

**Association between intravenous contrast media exposure and acute kidney injury in patients requiring emergency admission: a nationwide observational study in Japan**

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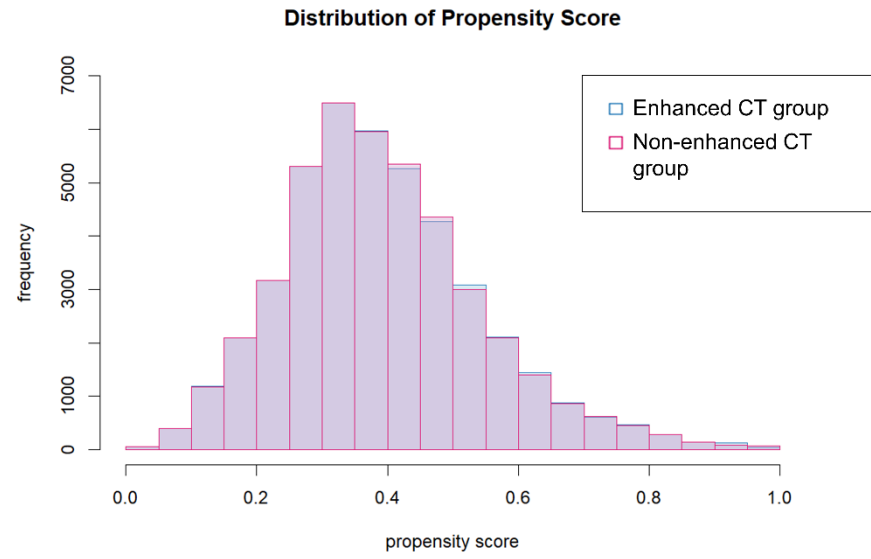
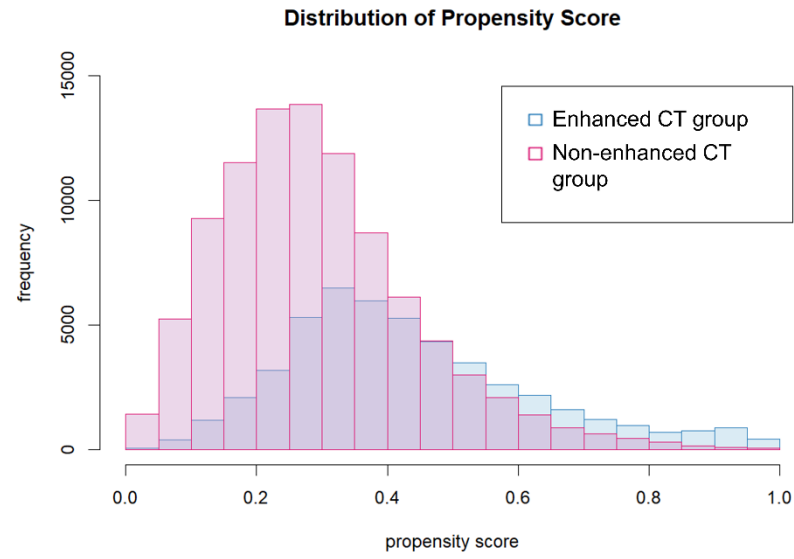
**ONLINE SUPPLEMENT MATERIAL**

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# Supplemental Figure 1



## Legend

**Supplemental Figure 1.** Distribution of propensity scores in the enhanced CT group and non-enhanced CT group before and after propensity score matching. The left-hand figure shows the distribution of propensity scores before propensity score matching. The right-hand figure shows the distribution of propensity scores after propensity score matching. *CT* computed tomography

