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The investigation of heparin effect on arterial blood gases analysis

Mina Pakmehr[1], Ali Rashki Ghaleno[2☼]

1.MSc Student of nursing ,Dept. of medical surgical ,Student Research Committee, School of Nursing and Midwifery, Zabol University of Medical Sciences, Zabol, IR Iran

2.Nurse, Zabol University of Medical Science, Zabol, Iran; MA student of clinical psychology, Islamic Azad University, Zahedan, Iran

☼**Corresponding author:**
Ali Rashki Ghaleno,
Zabol University of Medical Sciences,
Zabol,
Iran
Email: ganjresearch@gmail.com

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ABSTRACT

Background: Arterial blood gases analysis (ABG) is a common test performed in intensive care unit (ICU) of hospitals. In this critical unit, some intruding factors may influence ABG results. Heparin, a common in used anticoagulant, is among one of these interfering factors. In present study, effect of heparin was evaluated on ABG results.

Methods: In present quasi-experimental study, 200 specimens of arterial blood were drawn from the radial artery. From these, 100 samples were transferred into heparinized syringes (1 ml heparin per 1 ml blood sample), and 100 samples into dry syringes without any anticoagulants. Results of AGB were analyzed by SPSS 16 software.

Results: There were significant differences regarding means of pH, PCO_2, PO_2, HCO_3, and BE between the two groups. However, no significant difference was observed for O_2 saturation level.

Conclusion: Considering the adverse effects heparin on ABG results found in this study, using heparin as an anticoagulant in discouraged. It is advised to minimize using this anticoagulant in clinical procedures.

Keywords: Anticoagulants; Radial Artery; Blood Gas Analysis; Intensive Care Units

1. INTRODUCTION

Intensive care unit (ICU) is a critical part in which patients with acute life threatening conditions are being treated under supervision of most expert care givers (1). Patients attended in ICU generally suffer from hypoxia and pulmonary diseases associating with abnormal blood oxygenation (2). Arterial blood gas analysis (ABG) is among the most frequent ordered test in ICU units which is used for evaluating oxygenation, ventilation, and acid-base balance status (3). This is a historic test developed by Clork Caverdker approximately six decades ago. Remarkable achievements have been made since 1950 regarding arterial blood gas electrodes for measuring PO_2, PCO_2, and pH (4, 5). It has been estimated that over 150 million ABG tests are performed annually in the United States (US) (3).

ABG needs acceptable level of expertise and skill. In fact, it may be needed to perform the test several times (especially when targeting the radial artery) leading to possible discomforts such as hematoma, bleeding, thrombosis, and Aneurism and distal ischemia (6).

To perform ABG test, a heparinized syringe (1 ml heparin corresponding to 1000 units) is applied. For this purpose, the heparin should be draw into the syringe, and the excess heparin be discarded. Very low volume of the heparin will remain in the needle and dead space of the syringe which prevents blood from coagulation (7). Heparin, in complex with anti-thrombin, inhibits coagulation cascade by inactivating coagulation factor ten and preventing of active thrombin generation (8). Heparin is a potent acid consisting from sulfate and carboxylic acid units. In sodium heparin, acidic protons of the sulfate units are exchanged with sodium ions. Sodium heparin is the common anticoagulant utilized in ABG analysis. Blood gas alternations occurring in relatively low volumes of blood diluted in heparin have not been well studied (7).

Since the most of blood specimen and its sending should be done by the nurses (specially in ICU), therefore they should have enough knowledge of blood sample interferences, because these could influence the test results (9).

There are so many factors that affect the accuracy of blood gas analysis up to 75%, including pre-analytical influences such as skill of collecting sample, temperature, site of sampling, air in the syringe, time for analysis, improper mixing, syringe material, type and concentration of heparin (10).

There is a need for good understanding of interfering factors that could influence ABG analysis results. In present study, we aimed to assess possible effects of heparin on ABG test results.

2. MATERIALS AND METHODS

This was a quasi-experimental study. The study was performed using samples of patients in ICU1, ICU2, and ICU3 sections of Amir-Al-Momenin Hospital of Zabol city during August-November 2016. The study was ethically approved by ethical committee of research of Zabol University of medical sciences. For ethical consideration, the procedure was only performed when the test was necessary according to the physician. In the cases that patients were conscious, an informed consent was obtained from selected patients, unless the consent was acquired from their families.

Our sample constituted 200 arterial blood gas specimens drawn from radial artery of 100 patients randomly selected from the ICU sections. Before sampling, a 2-mlheparinized syringe was prepared by drawing /1 ml heparin into the syringe, and evacuating the excess heparin. Then, 2 ml arterial blood was drawn from the radial artery by a 2ml dry syringe. Immediately after obtaining the blood, the sample was transferred into ABG analyzer. Subsequently, 1 ml of the blood from the dry syringe was transferred into the ice-placed heparinized syringe (in concentration of /1 ml heparin to 1 ml blood). After auto rinse of ABG analyzer, and observing for the required delay, heparinized sample was analyzed.

For removing interfering effect of different concentrations of heparin, all syringes were heparinized in a same manner, and all were filled with exactly 1 ml of blood. For minimizing effect of time difference, effort was made to minimize tardiness and delay between the assessments (maximum time difference was 3 minutes), regarding that recommended maximum time without significant changes has been toted to bebetween10minutesuntil 2 hours. Some text books this time has been 20 minutes and in some other text, this was 1 hour (9).

