ejpmr, 2015,2(6), 290-293

SJIF Impact Factor 2.026

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 3294-3211

EJPMR

EFFECT OF EXTRA AMOUNT OF HEPARIN IN SYRINGE AND ITS EFFECT ON ARTERIAL BLOOD GAS ANALYSIS

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Article Received on 20/09/2015 **Article Revised on 10/10/2015** **Article Accepted on 01/11/2015**

ABSTRACT

Objectives: To determine the effect of dilution of heparin on several parameters of arterial blood gas analysis in normal healthy subjects. **Methods:** We compared arterial blood gas analysis in 2 samples of blood, 1st glass syringe flushed with heparin and 2nd glass syringe consisted of 0.2ml of heparin collected from 20 healthy subjects. **Results:** In the present study in sample-2, we observed a significant increase in the levels of PO_2 (208.5±33.6), pH (7.49±0.039) when compared to sample-1 PO_2 (88.85±6.22) and pH (7.4±0.041), with p-value<0.0001 in both. In sample -2 values of PCO_2 (16.17±2.21), HCO_3 (12.97±2.09) were significantly low when compared to sample-1 PCO_2 (40.26±3.22) and HCO_3 (24.55±1.59) with p-value of <0.0001 in both parameters. Values of oxygen saturation were also measured but there was no significant difference. **Conclusions:** Amount of heparin is an important variable factor for arterial blood gas analysis sampling. Extra amount of heparin can cause alteration in pH, PO_2, PCO_2, HCO_3, electrolytes and other parameters. Syringes should be flushed with heparin or should contain less than 0.1ml of heparin while analysis.

KEYWORDS: Heparin, Arterial blood gas analysis.

INTRODUCTION

Arterial blood gas analysis is a routine and important procedure in emergency and intensive care unit in daily practice specially for ventilator patients and for patients having cardiopulmonary compromise. Arterial blood sample can be used to measure acid-base balance, electrolytes, gases as well as saturation simultaneously within few minutes.[1] There are so many factors that affect the accuracy of blood gas analysis upto 75%, including preanalytical 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. [2-4]

Heparin influences various parametres of blood gas analysis that varies from the type of heparin, dry balanced vs. liquid in the preparation of the sample, amount of heparin and its mixing with blood sample.[5,6] Nowadays, preloaded heparin syringes are available in few centres. But because of non-availability of these syringes at few places and cost factor in India, residents and nursing staff are doing blood gas analysis by taking varies amount of heparin in syringe. We conducted this study to analyse the effect of heparin amount in sample on various parameters of blood gas analysis to reduce the preanalytical errors.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Anaesthesia, A.J. Institute of Medical Sciences, Mangalore. Informed consent was taken from all subjects before inclusion in the study. The study was approved by the Institute Ethics Committee.

Inclusion criteria were 20 healthy adults with age varying from 20-35 years. Exclusion criteria – subjects with other significant history of hypertension, renal disorder, smoking, alcohol, diabetes mellitus, any respiratory infection, asthma, chronic obstructive pulmonary disease, metabolic disorders, anemia were not taken into study. Samples were collected with identical 2-cc glass syringes, using an 24 gauge needle in all the subjects by well trained nurse. 2 samples were withdrawn from radial artery in 2ml syringe from each subject at an interval of 1 hour. In 1st sample heparin was flushed completely from the syringe and after that sample was taken and in 2nd sample 0.2ml of heparin was preloaded and blood was taken from subjects. Both samples were processed immediately within 5-10min from arterial blood gas analyzer. All other preanalytical errors i.e. temperature variation, time lag, air in syringe, improper mixing, were ruled out. The following parameters were noted i.e. pH, PO_2, PCO_2, HCO_3, SaO_2.

Statistical analysis was done using the SPSS version 16.0 (NY, USA). Data were expressed as mean ± standard deviation and were analyzed using Student's t-test. P value of <0.05 was considered statistically significant.

RESULTS

The table shows comparison of all parameters i.e. pH, PO2, PCO2, HCO3, SaO2 between two samples.

