The Effects of Time and Transport Condition on Blood Gases Analysis and Interpretation

Sean R. Chin[1,2] and Dr. David A. Colantonio[1]

[1]Department of Paediatric Laboratory Medicine, The Hospital for Sick Children, Toronto, ON, Canada, M5G 1X8
[2]Faculty of Health Sciences, University of Ontario Institute of Technology, Oshawa, ON, Canada, L1H 7K4

Introduction

Blood gases analysis are some of the most common and critical measurements used by health care professionals to monitor critically ill patients (Hedberg 2009). There are two main types of blood gases including Venous Blood Gas (VBG) which are usually drawn from the median cubital vein and Arterial Blood Gas (ABG) which are commonly drawn from the radial artery and are primarily used as a diagnostic tool to manage a patient's acid-base balance, oxygen status and metabolic parameters through various analytes. These key measurements not only describe the blood gas status, but it also depicts the overall metabolic status of the patient and can be used in a proactive manner to detect clinical changes, which allows physicians to respond accordingly. Common blood gas parameters measured include pH, pO_2, pCO_2, bicarbonate, base excess and oxygen saturation. These measurements help physicians know if the patient is having respiratory or metabolic issues. Understanding acid-base balance and knowing when a patient is in acidosis or alkalosis can help diagnosis problems such as diabetes, renal failure and many other complications (Adrogue´ 2009). It also helps them to monitor the outcome of the treatment and allows them to make adjustments accordingly.

Due to the unstable nature of blood gases It is known that pre-analytical errors are a primary cause of incorrect blood gas results. Such errors include improper handling, inhomogeneous mixing, transportation conditions, presence of air bubbles, contamination, collection device, expiry dates of syringes, and improper patient identification. Even though an institution may have the most accurate, precise and reliable analyzers, these pre-analytical scenarios can jeopardize the patient's treatment and outcome.

Objectives

• Primary objective of this study is to compare blood gas results and their associated analytes across three conditions including:
  i) Ideal conditions (on ice at 4ºC)
  ii) Room temperature (RT at 25ºC)
  iii) Presence of an Air bubble at RT

• Secondary objective is to examine the magnitude and rate of change of blood gas analytes over time. Comparing RT and RT w/ Air bubble to Ideal

Materials & Methods

- VBG collected from 6 "normal" individuals
- Three 2 mL blood gas samples (heparin syringe 80 IU/mL) Radiometer, PICO50
- Samples stored as: ideal (on ice), Room Temperature, RT w/ Air bubble
- 11 Analytes measured: pH, pCO_2, pO_2, HCO_3, Base excess, sO_2 , Sodium, Potassium, Glucose, Lactate and ionized Calcium
- Radiometer ABL 800 Flex analyzer
- Samples were measured every 15 minutes for 90 minutes

Acknowledgements

I would like to thank Dr. David A. Colantonio, Tina Henderson, Paula Carroll-Spence, The Hospital for Sick Children and the Medical Laboratory Science program at UOIT for their guidance and support throughout this study.

Results

Five of the analytes appear stable until 15 minutes:

Figure 1. Average Lactate Results

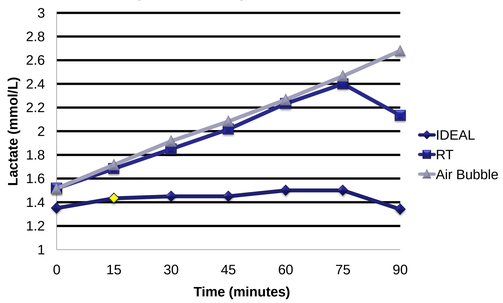


Figure 5. Average Oxygen Saturation Results

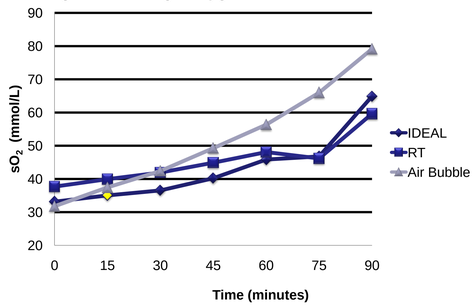
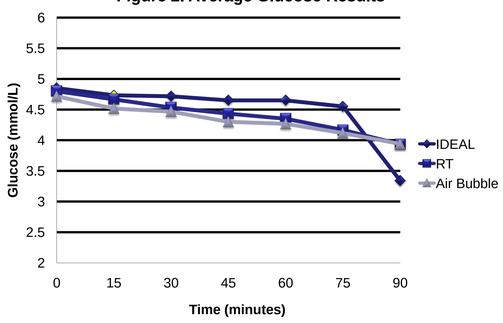


