



Low Pre-operative Serum Bicarbonate Levels Predict Acute Kidney Injury after Cardiac Surgery

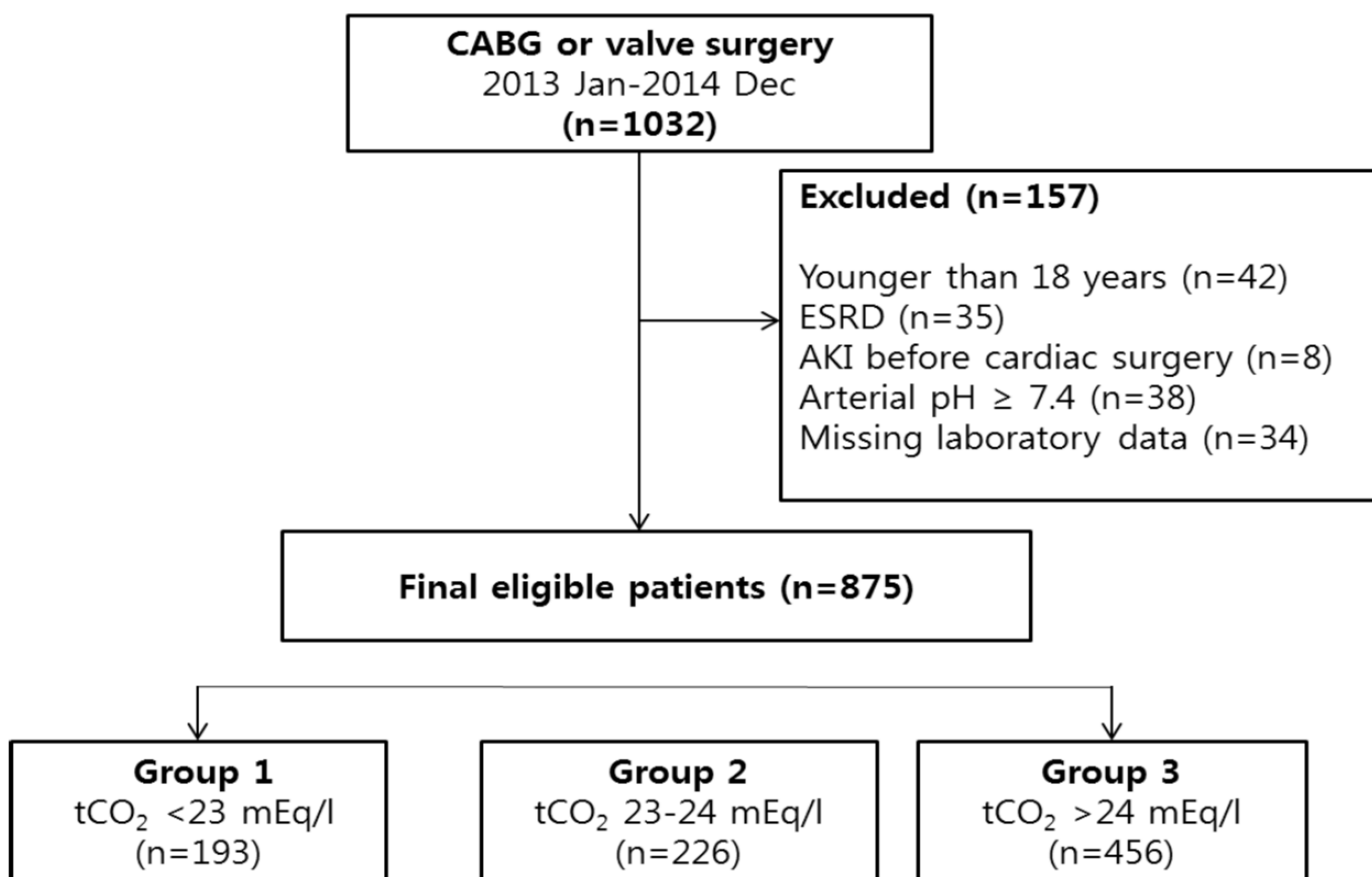
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Background

Acute kidney injury (AKI) after cardiac surgery is a common and serious complication, and is associated with high mortality rates. There is evidence showing that metabolic acidosis induce decline of glomerular filtration rate (GFR) in associated with activation of intrarenal renin-angiotensin system. Whether pre-operative serum bicarbonate levels are associated with the development of AKI in patients who undergo cardiac surgery is not well known. Therefore, the aim of this study was to identify the clinical implications of pre-operative serum bicarbonate levels on AKI occurrence after cardiac surgery.

