



Shaping Tomorrow's Nephrology: Insight-Driven Kidney Care

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Time-Varying Ultrafiltration Rate and Mortality in Hemodialysis Patients: a Nationwide Prospective Cohort in Korea

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Objectives : Patients undergoing maintenance hemodialysis experience markedly elevated mortality, predominantly driven by cardiovascular disease. Higher ultrafiltration rate (UFR) may represent a potentially modifiable determinant of adverse outcomes. Therefore, we examined its association with mortality in an Asian hemodialysis cohort.

Methods : We analyzed incident hemodialysis patients from a nationwide prospective cohort in Korea and categorized participants into five groups according to baseline UFR. The primary outcome was all-cause mortality, with cardiovascular and non-cardiovascular mortality as secondary outcomes. Associations between UFR and mortality were evaluated using time-dependent Cox regression and marginal structural models to account for time-varying exposure. Sensitivity analyses using alternative modeling approaches and subgroup analyses were performed to assess the consistency of the findings.

Results : Among 2,411 hemodialysis patients, 943 deaths (39.1%) occurred. In time-dependent competing risk models, UFR >14.5 mL/kg/h was associated with higher all-cause mortality (adjusted hazard ratio [aHR] 1.494, 95% confidence interval [CI] 1.001–2.227, $P = 0.049$) and cardiovascular mortality (aHR 2.190, 95% CI 1.090–4.400, $P = 0.028$), but not non-cardiovascular mortality (Table 1). The association persisted after accounting for time-varying confounding using marginal structural models (all-cause mortality, aHR 1.587, 95% CI 1.075–2.343, $P = 0.020$; cardiovascular mortality, aHR 2.013, 95% CI 1.008–4.020, $P = 0.047$; Table 2). Similar patterns were observed across multiple sensitivity analyses and clinically relevant subgroups.

Conclusions : In this nationwide cohort of Asian patients undergoing hemodialysis, higher UFR was independently associated with increased all-cause and cardiovascular mortality, particularly above 14.5 mL/kg/h. Further studies are warranted to determine whether modification of UFR improves clinical outcomes.

Table 1.jpg



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Table 1. Time-dependent competing risks Cox regression analysis of the association between ultrafiltration rate and mortality

	All-cause death		Cardiovascular death		Non- cardiovascular death	
	aHR (95% CI)	P value	aHR (95% CI)	P value	aHR (95% CI)	P value
Ultrafiltration rate, mL/kg/h						
<7	1.008 (0.743 – 1.367)	0.959	0.973 (0.529 – 1.789)	0.930	1.085 (0.714 – 1.650)	0.702
7-10	Reference		Reference		Reference	
10-13	0.773 (0.528 – 1.132)	0.186	0.487 (0.210 – 1.126)	0.093	0.932 (0.554 – 1.565)	0.789
13-14.5	1.071 (0.601 – 1.908)	0.816	0.582 (0.126 – 2.697)	0.489	1.498 (0.716 – 3.135)	0.283
>14.5	1.494 (1.001 – 2.227)	0.049	2.190 (1.090 – 4.400)	0.028	1.495 (0.842 – 2.655)	0.170

CI, confidence interval; aHR, adjusted hazard ratio.

Hazard ratios were estimated using a competing risks model with kidney transplantation as a competing event.

Adjusted for age, sex, body mass index, modified Charlson comorbidity index, diabetes, hemoglobin, albumin, and urine volume ≥ 100 mL/day.

Table 1.jpg

Table 2. Marginal structural model analysis of the association between ultrafiltration rate and mortality

	All-cause death		Cardiovascular death		Non- cardiovascular death	
	aHR (95% CI)	P value	aHR (95% CI)	P value	aHR (95% CI)	P value
Ultrafiltration rate, mL/kg/h						
<7	1.011 (0.745 – 1.372)	0.944	0.879 (0.484 – 1.596)	0.671	1.109 (0.729 – 1.689)	0.629
7-10	Reference		Reference		Reference	
10-13	0.742 (0.510 – 1.079)	0.118	0.458 (0.199 – 1.052)	0.066	0.913 (0.546 – 1.525)	0.728
13-14.5	0.971 (0.547 – 1.723)	0.920	0.388 (0.081 – 1.856)	0.236	1.203 (0.572 – 2.531)	0.627
>14.5	1.587 (1.075 – 2.343)	0.020	2.013 (1.008 – 4.020)	0.047	1.680 (0.969 – 2.913)	0.065

CI, confidence interval; aHR, adjusted hazard ratio.

Hazard ratios were estimated using a competing risks model with kidney transplantation as a competing event.

Adjusted for age, sex, body mass index, modified Charlson comorbidity index, diabetes, hemoglobin, albumin, and urine volume ≥ 100 mL/day.