Figure 2. Average Glucose Results



Three Representative analytes stable until 30-45 minutes:

Figure 6. Average Base Excess Results

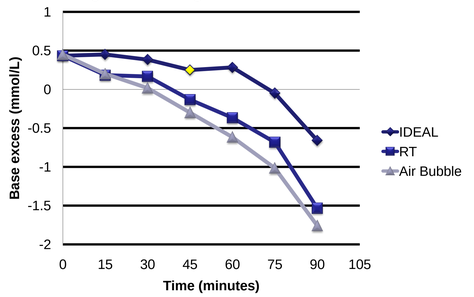


Figure 3. Average pO_2 Results

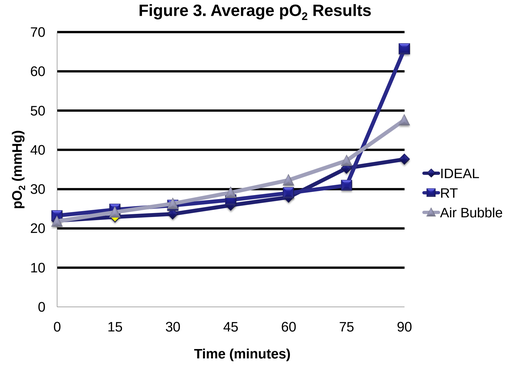
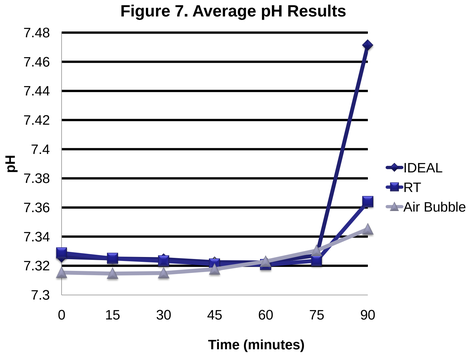


Figure 7. Average pH Results



Average Sodium Results

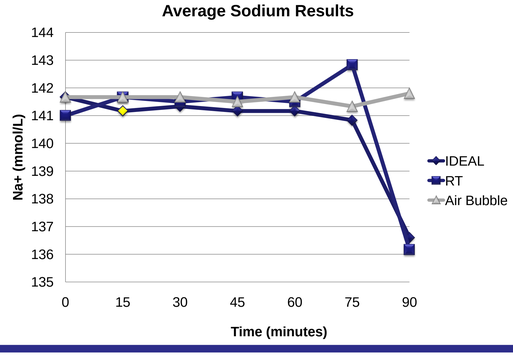


Figure 8. Average HCO_3 Results

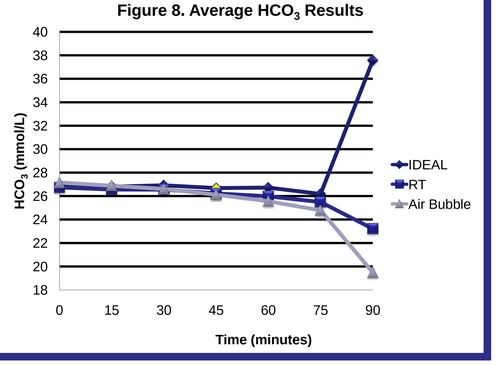


Table 1. The effects of transport condition when RT and RT w/ Air bubble samples are compared to Ideal conditions (4ºC) at different time-points. Data represented as mean (a p-value <0.05 was considered statistically significant and is marked with asterisks*) when the 25ºC and Air bubbled samples are compared to the 4ºC sample