Methods



AKI definition : Acute Kidney Injury Network (AKIN) Criteria

Results

Table 1. Baseline characteristics of non-AKI and AKI patients

	Total (n=875)	Non-AKI (n=647)	AKI (n=228)	P
Age (years)	60.5 ± 14.6	59.3 ± 14.8	63.9 ± 13.6	<0.001
Male (%)	518 (60.4)	385 (59.5)	133 (58.3)	0.757
Hypertension (%)	293 (33.5)	193 (29.8)	100 (43.9)	<0.001
Diabetes mellitus (%)	155 (17.7)	103 (15.9)	52 (22.8)	0.019
Type of surgery				
CABG (%)	294 (100)	234 (79.6)	60 (20.4)	0.007
Off-Pump	263 (100)	213 (81.0)	50 (19.0)	0.083
Valve surgery (%)	557 (100)	397 (71.3)	160 (28.7)	0.020
CABG + valve surgery (%)	24 (100)	16 (66.7)	8 (33.3)	0.479
Serum bicarbonate (mEq/l)	24.5 ± 2.9	24.8 ± 2.6	23.6 ± 3.4	<0.001
eGFR (ml/min/1.73m ²)	83.6 ± 23.2	87.7 ± 20.3	71.9 ± 26.6	<0.001
Hemoglobin (g/dl)	11.6 ± 2.2	11.8 ± 2.2	11.1 ± 2.2	<0.001
Glucose (mg/dl)	123.5 ± 50.3	123.6 ± 46.0	130.6 ± 60.8	0.116
Total cholesterol (mg/dl)	154.0 ± 38.3	157.0 ± 38.5	142.5 ± 35.1	0.001
Albumin (g/dl)	3.2 ± 0.8	3.2 ± 0.8	3.2 ± 0.8	0.214

Table 2. Comparison of post-operative ICU stay, hospital stay, and mortality in non-AKI and AKI patients

	Non-AKI (n=647)	AKI (n=228)	P
Post-operative ICU stay (day)	2.7 ± 2.2	6.2 ± 8.5	<0.001
Hospital stay (day)	16.0 ± 14.7	28.9 ± 26.5	<0.001
Mortality (%)	9 (1.4)	20 (8.8)	<0.001

Figure 1. Post-operative ICU and hospital stay according to pre-operative serum bicarbonate levels

