

To heparinize or not to heparinize: Effect on arterial blood gas measurements

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The most useful of investigations should be rapid and easy to perform, give reliable results and influence management decisions. The arterial blood gas goes a long way toward fulfilling the above needs. The utility of the arterial blood gas has been enhanced by the additional information provided by modern analyzers, including the plasma electrolytes, anion gap, ionized calcium and plasma lactate.^[1] Its continuing reliability is dependent upon recognition of changes in the normal values with changes in the methods and technology employed for measurement. Samples not analyzed at the point of care require anticoagulation albeit in very small quantities, viz heparin 1 U/ml. The ideal anticoagulant would be dry, free of interference in laboratory tests, inexpensive and completely reliable as an anticoagulant.^[2] 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.^[3]

In actual fact preanalytical sample handling is estimated to account for 75% of the errors in blood gas analysis.^[4] In the study by Chhapola *et al.*^[5] in this issue of the Journal examines an important aspect of arterial blood gas measurement, namely the influence on the various parameters of the type of heparin, dry balanced vs. liquid in the preparation of the sample. 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.^[4] Heparin has two different effects on blood gas samples based on its intrinsic chemical

Access this article online
Website: www.ijccm.org
DOI: 10.4103/0972-5229.125422
Quick Response Code:


properties and a 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%.^[4] The authors have painstakingly prepared liquid heparin syringes with meticulous attention to detail regarding the pH, Na⁺ and pO₂ content of the heparin available in an attempt to standardize the technique. Further strengths of the study include a single needle prick for sampling with both syringes that minimized sampling differences. duplicate analysis of each sample giving a coefficient of variation of 1%, point of care analysis and achieving a sample size larger than calculated for pCO₂. The authors however as stated did not measure ionized calcium a parameter previously shown to be influenced by various preparations of heparin.^[2]

What did This Study Show?

Although there was a significant difference between pH measured in samples collected in the two syringes, no value was beyond the total allowable error.^[5] Furthermore the actual means 7.42 and 7.41 are so close that the difference is unlikely to affect clinical decisions. By contrast, though the difference between mean pCO₂ values was not significant, 40% of the values were outside the total allowable error limits. Similar wide variability in the measurement of Na⁺, K⁺, Cl⁻ and HCO₃⁻ were

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noted. Thus values obtained by the two techniques dry balanced heparin and liquid heparin are not comparable. The magnitude of this difference may be even more marked where syringes are less meticulously prepared, or a time delay occurs in sample analysis causing a dilution effect a situation which occurs in everyday practice away from the rigorous conduct of a research trial. An earlier published study showed that the final heparin concentration in a blood gas sample could vary from 100 to 482 IU/ml and produced significant changes in the estimation of $p\text{CO}_2$, HCO_3^- , Na^+ , K^+ and ionic calcium varying from - 12% to 12%.^[3] The authors and others have previously shown that estimation of Na^+ , K^+ and Ca^{2+} may be low in a sample collected for and analyzed by the blood gas machine.^[2,6] This has previously been attributed to binding of cations from the sample by liquid heparin.^[4] Also, calculations based on these measurements may therefore be significantly affected. For instance studies have shown that the normal anion gap measured on selective electrodes had values as low as 6 ± 3 meq/L rather the median 12 used in calculations.^[7]

What are The Implications of This Study?

The use of dry balanced heparin syringes in India is probably still limited. Cost will remain a significant factor in the choice between the two types of syringes, but should not compromise the accuracy of measurement, calculation and clinical decisions. In addition erroneous results will translate into inappropriate interventions and avoidable costs.^[4] Although the pH may influence the decision to intervene, the nature of the intervention would require the complete panel, which differed widely between the two types of samples in this study. As it was not possible for the present study to determine a difference in clinical decision making, more studies are required. As the authors themselves have noted, variations in the measurement by different analyzers and measurement

of calcium will need to be determined by multicentric studies. In addition, it may be necessary to see how far the variations will affect clinical decision making. The present study is important as it provides an insight to the extent to which dilution by heparin may alter the values of $p\text{CO}_2$, HCO_3^- , Na^+ , K^+ and Cl^- . Further studies should concentrate on the determination of the anion gap, corrected anion gap where possible the diagnoses obtained and interventions arising from these calculations. In conclusion, heparin whose requiem in therapeutics appeared to have been sounded by the advent of low molecular weight analogs has returned to haunt clinical medicine this time in the guise of an anticoagulant for laboratory measurement.

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How to cite this article: Lobo V. To heparinize or not to heparinize: Effect on arterial blood gas measurements. *Indian J Crit Care Med* 2014;18:1-2.

Source of Support: Nil, **Conflict of Interest:** None declared.

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