		Time (minutes)						
Analyte (n=6)	**Condition**	***Baseline (0)***	***15***	***30***	***45***	**60**	**75**	**90**
pH	4ºC	7.33	7.33	7.32	7.32	7.32	7.33	7.47
	25ºC	7.33	7.33	7.32	7.32	7.32	7.32	7.36
	Air bubble	7.32	7.31*	7.32	7.32	7.32	7.33	7.35
pO_2 (mmHg)	4ºC	21.97	22.92	23.68	25.88	27.93	35.33	37.60
	25ºC	23.25	24.78	25.85	27.27	29.02	30.95	65.70
	Air bubble	21.82	24.13	26.32	29.13	32.32	37.27	47.64
pCO_2 (mmHg)	4ºC	53.33	53.48	53.73	53.50	53.60	52.03	49.48
	25ºC	52.85	52.95	53.13	52.73	52.32	51.03	43.93
	Air bubble	55.35	54.88	54.23	52.95	51.15*	48.78*	44.54
HCO_3 (mmol/L)	4ºC	26.81	26.81	26.92	26.68	26.72	26.18	37.58
	25ºC	26.74	26.56	26.55	26.23	25.98*	25.49	23.22
	Air bubble	27.16	26.89	26.61	26.13	25.56*	24.79*	19.49
sO_2 (%)	4ºC	33.13	35.03	36.55	40.20	45.83	46.78	64.88
	25ºC	37.70	39.92	41.92	44.88	48.08	46.16	59.62
	Air bubble	31.78	37.43	42.40	49.27	56.35	65.98*	79.12
Na^+ (mmol/L)	4ºC	141.67	141.17	141.33	141.17	141.17	140.83	136.60
	25ºC	141.00	141.67*	141.50	141.67*	141.50	142.83*	136.17*
	Air bubble	141.67	141.67*	141.67	141.50	141.67	141.33	141.80
K^+ (mmol/L)	4ºC	3.95	3.93	4.03	4.13	4.20	4.40	4.46
	25ºC	3.97	3.92	3.88*	3.87*	3.87*	3.97*	3.92*
	Air bubble	3.93	3.90	3.87*	3.85*	3.87*	3.85*	3.88*
Ca^{2+} (mmol/L)	4ºC	1.23	1.23	1.23	1.24	1.24	1.23	1.29
	25ºC	1.23	1.23	1.23	1.22	1.23	1.27	1.18
	Air bubble	1.24	1.24	1.24	1.24	1.25	1.23	1.25
Lactate (mmol/L)	4ºC	1.35	1.43	1.45	1.45	1.50	1.50	1.34
	25ºC	1.52	1.68	1.85	2.02*	2.23*	2.40*	2.13*
	Air bubble	1.52	1.72*	1.92*	2.08*	2.27*	2.47*	2.68*
Glucose (mmol/L)	4ºC	4.85	4.73	4.72	4.65	4.65	4.55	3.34
	25ºC	4.80*	4.67	4.53*	4.43*	4.35*	4.17*	3.93
	Air bubble	4.72*	4.52*	4.47*	4.30*	4.27*	4.12*	3.94
Base excess (mmol/L)	4ºC	0.43	0.45	0.38	0.25	0.28	-0.05	-0.66
	25ºC	0.43	0.18	0.17	-0.13	-0.37*	-0.68*	-1.53
	Air bubble	0.39	0.17	0.00	-0.23*	-0.53*	-0.86*	-1.76*

Discussions

- Five of the analytes (pO_2, sO_2, lactate, glucose, Na^+) appear to be stable only until the 15 minute time-point
- Six of the analytes (pH, pCO_2, HCO_3, base excess, K^+, Ca^{2+}) appear to be stable until 30-45 minutes
- "Add-ons" or additional tests should not be processed after 15 minutes
- Acceptable samples for blood gas analysis: transported at RT with no Air bubble present in a plastic syringe, but if analytes such as Lactate are requested, the sample should be transported on ice
- ABG should be used in a future study

Summary

1. Blood gases should be analyzed within 15-20 minutes from draw for accurate results
2. Pre-analytical errors, such as air bubbles, present in patient samples only for a few minutes can significantly affect patient pO_2 results

References

1. Hedberg, P., Majava A., Kiviluoma K., Ohtonen P. (2009). Potential preanalytical errors in whole-blood analysis: Effect of syringes sample volume on blood gas, electrolyte and lactate values. *Scandinavian Journal of Clinical and Laboratory Investigation,* 69(5):585-91
2. Adrogue´, H.J., Gennari, F.J., Galla, J.H., Madias, N.E. (2009). Assessing acid–base disorders. *Kidney Int*ernational, 76(12):1239-47