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Low Body Mass Index with Low Serum Creatinine level is Associated with Higher Mortality Rate in Hemodialysis Patients: A Korean, Nationwide, Population-based Analysis

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Objectives: Low body mass index (BMI) is a risk factor for mortality in chronic kidney disease patients. In addition, recent studies showed that low muscle mass might be associated with adverse outcomes, and serum creatinine level is considered as an indicator of muscle mass in hemodialysis (HD) patients. We aimed to determine the effect of serum creatinine levels on overall mortality and mortality between BMI groups.

Methods: Prevalent patients' data for HD quality assessment which was performed from October to December 2013 were retrieved from the Korean Health Insurance Review and Assessment Service database, and mortality data were collected until December 2017. The patients were classified into three groups according to the BMI; underweight (<18.5kg/m^2), normal (18.5~22.9kg/m^2), and overweight (≥23kg/m^2) groups. Creatinine levels were divided into three groups according to the tertiles; low, medium and high group. We compared the effect of serum creatinine on overall crude mortality rate, mortality rate according to the BMI groups. Moreover, propensity score matching analysis was performed for adjusting age, gender, diabetes mellitus and dialysis vintage. Cox proportional hazard regression analyses were conducted.

Results: A total 21,618 patients were included in this study, and mean age was 59.3±13.0 years old. Table 1 showed that crude death rate of low creatinine group was higher than medium and high creatinine group in all BMI group. Among low creatinine groups, underweight group showed highest crude death rate. By univariate and multivariate Cox regression analyses, low and medium creatinine group showed statistically higher hazard ratio compared to high creatinine group. Even after propensity score matching, all-cause mortality risk of low and medium creatinine groups were still higher than high creatinine group (Table 2)

Conclusions: Low creatinine level was associated with higher mortality risk in HD patients, and low creatinine with low BMI HD patients showed highest mortality risk.

Table 1

Table 1. Crude all-cause mortality rate and rate ratio according to the creatinine tertiles and body mass index groups

			Creatinine tertile		
		Total	**Low**	**Medium**	**High**
Underweight (BMI<18.5kg/m²)	Patients, n	2,368	1,056	742	570
	Death, n	866	593	208	65
	Crude death rate, /1000 patient-year	**108.83**	**189.01**	78.63	29.89
	Rate ratio (reference: high)		6.32	2.63	Reference
Normal (BMI=18.5~22.9kg/m²)	Patients, n	11,558	3,777	4,024	3,757
	Death, n	3,791	1,864	1,349	578
	Crude death rate, /1000 patient-year	**93.10**	**152.82**	94.75	40.47
	Rate ratio (reference: high)		3.78	2.34	Reference
Overweight (BMI≥23kg/m²)	Patients, n	7,692	2,343	2,455	2,894
	Death, n	2,427	1,024	837	566
	Crude death rate, /1000 patient-year	**88.34**	**129.37**	97.00	51.78
	Rate ratio (reference: high)		2.50	1.87	Reference
	Total patients, n	21,618	7,176	7,221	7,221
	Total deaths, n	7,084	3,481	2,394	1,209

Abbreviation: BMI, body mass index

Table 2

Table 2. Univariate and Multivariate Cox regression analysis for mortality risk of low creatinine group compared to high creatinine group

	Univariate					
	All patients			After propensity score matching		
	HR	95% CI	P	HR	95% CI	P
Low creatinine group	**3.451**	3.232-3.685	<0.001	**2.098**	1.936-2.273	<0.001
Medium creatinine group	**2.124**	1.982-2.277	<0.001	**1.479**	1.360-1.610	<0.001
High creatinine group (Reference)		Reference			Reference	
Age, year	1.065	1.063-1.067	<0.001			
Gender (vs. female)	1.127	1.074-1.182	<0.001			
Dialysis vintage, month	0.999	0.998-0.999	<0.001			
Body mass index, kg/m^2	0.979	0.972-0.986	<0.001			
Pre-HD Systolic blood pressure, mmHg	1.006	1.004-1.007	<0.001			
Pre-HD Diastolic blood pressure, mmHg	0.984	0.981-0.986	<0.001			
Diabetes mellitus (vs. no)	2.056	1.961-2.156	<0.001			
Charlson Comorbidity Index	1.203	1.188-1.218	<0.001			
Atrial fibrillation or flutter (vs. no)	1.781	1.604-1.978	<0.001			
Hemoglobin, g/dL	0.857	0.833-0.881	<0.001			
Albumin, g/dL	0.345	0.323-0.369	<0.001			
Creatinine, mg/dL	0.853	0.846-0.860	<0.001			
Phosphorus, mg/dL	0.825	0.810-0.841	<0.001			
Total calcium, mg/dL	0.924	0.901-0.947	<0.001			
Transferrin saturation, %	0.992	0.985-0.998	0.007			
Ferritin, ng/mL	1.000	1.000-1.000	<0.001			
spKt/V	0.886	0.807-0.973	0.011			

	Multivariate								
	Model 1			Model 2			Model 3		
	HR	95% CI	P	HR	95% CI	P	HR	95% CI	P
Low creatinine group	**1.803**	1.667-1.951	<0.001	**1.574**	1.453-1.704	<0.001	**1.974**	1.528-2.549	<0.001
Medium creatinine group	**1.440**	1.333-1.557	<0.001	**1.359**	1.257-1.469	<0.001	**1.552**	1.206-1.996	0.001
High creatinine group (Reference)		Reference			Reference			Reference	
Age, year	1.058	1.056-1.061	<0.001	1.057	1.054-1.060	<0.001	1.052	1.044-1.061	<0.001
Gender (vs. female)	1.232	1.170-1.297	<0.001	1.242	1.179-1.308	<0.001	0.970	0.805-1.170	0.751
Dialysis vintage, month	1.001	1.001-1.002	<0.001	1.002	1.001-1.002	<0.001	1.001	0.999-1.002	0.273
Body mass index, kg/m^2	0.986	0.978-0.994	0.001	0.986	0.978-0.995	0.001	0.964	0.939-0.991	0.008
Pre-HD Systolic blood pressure, mmHg	1.007	1.006-1.009	<0.001	1.005	1.003-1.007	<0.001	0.999	0.993-1.004	0.668
Pre-HD Diastolic blood pressure, mmHg	0.999	0.996-1.002	0.347	1.003	1.000-1.006	0.073	1.005	0.996-1.013	0.314
Charlson Comorbidity Index				1.131	1.115-1.147	<0.001	1.153	1.102-1.207	<0.001
Hemoglobin, g/dL				0.891	0.863-0.921	<0.001	0.967	0.873-1.071	0.515
Albumin, g/dL				0.617	0.570-0.667	<0.001	0.690	0.542-0.878	0.003
Phosphorus, mg/dL							0.964	0.902-1.030	0.279
Total calcium, mg/dL							0.959	0.880-1.045	0.339
Transferrin saturation, %							0.985	0.978-0.993	<0.001
Ferritin, ng/mL							1.000	1.000-1.001	0.025
spKt/V							0.780	0.552-1.103	0.160

Abbreviations: CI, confidence interval; HD, hemodialysis; HR, hazard ratio

Note: Variables used for propensity score matching are age, gender, diabetes mellitus, and dialysis vintage.