## Supplemental Table 1

**Supplemental Table S1. Definition of the presence of past history, primary diagnosis, and comorbid disease**

Group	Code type	ICD-10 code
Past history		
Congestive heart failure	ICD-10 codes in the complication	I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5– I42.9, I43.x, I50.x, P29.0
Diabetic nephropathy	ICD-10 codes in the complication	E10.2X and E11.2X
Chronic kidney disease	ICD-10 codes in the complication	N18.X except for N18.0 and N18.5
End-stage renal disease	ICD-10 codes in the complication	N18.0 and N18.5
Hypertension	ICD-10 codes in the complication	I11.x, I12.x, I15.x
Myocardial infarction	ICD-10 codes in the complication	I21.x, I22.x, I25.2
Primary diagnosis		
Trauma	ICD-10 codes in the primary diagnosis	S00.0-S99.9, T00.0-T14.9
Macrovascular disease	ICD-10 codes in the primary diagnosis	I26.0-I28.9, I70.0-79.9
Cerebrovascular disease	ICD-10 codes in the primary diagnosis	I60.0-I69.8
Sepsis	ICD-10 codes in the primary diagnosis	A00.0-A09.x, A19.0-A28.x, A31.0-A32.x, A36.0-A39.x, A42.x- A46.X, A48.0-A49.x, A59.x, A65.x, A69.x, A74.x, A75.x, A77.x- A81.x, A83.x-A96.x, A98.x-99.x, B00.x-10.x, B25.x-27.x, B29.4, B33.x-34.x, B37.x-50.x, B54.x-55.x, B58.x-60.x, B64.0, B67.x, B91.x, B95.0-B99.x, G00.0-G08.x, G14.x, H05.0x, H60.2, H70.0, I00.x, I02.x, I26.0, I26.9, I33.x, I38.x-I40.x, I76.x, I96.x, I98.1, J01.0-J06.x, J09.x-J22.x, J36.x, J39.x, J85.x-J86.x, K35.0-K37.x, K57.x, K61.x,

		K63.0, K63.1, K65.x, K75.0, K75.1, K75.3, K76.3, K77.0, K81.x, K83.0, K95.0, K95.8, L02.0-L08.x, M00.x-M08.x, M86.x, M89.6, N10.x, N15.x, N30.x, N39.0, N41.x, N45.x, N70.0-N77.x, R78.8, T80.2, T81.4, T82.6, T82.7, T83.5, T83.6, T84.5, T84.6, T84.7, T85.7, T88.0, U04.x
Organ dysfunction	ICD-10 codes in the primary diagnosis	D65.x, D69.5, E87.2-E87.9, G93.4, I46.x, I95x, J80.x, J95.2, J95.3, J95.x, K72.x, N00.x-N18.x, R09.x, R40.0-R40.4, R41.8, R55.x, R57.x
Charlson Comorbidity Index		
Myocardial infarction	ICD 10 codes in the concomitant or complication diagnoses	I21.x, I22.x, I25.2
Congestive heart failure	ICD 10 codes in the concomitant or complication diagnoses	I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5-I42.9, I43.x, I50.x, P29.0
Peripheral vascular disease	ICD 10 codes in the concomitant or complication diagnoses	I70.x, I71.x, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9
Cerebrovascular disease	ICD 10 codes in the concomitant or complication diagnoses	G45.x, G46.x, H34.0, I60.x-I69.x
Dementia	ICD 10 codes in the concomitant or complication diagnoses	F00.x-F03.x, F05.1, G30.x, G31.1
Chronic pulmonary disease	ICD 10 codes in the concomitant or complication diagnoses	I27.8, I27.9, J40.x-J47.x, J60.x-J67.x, J68.4, J70.1, J70.3
Rheumatic disease	ICD 10 codes in the concomitant or complication diagnoses	M05.x, M06.x, M31.5, M32.x-M34.x, M35.1, M35.3, M36.0
Peptic ulcer disease	ICD 10 codes in the concomitant or	K25.x-K28.x