Arterial blood gas parameters	Variables	Sample(1) flushed with heparin	Sample(2) with 0.2ml heparin	P value
PO_2	mean	88.85	208.5	<0.0001
	Standard deviation	6.22	33.6	
	range	86-92	193-224	
PCO_2	mean	40.26	16.17	<0.0001
	Standard deviation	3.22	2.21	
	range	39-42	15-17	
pH	mean	7.4	7.49	<0.0001
	Standard deviation	0.041	0.039	
	range	7.38-7.42	7.47-7.51	
HCO_3	mean	24.55	12.97	<0.0001
	Standard deviation	1.59	2.09	
	range	24-25	12-14	
SaO_2	mean	97.15	97.20	0.91 (Non-significant)
	Standard deviation	1.12	1.46	
	range	96.6-97.7	96.5-97.9	

A increase in the pH was observed in sample 2 when compared to sample 1(Figure-1). Both carbon dioxide pressure and bicarbonate concentration showed an inverse relation with the volume of heparin used. There was a close relation between the percentage change in each set of values for carbon dioxide pressure and actual bicarbonate concentration from baseline and the percentage volume of heparin in each sample (Figure-2,3).

A increase in PO_2 was observed in sample 2 (Figure-4), while there was no significant change in values of saturation (Figure-5).

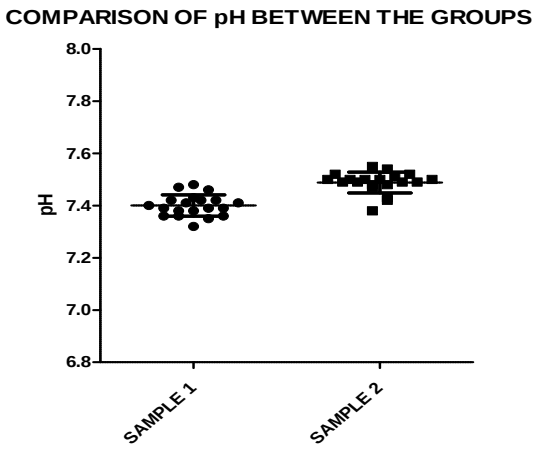

Figure-1.

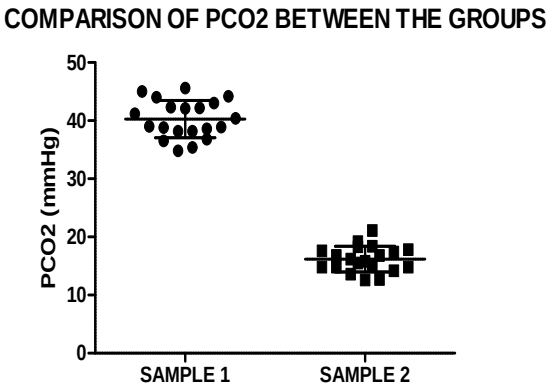

Figure-2.

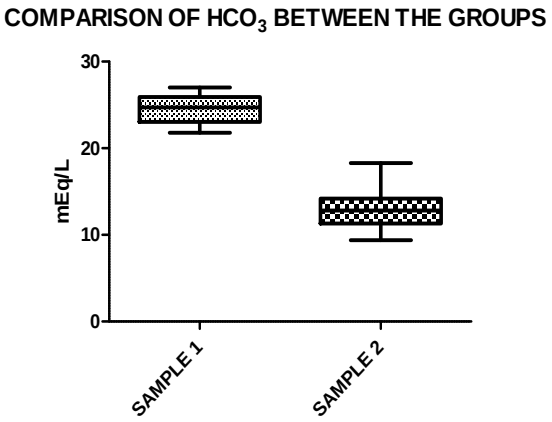

Figure-3.

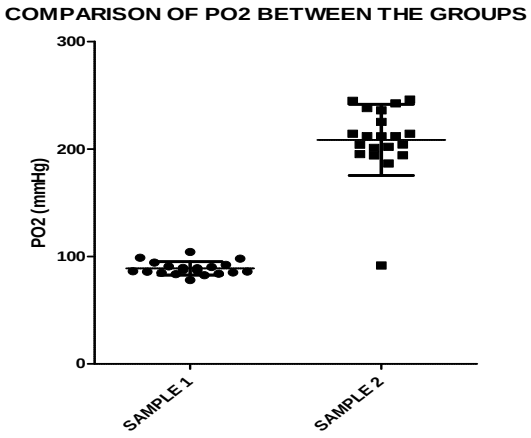

Figure-4.

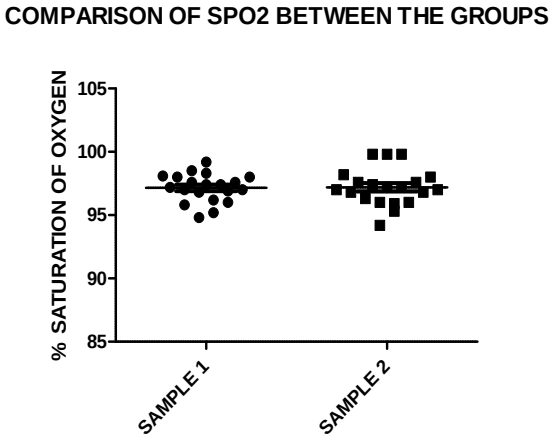

Figure-5.

