Arterial blood collection: sampling and storage - part 2 of 2

October 2005



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The collection of arterial specimens with glass syringes and immediate storage in iced water was the accepted industry standard for many years. Practice has changed over the past several years to blood gas sample collection in plastic syringes, likely due to the cost, safety and convenience of plastic.

This change in practice has led to a re-evaluation of the impact of the collection device, storage time and storage conditions on the acid/base, oxygen and carbon dioxide results. A comparison of the knowledge gained in the use of glass syringes as compared to plastic syringes and the resultant changes on the measured results is necessary to identify and control the potential for measurement error.

The arterial collection and analysis guidelines published by the Clinical and Laboratory Standards Institute (CLSI) provide specific recommendations regarding specimen collection devices, sample handling, specimen transport and storage conditions based on scientific studies. This two-part article will examine what we have learned from the studies and how it might be applied in daily practice.

Part 2 of 2

Part two of this two-part article continues with collection devices and high initial pO_2 , recent studies and current recommendations.

Collection devices and high $pO_2(aB)$

The recommendation to analyze arterial blood specimens within 15 to 30 minutes when collected in plastic syringes was developed based on studies performed in a normal range. The increased diffusion gradient in specimens with a high partial oxygen tension may cause substantial errors in right-to-left shunt calculations performed from a 100 % oxygen test.

A study published in Thorax in 2004 examined the effect of sample storage time, temperature and syringe type on blood gas tensions in samples with high oxygen partial pressure [8].

Pretto *et al* evaluated the changes in $pO_2(aB)$ for samples with a high initial partial pressure collected in a high-density polypropylene syringe. Tonometered whole blood was placed in three brands of plastic syringes and in glass syringes. The samples were either stored at room temperature or in iced water. Sample analysis was performed at baseline, and after 5, 10, 20, 40, 60, 90 and 120 minutes. The $pO_2(aB)$ measured from the plastic syringes stored at room temperature fell an average of 1.21 kPa/min for the first 10 minutes. When the sample was placed in iced water, the decline decreased to 0.19 kPa/min.

The samples collected in glass syringes and stored at room temperature averaged 0.49 kPa/min. The changes in $pO_2(aB)$ when collected in a plastic syringe and stored at room temperature could lead to an overestimation of pulmonary shunt measured at 100 % oxygen of approximately 0.06 % per minute. The results of this study suggest that for blood gas samples with a high $pO_2(aB)$, samples should be analyzed immediately for accurate results.

If a longer storage time is required, then the use of glass syringes and adequate specimen cooling may be required for accurate blood gas results. Procedures for transporting, storing and analyzing blood gas results must be clearly defined for both routine specimens and special procedures.

Smeenk et al further evaluated the influence of the type of syringe, the temperature of the sample during storage and the total storage time on $pO_2(aB)$, $pO_2(aB)$ and ultimately the pulmonary shunt calculation [9].

Ten subjects were studied. The subjects were ventilated with 100 % oxygen for at least 30 minutes. Four samples were obtained, two using 5-mL glass syringes and two using 3-mL plastic syringes. One sample of each collected in glass and plastic were stored on ice and the other two remaining samples were stored at ambient temperature. Samples were analyzed at 5, 15, 30, 60 and 120 minutes.

All results were compared to the samples obtained in the glass syringe, cooled in ice water immediately and analyzed approximately 5 minutes post sampling. Shunt calculations were performed on all samples post analysis. The pulmonary shunt calculations did not change significantly when the sample was obtained in a glass syringe and stored on ice water, regardless of the storage time.

All other sampling methods, storage and analysis times influenced the shunt calculations. Samples collected in plastic syringes and stored at room temperature resulted in significantly lower $pO_2(aB)$ values, which continued to decrease with increased storage times. The $pO_2(aB)$ values remained stable despite the different sampling methods. The mean shunt calculated from the sample obtained in a glass syringe and stored on ice water was 10.4 %.

The error in the pulmonary shunt value varied form 0.8 to 9.9 % when the samples were not obtained in a glass syringe and stored in ice water.

The authors concluded that when a 100 % test is requested, samples should be collected in a glass syringe, stored on ice water and analyzed within 60 minutes.

Recent studies

In 2005, Licht published a study examining the influence of sodium fluoride on the stability of human blood samples and blood gas measurements [10].

The addition of sodium fluoride to the sample is intended to inhibit the metabolic reactions that continue when the sample is stored at room temperature. Arterial specimens were collected from six volunteers and then distributed over 104 capillary samples, which contained different concentrations of the sodium fluoride.

The partial pressure of carbon dioxide and the pH could be stabilized with a defined concentration of fluoride, but the partial pressure of oxygen decreased significantly over a 70-minute time period. Additional studies will be needed to further evaluate this proposed method.

More recently, equine studies have also evaluated the

effect of syringe material and temperature and storage on the stability of arterial blood gas values. The impact of each of these influences may be different in other species, and the knowledge gained in human studies may not extend to all other sampling that may occur in animal studies.

Current recommendations

The current documents for collection and analysis of arterial specimens from CLSI serve as a basis for the current recommendations [2, 3]. Arterial specimens should be collected in a plastic syringe, left at room temperature and analyzed within 30 minutes.

Blood collected for special studies should be analyzed within 5 minutes. There are still situations in which a glass syringe should be selected as the collection device.

The Clinical and Laboratory Standards Institute reviews and updates guidance documents on a regular basis reviewing all current scientific studies.

Summary

Multiple variables may impact the results of arterial blood specimens, including collection device, patient condition, initial arterial values prior to collection and storage conditions.

Given the number of variables impacting the results in the preanalytical stage, both sample collection and storage must be guarded by strict rules or standardized according to current guidance documents in order to avoid false results.

The impact of each of these variables must also be well understood by those collecting the specimen and interpreting the results to facilitate clinically relevant decisions.

Additional reading

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