Mild liver disease	complication diagnoses ICD 10 codes in the concomitant or complication diagnoses	B18.x, K70.0–K70.3, K70.9, K71.3–K71.5, K71.7, K73.x, K74.x, K76.0, K76.2–K76.4, K76.8, K76.9, Z94.4
Diabetes without chronic complications	ICD 10 codes in the concomitant or complication diagnoses	E10.0, E10.1, E10.6, E10.8, E10.9, E11.0, E11.1, E11.6, E11.8, E11.9, E12.0, E12.1, E12.6, E12.8, E12.9, E13.0, E13.1, E13.6, E13.8, E13.9, E14.0, E14.1, E14.6, E14.8, E14.9
Diabetes with chronic complications	ICD 10 codes in the concomitant or complication diagnoses	E10.2–E10.5, E10.7, E11.2–E11.5, E11.7, E12.2–E12.5, E12.7, E13.2–E13.5, E13.7, E14.2–E14.5, E14.7
Hemiplegia or paraplegia	ICD 10 codes in the concomitant or complication diagnoses	G04.1, G11.4, G80.1, G80.2, G81.x, G82.x, G83.0–G83.4, G83.9
Renal disease	ICD 10 codes in the concomitant or complication diagnoses	I12.0, I13.1, N03.2–N03.7, N05.2–N05.7, N18.x, N19.x, N25.0, Z49.0–Z49.2, Z94.0, Z99.2
Any malignancy, including lymphoma and leukemia except malignant neoplasm of skin	ICD 10 codes in the concomitant or complication diagnoses	C00.x–C26.x, C30.x–C34.x, C37.x–C41.x, C43.x, C45.x–C58.x, C60.x–C76.x, C81.x–C85.x, C88.x, C90.x–C97.x
Moderate or severe liver disease	ICD 10 codes in the concomitant or complication diagnoses	I85.0, I85.9, I86.4, I98.2, K70.4, K71.1, K72.1, K72.9, K76.5, K76.6, K76.7
Metastatic solid tumor	ICD 10 codes in the concomitant or complication diagnoses	C77.x–C80.x
AIDS/HIV	ICD 10 codes in the concomitant or complication diagnoses	B20.x–B22.x, B24.x

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*ICD* International Classification of Diseases, *AIDS* acquired immune deficiency syndrome, *HIV* human immunodeficiency virus





## Supplemental Table 2

**Supplemental Table S2. The 19 variables used to calculate propensity scores in the regression model**

Category of variables	Subcategory of variables
Patient characteristics	1) age, 2) sex
Hospital state	3) hospital volume
Pre-existing condition	4) congestive heart failure, 5) chronic kidney disease, 6) hypertension, 7) diabetic nephropathy, 8) Myocardial infarction
Laboratory results on admission	9) creatine, 10) anemia (Hb <11)
Primary diagnosis	11) trauma, 12) sepsis, 13) cerebrovascular disease, 14) macrovascular disease
Concomitant therapy	15) ICU admission, 16) emergency operation, 17) NSAIDs, 18) catecholamine, 19) diuretic medication

*ICU* intensive care unit, *NSAIDs* non-steroidal anti-inflammatory drugs

### Supplemental Table 3

**Supplemental Table S3. Risk of outcomes in propensity score-matched groups by age  $\geq 65$  and  $< 65$  years old**

Subgroup	Outcomes	Non-enhanced CT n (%)	Enhanced CT n (%)	Odds ratio	95% CI	P-value
Age $\geq 65$ years		N=26739	N=26739			
	AKI stage 1-3	1576 (5.9)	1468 (5.5)	0.928	0.861-0.999	0.046
	AKI stage 3	270 (1.0)	328 (1.2)	1.217	1.032-1.437	0.019
	CIN	2663 (10.0)	2476 (9.3)	0.923	0.871-0.978	0.006
	RRT during hospitalization	269 (1.0)	372 (1.4)	1.388	1.182-1.632	<0.001
	RRT dependence	125 (0.5)	166 (0.6)	1.330	1.048-1.692	0.019
	In-hospital mortality	2332 (8.7)	1863 (7.0)	0.784	0.735-0.836	<0.001
Age $< 65$ years		N=16385	N=16385			
	AKI stage 1-3	635 (3.9)	477 (2.9)	0.744	0.658-0.841	0.487
	AKI stage 3	154 (0.9)	153 (0.9)	0.993	0.788-1.252	1.000
	CIN	1281 (7.8)	1122 (6.8)	0.867	0.797-0.943	0.001
	RRT during hospitalization	147 (0.9)	154 (0.9)	1.048	0.830-1.324	0.728
	RRT dependence	54 (0.3)	80 (0.5)	1.484	1.037-2.138	0.030
	In-hospital mortality	524 (3.2)	440 (2.7)	0.835	0.733-0.952	0.007

