CI	p	β (Estimate)	95% CI	p
Main effect: Time (Combined super high-flux group)						
3 months	-77.98	-174.23 to 18.27	0.114	0.04	-2.40 to 2.48	0.975
6 months	-98.96	-196.63 to -1.29	0.049	-1.31	-3.75 to 1.13	0.294
9 months	-87.80	-185.74 to 10.13	0.081	-0.08	-2.52 to 2.36	0.947
Interaction: Time $\times$ Group (Medium-flux versus combined super high-flux)						
3 months	-1.96	-22.46 to 18.54	0.851	1.46	-1.99 to 4.92	0.409
6 months	3.84	-16.53 to 24.21	0.712	7.45	3.99 to 10.91	<0.001
9 months	12.51	-7.79 to 32.81	0.228	4.09	0.63 to 7.55	0.022

Footnotes: β coefficients (95% confidence intervals) were estimated using linear mixed-effects models with random intercepts, adjusted for covariates. Main effects show changes from baseline within the combined super high-flux group, interactions show differences in change over time between the medium-flux and combined super high-flux groups.

Table 3. Linear mixed-effects model for quality-of-life scores

Variables	PSQI score			5-D Itch Scale score		
	β (Estimate)	95% CI	p	β (Estimate)	95% CI	p
Main effect: Time (Combined super high-flux group)						
9 months	-0.27	-1.75 to 1.22	0.726	-0.73	-3.23 to 1.78	0.574
Interaction: Time $\times$ Group (Medium-flux versus combined super high-flux)						
9 months	2.43	0.34 to 4.53	0.027	2.69	-0.86 to 6.24	0.143

Footnotes: β coefficients (95% confidence intervals) were estimated using linear mixed-effects models with random intercepts, adjusted for age and sex. Main effects show changes from baseline within the combined super high-flux group, interactions show differences in change over time between the medium-flux and combined super high-flux groups.

Abbreviations: PSQI, Pittsburgh Sleep Quality Index.