Letters to Editor

## Unexpected values of mixed venous blood analysis: Back to basics before sampling

Dear Editor,

A 62-year-old man, an operated case of coronary artery bypass graft surgery and aortic valve replacement, had low-cardiac-output syndrome in the intensive care unit. A mixed venous blood sample was taken from the pulmonary artery (PA) catheter to determine whether the cardiac output and oxygen delivery are sufficient enough to meet the body's requirement. Compared to the simultaneous arterial blood sample, the sample obtained from the PA port revealed a higher pH (7.804 vs. 7.466), Partial Pressure of Oxygen (PO<sub>2</sub>) (197.3 mmHg vs. 112.3 mmHg), Oxygen saturation (SO<sub>2</sub>) (99.5% vs. 98.5%), anion gap (8.6 mmol/L vs. 7.5 mmol/L), and lactate (2.96 mmol/L vs. 1.93 mmol/L); and a lower Partial Pressure of carbon dioxide (PCO<sub>2</sub>) (8.4 mmHg vs. 23.7 mmHg), Total carbon dioxide (tCO<sub>2</sub>) (13.2 mmol/L vs. 17.4 mmol/L), and bicarbonate (12.9 mmol/L vs. 16.7 mmol/L) [Figure 1a and b]. A careful observation of the PA pressure tracing revealed a wedge pressure waveform. After the PA catheter was withdrawn by 3 cm, the blood gas analysis of the mixed venous sample showed a lower  $PO_{2}(28.8 \text{ mmHg})$  compared to the arterial and "wedge" blood samples [Figure 1c].

The case described highlights the importance of checking the position and waveform of the PA catheter while withdrawing mixed venous blood. Brewster et al.[1] also found a significantly higher PO<sub>2</sub> and pH; and lower PCO<sub>2</sub> in the "wedge" samples compared to the simultaneous arterial samples during cardiac catheterization. They presumed that wedging a catheter in a branch of PA produces a localized area of abnormally high ventilation-perfusion ratio and that the blood sampled via collateral pathways equilibrates with the overventilated segment. Dual blood supply of the lungs and contribution of the bronchial arteries to the higher  $PO_2$  is another explanation. The blood so obtained has flowed from the pulmonary capillaries and possibly pulmonary veins in a retrograde fashion producing high PO<sub>2</sub> and saturation. They rationalized that the blood passes through the pulmonary capillaries twice-once forward and a second time backward—while flowing to the aspirating catheter. The second exposure to alveolar gas increases the PO<sub>2</sub> of the pulmonary capillary blood. Recently, Khirfan et al.<sup>[2]</sup> have compared the PA wedge sample with mixed venous blood. They found higher PO<sub>2</sub>, pH, lactate, and lower PCO2, bicarbonate in the "wedge" sample