*CT* computed tomography, *CI* confidence interval, *AKI* acute kidney injury, *CIN* contrast-induced nephropathy, *RRT* renal replacement therapy

## Supplemental Table 4

**Supplemental Table S4. Risk of outcomes in propensity score-matched groups by sex**

Subgroup	Outcomes	Non-enhanced CT n (%)	Enhanced CT n (%)	Odds ratio	95% CI	P-value
Sex, male		N=24029	N=24029			
	AKI stage 1-3	1275 (5.3)	1194 (5.0)	0.933	0.860-1.013	0.098
	AKI stage 3	256 (1.1)	305 (1.3)	1.194	1.007-1.417	0.041
	CIN	2028 (8.4)	1915 (8.0)	0.939	0.880-1.003	0.063
	RRT during hospitalization	265 (1.1)	334 (1.4)	1.264	1.071-1.492	0.005
	RRT dependence	130 (0.5)	173 (0.7)	1.333	1.055-1.688	0.015
	In-hospital mortality	1698 (7.1)	1334 (5.6)	0.773	0.717-0.833	<0.001
Sex, female		N=19279	N=19279			
	AKI stage 1-3	927 (4.8)	777 (4.0)	0.831	0.753-0.918	<0.001
	AKI stage 3	186 (1.0)	183 (0.9)	0.984	0.797-1.214	0.917
	CIN	1879 (9.7)	1719 (8.9)	0.907	0.846-0.972	0.005
	RRT during hospitalization	178 (0.9)	197 (1.0)	1.108	0.899-1.366	0.350
	RRT dependence	80 (0.4)	76 (0.4)	0.950	0.684-1.318	0.810
	In-hospital mortality	1202 (6.2)	1001 (5.2)	0.824	0.755-0.899	<0.001

*CT* computed tomography, *CI* confidence interval, *AKI* acute kidney injury, *CIN* contrast-induced nephropathy, *RRT* renal replacement therapy



## Supplemental Table 5

**Supplemental Table S5. Risk of outcomes in propensity score-matched groups by diagnostic diseases on admission**

Subgroup	Outcomes	Non-enhanced CT	Enhanced CT	Odds ratio	95% CI	P-value
		n (%)	n (%)			
Trauma		N=2998	N=2998			
	AKI stage 1-3	114 (3.8)	140 (4.7)	1.239	0.955-1.610	0.109
	AKI stage 3	5 (0.2)	20 (0.7)	4.019	1.461-13.72	0.004
	CIN	207 (6.9)	231 (7.7)	1.126	0.922-1.375	0.254
	RRT during hospitalization	11 (0.4)	21 (0.7)	1.915	0.881-4.407	0.109
	RRT dependence	10 (0.3)	10 (0.3)	1.000	0.373-2.682	1.000
	In-hospital mortality	93 (3.1)	140 (4.7)	1.530	1.162-2.021	0.002
Sepsis		N=2604	N=2604			
	AKI stage 1-3	360 (13.8)	355 (13.6)	0.984	0.838-1.156	0.872
	AKI stage 3	134 (5.1)	167 (6.4)	1.263	0.993-1.609	0.057
	CIN	361 (13.9)	344 (13.2)	0.946	0.804-1.112	0.517
	RRT during hospitalization	144 (5.5)	196 (7.5)	1.390	1.107-1.749	0.004
	RRT dependence	57 (2.2)	66 (2.5)	1.162	0.799-1.694	0.466
	In-hospital mortality	377 (14.5)	310 (11.9)	0.796	0.675-0.938	0.006
Macrovascular disease		N=420	N=420			
	AKI stage 1-3	71 (16.9)	77 (18.3)	1.103	0.761-1.600	0.651
	AKI stage 3	16 (3.8)	28 (6.7)	1.802	0.925-3.626	0.087

