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Letter to Editor

Biochemistry Section

Correct Blood Sampling for Blood Gas Analysis

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Sir,

Blood Gas Analysis (BGA) is almost a routine test in patients admitted in ICCU/ICU. Recently, I happened to visit a relative admitted in ICCU of a medical institute and there, I found the consultant doctors discussing the accuracy of BGA report. Their conclusion was that most of the times the results were not satisfactory. Unfortunately, a month ago, I was admitted in the same institute for my renal calculi surgery and due to some post-operative complications, I was shifted to ICU. At the ICU my BGA was done thrice and to my dismay, all the 3 times the residents collecting my blood from the radial artery were unaware of heparin to blood ratio. Then, I realised why the reports of BGA were not satisfactory. This prompted me to write this letter about sampling and choice of blood for BGA.

Blood Sampling: Heparinised blood is used for BGA but the correct amount of heparin and blood is very important to prevent coagulation of blood and to obtain accurate test results. It has been recommended by the International Federation of Clinical Chemistry (IFCC) that heparin should be taken in the syringe to lubricate the inner wall of the syringe and then heparin should be expelled from the syringe completely and at least 20 times the dead space volume of blood should be collected [1]. The dead space of the syringe is the volume of liquid remaining in the hub and the needle after completely emptying the syringe. It varies with the size of the syringe and the needle, type of material etc., [2]. On an average, the dead space is 0.08–0.25ml depending on the size of the syringe and needle (1ml-10ml) [2-5]. So as per IFCC recommendations if we collect blood in a 2ml heparinised syringe then considering the dead space about 0.1ml the syringe should be completely filled (2ml) to make the blood 20 times the dead space volume. Under-filling the syringe would result in erroneous results due to dilution and chemical effects. The dilution effect of heparin may cause a fall in pCO_2 and bicarbonate concentration and since the heparin is acidic the use of concentrated heparin may result in an increase in pCO_2 and reduction in pH [1,6]. pO_2 may also be affected by too much heparin [7]. This problem of dilution effects of heparin can be avoided by use of syringe pre-loaded with lyophilized heparin but under-filling of this syringe would also result in erroneous results. Moreover, such syringes are costly.

It is also preferred to use low concentration heparin (1000IU/ml) because this would result in Final Heparin Concentration (FHC) of about 50IU/ml in a fully filled 2ml syringe which would be sufficient for correct BGA results. However, the heparin used in our hospitals for anti-coagulation treatment of patients is usually 5000IU/ml and the same in generally used for heparinising the syringe for blood collection. This heparin would result in more FHC (e.g., 250IU/ml in fully filled 2ml syringe). However, this FHC would give acceptable test results as recently it has been reported that FHC of 100-351 IU/ml gave acceptable changes in pH, pCO_2, pO_2, Na^+, K^+ and Ca^{++} [7].

Choice of blood:

Arterial blood specimen is the first choice for BGA for assessing ventilation and acid – base status. However, arterial blood collection causes patient discomfort and other complications [8]. Therefore, many times venous blood is used for acid – base status assessment although the composition of venous blood is affected by the local activities of the organ drained by the vessel in question and the rate of blood flow through these peripheral tissues. It is therefore not indicative of the acid – base status of the whole body [9].

Moreover, the opinion is divided on the use of venous blood over arterial blood. Central venous pH is usually 0.03 to 0.05pH units lower than arterial blood pH where as peripheral venous pH is approximately 0.02–0.04 units lower. pCO_2 is usually 4-5mmHg higher in central venous blood while in peripheral venous blood pCO_2 is 3-8mmHg higher than arterial pCO_2 [10]. Regression equations [11] have also been derived to predict arterial values from venous values as follows:

Arterial pH = - 0.307+1.05 x venous pH

Arterial pCO_2 = 0.805+0.936 x venous pCO_2

Arterial HCO_3 = 0.513 + 0.945 x venous HCO_3

However, a recent meta-analysis showed that peripheral venous BGA compares well with arterial BGA for pH estimation in adults but not to pCO_2 or pO_2 [12]. Nevertheless, venous percent oxygen saturation has been found to be a good tool for treatment in sepsis [13,14].

It is also important that the blood sample for BGA should be transported to the laboratory as soon as possible because it should be analysed for BGA within 15-30 minutes of blood collection. If there is any delay, then the syringe should be placed in ice – water slurry (not with ice alone) to reduce cellular metabolism.

Steps for blood collection for BGA

1. Take a little amount of heparin in a 2ml syringe to lubricate the inner wall of the syringe and then flush out the heparin completely.
2. Collect 2ml arterial/venous blood in this heparinised syringe (filling the syringe completely is very important).
3. Remove air bubbles quickly, if any, and place the needle cap (don't bend the needle as it may hurt the analyst) or better insert the tip of the needle into a rubber cap (of injection vial) or a bung to prevent any leakage of gases. Mix the blood in the syringe gently by rotating the syringe between the palms of the hands to ensure mixing of blood with heparin.

4. Send the sample to the laboratory immediately. If it is not possible to send immediately then keep the syringe in a container having ice-water slurry (not with ice alone) but not for too long because the plastic syringes are partially gas permeable and this permeability increases at a lower temperature.

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