The difference between tissue oxygenation markers and development of acute kidney injury in minimally transfused and non-transfused cardiac surgery patients

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Goal of Study: To compare AKI development and tissue oxygenation by evaluating ScvO₂, lactate, venoarterial PCO₂ difference(ΔPCO₂) in minimally transfused and non-transfused cardiac surgery patients.

Materials and Methods: One hundred twentyseven ASA I-II elective coronary artery and valvular heart surgery patients without major intraoperative complications were included in this prospective nonrandomized study. Blood transfusions were driven primarily by hemoglobin levels (7.0 g/dL during cardiopulmonary bypass(CPB) and 8.0 g/dL at other times). Patients were divided into two groups: Minimally(1-2 U) Transfused(Group T) and Non-Transfused(Group NT). ScvO₂, lactate, ΔPCO₂ levels were evaluated after anesthesia induction(T1) and at the end of the operation(T2) and compared between the groups. Postoperative Grade I AKI was defined as increase in serum creatinine of more than or equal to 0.3 mg/dL. The lengths of mechanical ventilation and ICU period, development of Grade I AKI and 28 days mortality were recorded and compared between the groups. Chi-square, Fisher’s Exact, Student’s T, Paired samples T, Mann Whitney-U, Wilcoxon Signed ranks tests were used to compare categoric and scale variables between two groups for statistical analysis.

Results and Discussion: The operation, CPB, cross clamp times, hemodynamic variables, urine output were similar between two groups. Increment rate of lactate and ΔPCO₂ levels in Group T were significantly higher than those levels in Group NT. Twentytwo patients (17.5%) showed AKI and 4 patients (3.1%) died in hospital. Group T patients had more (28,0%) postoperative AKI without statistically significance. Hospital mortality in Group T was higher than those Group NT with significant difference(p=0.024). Patients with lactate ≥2 mmol/L at the end of operation showed more AKI than those patients with normal lactate (24.2% vs 9.1%, respectively; p=0.030). Lactate, ΔPCO₂, ScvO₂ levels showed good correlation for the development of AKI in both groups.

Conclusions: We concluded that intraoperative anemia that is treated with 1-2 units of blood transfusion causes impairment of tissue oxygenation and increases risk of postoperative AKI in cardiac surgery. Impairment of renal tissue oxygenation may be one of the possible mechanisms for the development of postoperative AKI.

Table 1. Tissue oxidation parameters (ΔCO₂, S_{cv}O₂ and Lactate) according to groups

ΔCO ₂	T1	T2	P
	Mean±Std.Dev; (Median; Min-Max)	Mean±Std.Dev; (Median; Min-Max)	
Group NT	6.1±2.8; (6.1; 0.1-14.5)	6.1±3.4; (6.0; 0.4-20.3)	0.929>0.05
Group T	4.9±2.9; (5.2; 0.8-10.1)	8.8±7.1; (7.4; 0.8-31.9)	0.018<0.05
Total	5.8±2.8; (5.8; 0.1-14.5)	6.6±4.5; (6.2; 0.4-31.9)	0.264>0.05
P	0.073>0.05	0.057>0.05	-
S _{cv} O ₂			
Group NT	73.2±9.0; (74.5; 45.5-89.8)	64.3±9.6; (63.0; 36.8-85.0)	0.000<0.001
Group T	71.9±10.1; (71.7; 54.0-88.8)	62.3±9.7; (62.0; 40.4-79.6)	0.003<0.01
Total	72.9±9.2; (73.9; 45.5-89.8)	63.9±9.6; (62.7; 36.8-85.0)	0.000<0.001
P	0.522>0.05	0.371>0.05	-
Lactate			
Group NT	1.1±0.5 (1.0; 0.2-2.7)	2.2±1.1 (2.0; 0.7-5.6)	0.000<0.001
Group T	1.0±0.3 (1.0; 0.6-1.8)	2.9±1.6 (2.1; 0.9-7.0)	0.000<0.001
Total	1.0±0.4 (1.0; 0.2-2.7)	2.3±1.2 (2.0; 0.7-7.0)	0.000<0.001
P Between Groups	0.566 > 0.05	0.009 < 0.01	-

Table 2. Comparison of variations in ΔCO₂, S_{cv}O₂, lactate

Δ(ΔCO ₂)	Mean±Std.Dev;(Median; Min-Max)
Group NT	1.7±9.0 (0.0; -0.9-64.0)
Group T	2.0±4.3 (0.4; -0.9-19.4)
Total	1.8±8.3 (0.1; -0.9-64.0)
p	0.015<0.05
ΔS _{cv} O ₂	
Group NT	-0.11±0.17 (-0.13; -0.53-0.46)
Group T	-0.11±0.18 (-0.06; -0.48-0.27)
Total	-0.11±0.17 (-0.12; -0.53-0.46)
p	0.591>0.05
ΔLactate	
Group NT	1.3±1.2 (0.9; -0.4—6.0)
Group T	2.3±2.4 (1.6; -0.3-10.7)
Total	1.5±1.5 (1.0; -0.4-10.7)
p	0.025<0.05

Table 3. Distribution of AKI and increase of kreatinine levels according to groups

Distribution of patients according to transfusion and AKI subgroups			
Groups	AKI +	AKI -	TOTAL
Group NT	15 (14.9%)	86 (85.1%)	101 (80.2%)
Group T	7 (28.0%)	18 (72.0%)	25 (19.8%)
Total	22 (17.5%)	104 (82.5%)	126 (100.0%)
p	0.143>0.05		
Increase in kreatinine levels according to groups (mg/dL)			
Group NT Mean + SD (Median; Min-Max)	0.06+0.24 (0.05; -0.57-0.85)		p: 0.204 > 0.05
Group T Mean + SD (Median; Min-Max)	0.26+0.55 (0.09; -0.37-1.81)		
Total Mean + SD (Median; Min-Max)	0.10+0.10 (0.06; -0.57-1.81)		

Table 4. Distribution of one-month mortality of T and NT groups in different AKI subgroups

	GROUP	ONE-MONTH MORTALITY			p
		NO	YES	TOTAL	
AKI -	NT	85 (98.8%)	1 (1.2%)	86 (82.7%)	0.318>0.05
	T	17 (94.4%)	1 (5.6%)	18 (17.3%)	
	TOTAL	102 (98.1%)	2 (1.9%)	104 (100.0%)	
AKI +	NT	15 (100.0%)	0 (0.0%)	15 (68.2%)	0.091>0.05
	T	5 (71.4%)	2 (28.6%)	7 (31.8%)	
	TOTAL	20 (90.9%)	2 (9.1%)	22 (100.0%)	
TOTAL	NT	100 (99.0%)	1 (1.0%)	101 (80.2%)	0.024<0.05
	T	22 (88.0%)	3 (12.0%)	25 (19.8%)	
	TOTAL	122 (96.8%)	4 (3.2%)	126 (100.0%)	