	CIN	85 (20.2)	78 (18.6)	0.899	0.629-1.284	0.601
	RRT during hospitalization	27 (6.4)	30 (7.1)	1.120	0.630-1.997	0.784
	RRT dependence	16 (3.8)	17 (4.0)	1.065	0.498-2.287	1.000
	In-hospital mortality	49 (11.7)	36 (8.6)	0.710	0.438-1.143	0.169
Cerebrovascular disease		N=2963	N=2963			
	AKI stage 1-3	177 (6.0)	186 (6.3)	1.054	0.848-1.312	0.665
	AKI stage 3	24 (0.8)	25 (0.8)	1.042	0.570-1.910	1.000
	CIN	337 (11.4)	330 (11.1)	0.977	0.828-1.151	0.805
	RRT during hospitalization	18 (0.6)	29 (1.0)	1.617	0.866-3.099	0.142
	RRT dependence	10 (0.3)	17 (0.6)	1.704	0.735-4.171	0.247
	In-hospital mortality	282 (9.5)	295 (10.0)	1.051	0.882-1.253	0.599

*CT* computed tomography, *CI* confidence interval, *AKI* acute kidney injury, *CIN* contrast-induced nephropathy, *RRT* renal replacement therapy, *Inf* infinity

## Supplemental Table 6

**Supplemental Table S6. Risk of outcomes in propensity score-matched groups with and without underlying CKD**

Subgroup	Outcomes	Non-enhanced CT n (%)	Enhanced CT n (%)	Odds ratio	95% CI	P-value
With CKD		N=544	N=544			
	AKI stage 1-3	110 (20.2)	188 (34.6)	2.082	1.571-2.769	<0.001
	AKI stage 3	39 (7.2)	108 (19.9)	3.204	2.150-4.857	<0.001
	CIN	95 (17.5)	143 (26.3)	1.685	1.246-2.285	0.001
	RRT during hospitalization	50 (9.2)	134 (24.6)	3.226	2.251-4.680	<0.001
	RRT dependence	27 (5.0)	89 (16.4)	3.741	2.359-6.100	<0.001
	In-hospital mortality	57 (10.5)	70 (12.9)	1.261	0.856-1.866	0.257
Without CKD		N=42793	N=42793			
	AKI stage 1-3	2124 (5.0)	1785 (4.2)	0.833	0.781-0.889	<0.001
	AKI stage 3	396 (0.9)	376 (0.9)	0.949	0.821-1.096	0.492
	CIN	3836 (9.0)	3516 (8.2)	0.909	0.866-0.954	<0.001
	RRT during hospitalization	393 (0.9)	396 (0.9)	1.008	0.874-1.162	0.943
	RRT dependence	170 (0.4)	151 (0.4)	0.888	0.708-1.112	0.314
	In-hospital mortality	2800 (6.5)	2259 (5.3)	0.796	0.751-0.843	<0.001

*CKD* chronic kidney disease, *CT* computed tomography, *CI* confidence interval, *AKI* acute kidney injury, *CIN* contrast-induced nephropathy, *RRT* renal replacement therapy





**Supplemental Table 7**

**Supplemental Table S7. Risk of outcomes in propensity score-matched groups with and without ICU admission**

Subgroup	Outcomes	Non-enhanced CT	Enhanced CT	Odds ratio	95% CI	P-value
		n (%)	n (%)			
ICU admission		N=2705	N=2705			
	AKI stage 1-3	441 (16.3)	410 (15.2)	0.917	0.790-1.065	0.263
	AKI stage 3	146 (5.4)	154 (5.7)	1.058	0.832-1.345	0.678
	CIN	502 (18.6)	432 (16.0)	0.834	0.722-0.963	0.013
	RRT during hospitalization	144 (5.3)	176 (6.5)	1.238	0.980-1.564	0.074
	RRT dependence	52 (1.9)	59 (2.2)	1.137	0.767-1.692	0.565
	In-hospital mortality	356 (13.2)	347 (12.8)	0.971	0.826-1.141	0.746
General wards admission		N=40467	N=40467			
	AKI stage 1-3	1731 (4.3)	1532 (3.8)	0.881	0.820-0.945	<0.001
	AKI stage 3	287 (0.8)	310 (0.8)	1.081	0.917-1.274	0.366
	CIN	3312 (8.2)	3183 (8.1)	0.958	0.910-1.008	0.098
	RRT during hospitalization	297 (0.7)	332 (0.8)	1.119	0.953-1.314	0.173
	RRT dependence	148 (0.4)	187 (0.5)	1.265	1.013-1.581	0.037
	In-hospital mortality	2428 (6.0)	1956 (4.8)	0.796	0.748-0.846	<0.001