Effort was made to prevent air bubbles when filling heparinized syringe, and when this was not fulfilled, the samples were excluded from further analysis. Accuracy of syringes was tested by repeated filling and emptying, and subsequent measuring the volumes. Amount of remained heparin in syringes after emptying excess heparin was verified as 0.1 ml after 10 times of repeating the measurement.

For measurement of ABG parameters, GASTAT_602i instrument was used. The analyzer was calibrated using three solutions including acidic, alkali, and normal. Also, the instrument had been automatically calibrated every 3 hours for pH, and every 12 hours for pH, PCO_2, and PO_2. Statistical analyses were performed in SPSS 16 software.

3. RESULTS

Mean age of the participant was 52 years old. Females and males comprised (101) 50.5%, and (99) 49.5% respectively. Mean of admission period to hospital was 11 days. Majority of the patients (55%) were incubated and were under SIMV. The most diagnosed clinical conditions were MT (33.5%), and ICH (17%) respectively.

Data analysis using paired sample t-test showed that mean values of pH, PCO_2, PO_2, HCO_3, and BE were significantly different between dry and heparinized syringes. However, no significant difference was found regarding O_2Sat between heparinized and non-heparinized syringes (Table 1).

Table 1 result of analysis of arterial blood gases

Variable	Mean ± Std. Deviation	Paired Differences			t	df	p
		95% Confidence Interval of the Difference		Mean			
		Upper	Lower				
PH without heparin	7/419± /07	/009	/004	/006	5/06	199	p</05
PH with heparin	7/426± /07						
Pco_2 without heparin	40/20±11/51	1/72	2/78	2/25	8/41	199	p</05
Pco_2 with heparin	37/94±11/00						
Po_2 without heparin	104/55±42/38	2/32	/15	1/23	2/25	199	p</05
Po_2 with heparin	105/79±41/35						
Hco_3 without heparin	26/18±7/32	/44	1/07	/75	4/77	199	p</05
Hco_3 with heparin	25/42±7/15						
O_2sat without heparin	95/78±4/69	/27	/11	/08	/84	199	p>/05
O_2sat with heparin	95/87±4/82						
BE without heparin	2/10±6/20	/22	/69	/45	3/85	199	p</05
BE with heparin	2/55±6/36						

4. DISCUSSION

Data analysis showed that pH, PCO_2, PO_2, HCO_3, and BE parameters were significantly different between heparinized and non-heparinized syringes. Also, Kumar et al compared pH, PCO_2, PO_2, HCO_3, and O_2saturation levels in a heparin flushed syringe and a syringe containing 2 ml heparin. In the recent study, levels of pH, PCO_2, PO_2, and HCO_3 were dependent on heparin concentration while O_2 saturation level was not a variable of heparin concentration. They also recommend that no more than 0/1 cc of heparin to be use in the syringe for arterial blood drawn or to flush the syringe with heparin is sufficient as it will alter all parameters (10).

Hutchison et al (1983) reported that if heparin makes up 10% or more of the total volume of sample for blood gas analysis important errors in PCo2, HCo3 and BE will occur. They recommend a maximum of 0/2 ml of 1000 units sodium heparin/ml in a 5 ml sample, or 0/1 ml in 2 ml sample, giving approximately 20 units heparin/ml blood, and any sample of a volume of 1 ml or less should be considered (technically) unsuitable for analysis (11).

Ordog et al (1985) argued that the liquid heparin decreased statistically the PCO_2, PO_2, HCO_3, and base excess, while the pH remained unchanged. They also reported that by using a 2cc blood sample with a 5cc glass syringe and a 11/2inch, 18 gauge needle to draw the heparin solution up to the 2cc mark, and then completely evacuating it, 0.025 cc of solution remained to coat the syringe that this remaining solution would cause a 1.25% error in the blood gas results (12).

Hopper et al in their study on animal models (6 mature dogs) found that diluting of blood sample by sodium heparin resulted in alternations of PO_2, PCO_2, and base deficit. These researchers proposed that blood samples should be diluted with heparin in less than 4% ratio (13).

Results of Malikzade et al (2005) indicated that alternations in heparin dependent did not affect PO_2, and O_2 saturation. This is similar to our results that showed no significant change in O_2 saturation in heparinized syringe. This is while we found a meaningful difference in PO_2 level. In their study, Malikzade et al stated a meaningful change in HCO_3, BB, BEecf, PCO_2, and pH with maximum alternation was related to HCO_3, and the least changes belonged to PCO_2 (7). Bradly et al stated a 28% deviation rate in PCO_2 level in heparin diluted blood samples (14).

Different studies indicate that heparin contamination may occur while taking an ABG sample (7, 10, 11, 12). In our study, we showed that even low amount of heparin (/1 ml sodium heparin in 1 ml blood) can result in significant changes in ABG results. This is important because even these small changes (1-2%) in PO_2, PCO_2, pH, BE, and HCO_3, or even 0.01% alternation in pH can affect ABG results interpretation (7).

5. CONCLUSION

Regarding the high importance of ABG results and significant effects of heparin on these results, it is recommended to provide ABG analyzers in ICU to immediately obtain results of ABG samples withdrawn in this unit. This obviates the needing for heparinized syringes in order to prevent coagulation. It is recommended to further study effects of heparin contamination on ABG results in future studies.

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CONFLICT OF INTEREST

None declared

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