DISCUSSION

Arterial blood gas analysis is very important mode of investigation to monitor ventilator patients and sick patients. This is a routine procedure performed in ICU. But its accuracy is affected by several factors like post-draw metabolism, heparin, air bubble, storage, temperature, transport, abnormal cell count, abnormal mixing and several other factors.

Heparin, first isolated in 1916 from liver tissue, is a naturally occurring anticoagulant present in all mammalian species.[7] It is synthesized in mast cells and basophils, and stored in the secretory granules of these cells. Since mast cells are present in many tissue types, heparin can be sourced from a range of extra-hepatic tissues.[8] Commercial preparations are now most commonly derived from the mucosal intima of pig (porcine) intestine. The ideal anticoagulant should be dry, free of interference in laboratory tests, inexpensive and completely reliable as an anticoagulant.[9] The International Federation of Clinical Chemistry recommend for blood gas sampling, filling up of the dead space of the syringe with heparin, to lubricate the inner wall of the syringe, to expel the excess anticoagulant and to collect at least 20 times the dead space volume of blood to avoid preanalytical errors.[10,11] Dry balanced heparin is "electrolyte balanced," (containing Lithium and Zinc rather than sodium or calcium) to prevent interference with the numerous electrolytes and other parameters estimated.[12,13] A variety of heparin salts, in either liquid or lyophilized form, have been used as anticoagulants. Lithium heparin, the most commonly used anticoagulant, induces a negative bias in the measurement of ionized calcium concentration.[14] Heparin is acidic and lowers pH. Heparin of lower strength (1000 instead of 5000 units per ml) or heplock solution should be used. Small volume of heparinised saline just for lubricating the syringe and plunger should be used. If volume is more, dissolved oxygen in heparinised saline may increase PaO2.The principle disadvantage of liquid heparin is a potential for error if blood is over-diluted with heparin. This potential error is due to the considerable difference in pH, pCO_2, and pO_2 of liquid heparin compared with that of arterial blood.[15] Approximate values for heparin solution are pH 6.4; pCO2, 7.5 mmHg (1kPa), and pO2, 160 mmHg (21kPa), reflecting the fact that heparin is an acidic solution in equilibrium with air.[16,17]

Heparin has two different effects on blood gas samples based on its intrinsic chemical properties and dilution of the sample. As heparin dilutes mainly the plasma phase of the blood sample the magnitude of the dilution of a 1 ml blood sample by 0.05 ml of liquid heparin may be around 10%. Siggaard Andersen found a fall in Pco2 of 16% when blood was diluted by 12-13% with saline. When adding dry heparin to concentrations of 2, 4 and 10 mg/ml, Siggaard Andersen found that the average effect of 1 mg heparin per ml blood was +0.1 mmHg Pco2.[18] In contrast, Bradley et al. reported a 28% fall in Pco2, at the same dilution.[19]

Few studies have suggested that measured pH is resistant to dilution of heparin, even if heparin and blood are mixed in equal volumes (i.e.,50% dilution of blood), presumably due to the buffering capacity of blood. In some studies, no effect on pO2 was observed, while in others, an increase in pO2 was observed at high (35% to 50%) dilution. pCO2 is the most susceptible parameter. As long as dilution is less than 10% (e.g., 0.5 mL heparin added to 5.0 mL of blood), pCO2 is not significantly affected, but dilutions above 10% are associated with significant decline in pCO2 values. There is an approximate 1% decline in pCO2 for every 1% increase in dilution. Calculated acid-base parameters, bicarbonate, and base excess that are derived from measured pCO2 are affected to the same magnitude. [20-22]

Previous studies suggest that heparin dilution also affects Na+, K + and ionic calcium varying from − 12% to 12%. Various authors have previously shown that estimation of Na+, K + and Ca2 + may be low in a sample collected for and analyzed by the blood gas machine. This has previously been attributed to binding of cations from the

sample by liquid heparin.[23-25] Previous studies are also supportive of the fact that arterial blood sample should be collected in appropriate conditions with minimal amount of heparin and other prerequisite conditions to be followed, for accurate report.[26,27]

CONCLUSION

We 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. It is desirable to collect sample anaerobically and use a glass syringe as plastic syringes are permeable to air. The sample should be processed immediately, preferably within 30 minutes because cells consume oxygen and produce CO2. PaO_2 varies with dilution and can be increased also giving misconception of good ventilation.

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