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Rapic	svst	ems	Rap	abyc		PA	SAMPLE		
			WEDGE SAMPLE			29.10.202	29.10.2021 19:09		
ARTERIAL SAMPLE			29.10.2021 18:58			System Nam	System Name ICU 5		
29.10.2021 19:00 System Name ICU 5			System Name ICU 5				System ID 1265-18988		
System Nam	10 100 5	000	System II	1265-1	8988	Patient II	)		
System ID	1205-18	900	Patient	ID					
Patient ID	)		Factorit	-					
						ACID/BASE	37.0 °	C	
			ACID/BASE	F 37 0	C	pH	7.430		
ACID/BASE	37.0 0		pH	7.8041		pC0 <sub>2</sub>	30.74	mmHg	
pH	7.466† 23.74 r		pC02		mmHg	p0,	28.84	mmHg	
pC0 <sub>2</sub>	112.31		002	197.31	mmHq	HCO3 act	19.9	mmol/L	
p02	16.7	mmol/L	HC03 act	12.9	mmol/L	HCO3 std	20.6	I/ I omm	
HCO3 act		mol/L	HC03 std	20.3		BE(B)	-3.8	mmol/L	
HCO3 <sup>-</sup> std		mmol/L	BE(B)	-5.0	mmo1/L	BE(ocf)	-4.4	mmol/L	
BE(B)		mmol/L	BE(ecf)	-5.4		ctCO,	20.9	mmol/L	
BE(ecf)		mmol/L	ctC02	13.2	mmo1/L				
ctCO <sub>2</sub>	17.4 1	mmol/L	01002	13.2	thing the	CO-OXIMETE			
			CO-OXIMET	TOV		Hct	25	%	
CO-OXIMETE		Y	Het	17	%	tHb		g/dL	
Hct		%	tHb		g/dL ,	80,	50.0	%	
tHb	7.74	g/aL	502	99.5	%	F0 <sub>2</sub> Hb	49.41		
s02	98.5	70	FO2Hb	98.21		FCOHb	0.9	%	
F0 <sub>2</sub> Hb	97.11		FCOHb	1.0	8	<b>FMetHb</b>	0.3	%	
FCOHb		%	FMetHb	0.3	*	FHHb	49.41	%	
FMetHb		%	FHHb	0.5	\$				
FHHb	1.5	%	Fring	0.0	~	OXYGEN STA	<b>TUS 37</b>	.0 °C	
			OXYGEN ST	ATUS 37	0 .0	B02	11.7	mL/dL	
OXYGEN ST	10.6	mL/dL	BO2	8.0	mL/dL	p50	30.0	mmHg	
B02		mL/dL	ct02(a)	8.5	mL/dL	ct02(a)	5.9	mL/dL	
ct02(a)	10.7	mL/aL	0102(4)	0.0	line / one				
			ELECTROLYTES		ELECTROLYTES				
ELECTROLY	130.74		Na <sup>+</sup>		mmol/L	Na*		mmol/L	
Na*	4.511		K*	4.46	mmol/L	K+	4.47	mmo1/L	
K*	0.931		Ca**		mmol/L	Ca++	0.941	mmol/L	
Ca**		mmol/L	CI-		mmol/L	Ca**(7.4)	0.95	mmol/L	
Ca**(7.4)		mmol/L	AnGap		mmol/L	CI-	1111	mmo1/L	
CI-		mmol/L	1 anoth			AnGap	6.7	mmol/L	
AnGap	1.5		METABOLIT	ES					
METABOLITE	-0		Glu		mg/dL	METABOLITE	S		
GIU	04#	mg/dL	Lac	2.961	mmol/L	Glu	84#	mg/dL	
	1.931	mmol/l	81			Lac	1.801	mmol/L	
Lac	1.931 1	intro i ve	pAtm	730	mmHa	1			
	730	mmHq	1	0.000		pAtm	730	gHmm	
pAtm	130 1	inining	PATIENT R	ANGES					
PATIENT RA	MCER		pH		- 7.450	PATIENT RA	NGES		
	7 250	- 7.450	pC02	35.0		pH	7.350	- 7.450	
pH	35.0		p02		- 100.0	pC0 <sub>2</sub>	35.0		
pC02	30.0	- 100.0	Na <sup>+</sup>	135.0	- 148.0	p02	75.0		
p02	10.0	- 148.0	K*	3.50		Na <sup>+</sup>	135.0		
Na*			Catt	1.15		K*	3.50	- 4.50	
K*	3.50 .		CI-	98		Ca++	1.15		
Ca**	1.15 .			70		CI-	98		
CI-	98 -		Glu	0.50	100	Glu	70		
Glu	70 -		Lac	12.0		Lac	0.50		
Lac	0.50 -		tHb		- 18.0	tHb	12.0		
tHb	19.0 .		F0 <sub>2</sub> Hb	9.50			.5		
FO <sub>2</sub> Hb	.0.		FCOHb	1.15		F02Hb	10		
COHP	.5 .		FMetHb	5	1.5	FCOHb			
FMetHb	0.0 -		FHHb	0.0	- 5.0	FMetHb	0.0		
FHHb	0.0 -		Constant of the		1	FHHb	0.0	- 5.0	

**Figure 1:** Blood gas analyses of the samples withdrawn from the systemic artery (a), pulmonary artery catheter in wedge position (b), and mixed venous blood from the pulmonary artery (c)

compared to the mixed venous sample. They also postulated that the differences in the "wedge" blood are due to the double passage of the blood through the lungs and its exposure to the alveolar gas for a longer period. Higher lactate in the wedge sample suggests its increased production in the lungs in patients with circulatory and respiratory failures. Douzinas *et al.*<sup>[3]</sup> have also found a similar organ-specific increase in the lactate concentration in the wedge sample in patients with respiratory failure. Even a mild degree of lung dysfunction occurring after cardiopulmonary bypass is associated with an increased pulmonary lactate release.<sup>[4]</sup>

In conclusion, the blood gas values can indicate the source of blood withdrawn from a flow-directed PA catheter. At the same time, we need to be careful about the PA pressure waveform, as prolonged, unintentional, distal migration of the PA catheter in a "wedged" position may lead to pulmonary infarct and must be avoided.

#### **Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/

their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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#### **Conflicts of interest**

There are no conflicts of interest.

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