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Patient Acuity and Cardiovascular outcome in Hemodialysis patients: A Korean Nationwide Cohort Study

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Objectives: Patients acuity has been reported to be associated with poor outcome in hospitals. However, the effect of the patient acuity of hemodialysis center on the prognosis of individual patients is not well known. In this study, the association between the severity of illness in hemodialysis facility and major adverse cardiac and cerebrovascular event (MACCE) in patients undergoing hemodialysis was investigated.

Methods: 15,633 participants receiving hemodialysis in the primary health care center who participated in the Periodic Hemodialysis Quality Assessment by Health Insurance Review & Assessment Service (HIRA) were examined. The main predictor was severity-to-nurse ratio, defined as a sum of Charlson comorbidity index of all patients divided by the number of nurses in each hemodialysis facility. The primary and secondary outcome were MACCE, and all-cause mortality, respectively.

Results: During a median follow-up of 5.5 years, MACCE and all-cause mortality occurred in 7,966 (51.0%) and 6,536 (41.8%) participants. Participants with higher severity-to-nurse ratio tended to have higher incidence rate of MACCE. The hazard ratios (HRs) of MACCE for the second, third, and highest quartiles compared with the lowest quartile of severity-to-nurse ratio were 1.05 (95% confidence intervals [CI], 0.98-1.11; $P=0.151$), 1.07 (95% CI, 1.00-1.14; $P=0.053$), and 1.08 (95% CI, 1.00-1.16; $P=0.040$). When treating severity-to-nurse ratio as a continuous variable, MACCE risk increased by 1% per 1 increase in severity-to-nurse ratio (HR, 1.01; 95% CI, 1.00 - 1.02; $P=0.003$). Compared to the lowest quartile group, the HRs of all-cause mortality for second, third and fourth quartile were 1.12 (95% CI, 1.04-1.19; $P=0.002$), 1.11 (95% CI, 1.03-1.19; $P=0.005$), and 1.16 (95% CI, 1.07-1.25; $P<0.001$), respectively.

Conclusions: As the part of the Joint Project on Quality Assessment Research by HIRA, the present study showed that the patient acuity was strongly associated with an increased risk of poor outcomes in hemodialysis patients.

Table 1. Incidence rate of outcomes according to quartiles of severity-to-nurse ratio.

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Outcomes	Quartiles of Severity-to-nurse ratio				Total
	Q1	Q2	Q3	Q4	
No of participants	3909	3908	3908	3908	15633
MACCE					
No. of person-years	21.3	19.7	18.7	18.0	77.6
Incidence of outcomes, n(%)	2016 (51.6)	1963 (50.2)	1946 (49.8)	2041 (52.2)	7966 (51.0)
Incidence rate per 1000 person-year	94.5	99.8	104.2	113.7	9.7
All-cause mortality					
No. of person-years	23.7	21.7	20.7	20.0	86.2
Incidence of outcomes, n(%)	1653 (42.3)	1637 (41.9)	1574 (40.3)	1672 (42.8)	6536 (41.8)
Incidence rate per 1000 person-year	69.7	75.4	75.9	83.6	13.2

Abbreviation: MACCE, major adverse cardiovascular cerebrovascular events.

Table 2. Hazard ratios for all-cause mortality and MACCE based on the severity-to-nurse ratio.

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	Model 1		Model 2		Model 3	
	HR (95% CI)	P	HR (95% CI)	P	HR (95% CI)	P
MACCE						
Continuous	1.01 (1.01 - 1.02)	<0.001	1.01 (1.01 - 1.02)	<0.001	1.01 (1.00 - 1.02)	0.003
Quartile						
Q1	<i>reference</i>		<i>reference</i>		<i>reference</i>	
Q2	1.04 (0.98 - 1.11)	0.210	1.04 (0.97 - 1.10)	0.252	1.05 (0.98 - 1.11)	0.151
Q3	1.09 (1.02 - 1.16)	0.010	1.08 (1.01 - 1.14)	0.024	1.07 (1.00 - 1.14)	0.053
Q4	1.16 (1.09 - 1.24)	<0.001	1.13 (1.06 - 1.20)	<0.001	1.08 (1.00 - 1.16)	0.040
All-cause mortality						
Continuous	1.02 (1.01 - 1.02)	<0.001	1.02 (1.01 - 1.02)	<0.001	1.01 (1.01 - 1.02)	<0.001
Quartile						
Q1	<i>reference</i>		<i>reference</i>		<i>reference</i>	
Q2	1.10 (1.03 - 1.18)	0.006	1.10 (1.03 - 1.18)	0.005	1.12 (1.04 - 1.19)	0.002
Q3	1.14 (1.06 - 1.22)	<0.001	1.12 (1.04 - 1.20)	0.002	1.11 (1.03 - 1.19)	0.005
Q4	1.25 (1.16 - 1.34)	<0.001	1.21 (1.13 - 1.30)	<0.001	1.16 (1.07 - 1.25)	<0.001

Model 1: age, sex, medical aid

Model 2: Model 1 plus BMI, SBP, medical history including diabetes, ischemic heart disease, congestive heart failure, cerebrovascular disease

Model 3: Model 2 plus dialysis character including case workload, spKT/V and laboratory parameters including hemoglobin, calcium, phosphate, albumin.

Abbreviations: HR, hazard ratio; CI, confidence interval; MACCE, major adverse cardiovascular cerebrovascular events; BMI, body mass index; SBP, systolic blood pressure; spKT/V, single pooled KT/V