*CT* computed tomography, *CI* confidence interval, *ICU* intensive care unit, *AKI* acute kidney injury, *CIN* contrast-induced nephropathy, *RRT* renal replacement therapy



## Supplemental Table 8

**Supplemental Table S8. Risk of outcomes in propensity score-matched groups with and without organ dysfunction**

Subgroup	Outcomes	Non-enhanced CT n (%)	Enhanced CT n (%)	Odds ratio	95% CI	P-value
With organ dysfunction		N=9934	N=9934			
	AKI stage 1-3	1098 (11.1)	1029 (10.4)	0.930	0.849-1.018	0.119
	AKI stage 3	302 (3.0)	343 (3.5)	1.141	0.972-1.339	0.109
	CIN	1421 (14.3)	1343 (13.5)	0.937	0.863-1.016	0.114
	RRT during hospitalization	330 (3.3)	395 (4.3)	1.205	1.036-1.403	0.015
	RRT dependence	113 (1.1)	153 (1.5)	1.359	1.057-1.752	0.016
	In-hospital mortality	1387 (14.0)	1298 (13.1)	0.926	0.853-1.006	0.068
Without organ dysfunction		N=32606	N=32606			
	AKI stage 1-3	990 (3.0)	914 (2.8)	0.921	0.840-1.010	0.081
	AKI stage 3	93 (0.3)	119 (0.4)	1.281	0.968-1.699	0.085
	CIN	2241 (6.9)	2265 (6.9)	1.012	0.952-1.075	0.098
	RRT during hospitalization	73 (0.2)	116 (0.4)	1.591	1.177-2.164	0.002
	RRT dependence	61 (0.2)	90 (0.3)	1.477	1.055-2.080	0.022
	In-hospital mortality	1188 (3.6)	997 (3.1)	0.834	0.765-0.910	<0.001

*CT* computed tomography, *CI* confidence interval, *AKI* acute kidney injury, *CIN* contrast-induced nephropathy, *RRT* renal replacement therapy



## Supplemental Table 9

<b>Supplemental Table S9. Sensitivity analysis for the risk of outcomes on enhanced CT in a logistic regression model</b>				
Outcomes	Subset	Adjusted Odds ratio	95% CI	<i>P for interaction*</i>
AKI stage 1-3	Overall	0.903	0.853-0.957	
	With CKD	2.210	1.761-2.770	<0.001
	Without CKD	0.858	0.809-0.911	
AKI stage 3	Overall	1.300	1.140-1.470	
	With CKD	3.780	2.720-5.230	<0.001
	Without CKD	1.090	0.950-1.260	
CIN	Overall	1.010	0.970-1.060	
	With CKD	1.850	1.470-2.310	<0.001
	Without CKD	0.986	0.944-1.030	
RRT during hospitalization	Overall	1.370	1.210-1.550	
	With CKD	3.850	2.860-5.170	<0.001
	Without CKD	1.140	0.995-1.310	
RRT dependence	Overall	1.280	1.080-1.530	
	With CKD	3.370	2.351-4.802	<0.001
	Without CKD	0.990	0.850-1.211	
In-hospital mortality	Overall	0.837	0.795-0.881	

With CKD	1.140	0.853-1.520	<0.001
Without CKD	0.831	0.789-0.876	

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*CT* computed tomography, *CI* confidence interval, *ICU* intensive care unit, *AKI* acute kidney injury, *CIN* contrast-induced nephropathy, *RRT* renal replacement therapy, *CKD* chronic kidney disease

\* The value of the interaction term between enhanced CT and CKD

Independent variables: enhanced CT, age, sex, hospital volume, congestive heart failure, chronic kidney disease, hypertension, diabetic nephropathy, myocardial infarction, serum creatine, anemia (Hb <11), trauma, sepsis, cerebrovascular disease, macrovascular disease, ICU admission, emergency operation, NSAIDs, catecholamine, diuretic medication, and interaction term between enhanced CT and CKD.