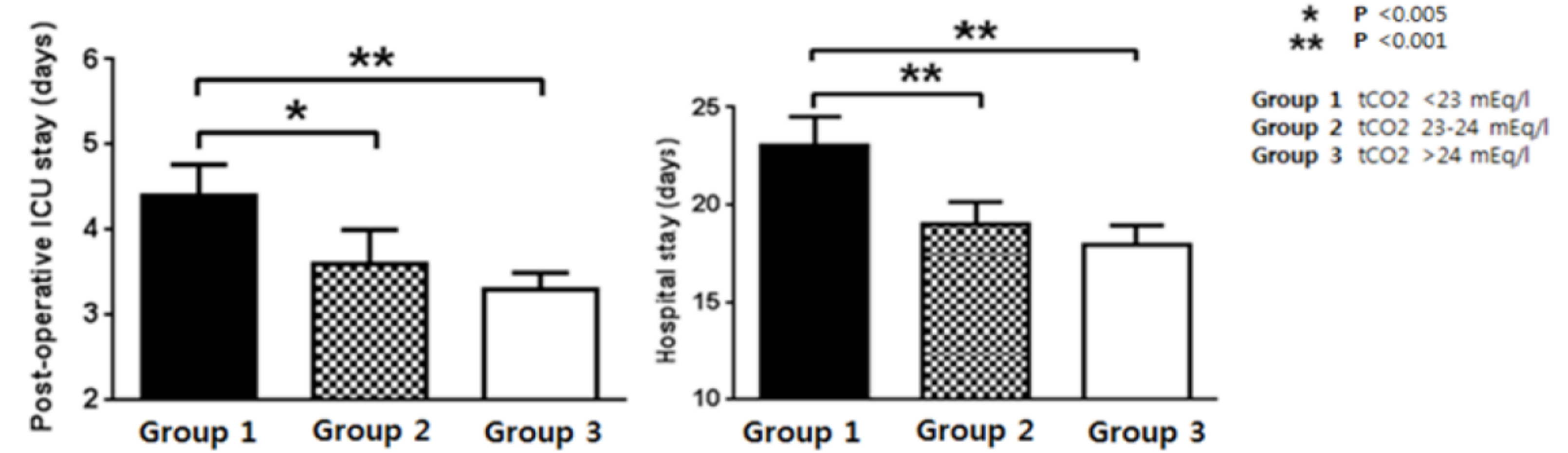


Table 3. Univariate logistic regression analysis of post-cardiac surgery AKI development with clinical and biochemical variables

	Univariate		
	OR	95% CI	P
Serum bicarbonate			
Group 1 (tCO ₂ <23 mEq/l)	2.86	1.98-4.13	<0.001
Group 2 (tCO ₂ 23-24 mEq/l)	1.49	1.02-2.17	0.037
Group 3 (tCO ₂ >24 mEq/l)	reference		
Age (per 1 year increase)	1.02	1.01-1.04	<0.001
Male (vs. female)	1.05	0.77-1.05	0.757
Hypertension	1.84	1.35-2.51	<0.001
Diabetes mellitus	1.56	1.07-2.27	0.020
OP type			
CABG	reference		
Valve surgery	1.57	1.12-2.20	0.009
CABG + valve surgery	1.95	0.80-1.77	0.144
Hemoglobin (per 1 g/dl increase)	0.86	0.80-0.92	<0.001
eGFR (per 1 ml/min/1.73m ² increase)	0.97	0.96-0.97	<0.001

Table 4. Multivariate logistic regression analysis of clinical and biochemical variables independently associated with post-cardiac surgery AKI development

	Model 1			Model 2			Model 3		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Serum bicarbonate									
Group 1 (tCO ₂ <23 mEq/l)	2.64	1.82-3.84	<0.001	2.57	1.76-3.74	<0.001	2.36	1.57-3.54	<0.001
Group 2 (tCO ₂ 23-24 mEq/l)	1.46	1.00-2.13	0.050	1.47	1.00-2.14	0.049	1.54	1.03-2.30	0.034
Group 3 (tCO ₂ >24 mEq/l)	reference								
Age (per 1 year increase)	1.02	1.01-1.03	0.001	1.02	1.00-1.03	0.005	0.99	0.98-1.00	0.347
Male (vs. female)	0.97	0.71-1.33	0.855	0.96	0.70-1.32	0.809	1.51	1.06-2.16	0.023
Hypertension				1.55	1.10-2.18	0.013	1.59	1.09-2.32	0.015
Diabetes mellitus				1.13	0.75-1.71	0.568	1.27	0.80-2.00	0.307
OP type									
CABG							reference		
Valve surgery							2.47	1.66-3.70	<0.001
CABG + valve surgery							1.69	0.60-4.73	0.322
Hemoglobin (per 1 g/dl increase)							0.88	0.81-0.95	0.002
eGFR (per 1 ml/min/1.73m ² increase)							0.97	0.96-0.98	<0.001

Model 1, adjusted for age, sex

Model 2, adjusted for age, sex, hypertension, diabetes mellitus

Model 3, adjusted for age, sex, hypertension, diabetes mellitus, operation type, hemoglobin, eGFR

Conclusion

- Low pre-operative serum bicarbonate levels were significantly associated with AKI even after adjusting for age, sex, history of hypertension, history of diabetes mellitus, operation type, hemoglobin levels, and eGFR.
- Low pre-operative serum bicarbonate levels are an independent risk factor for AKI after cardiac surgery.
- Correction of low serum bicarbonate levels before cardiac surgery may reduce the risk of AKI development.

