

## TIME, TEMPERATURE, TRANSPORT, AND TYPE OF SYRINGE: A Review and Recommendations *by Wesley Granger PhD, RRT*



This article is the result of several questions I have received recently, including; what is the current thought on icing blood gas samples? What is the recommended time delay that will prevent inaccurate results? What is the affect on results of transporting blood gas samples in vacuum tube transport systems? Are there any circumstances when a glass syringe should be used instead of plastic? I am going to attempt to answer these based on recent research publications and I will summarize the recommendations.

Several studies in the early 1980's found that blood gas samples held at room temperature were acceptable for up to 20 minutes as long as there were no air bubbles present. A study by Liss et al. in 1993 discussed the significance of the higher solubility of gases in the walls of the plastic syringes when placed on ice and recommended that samples drawn in plastic syringes should be analyzed within 30 minutes and not iced. It has been estimated that because of the solubility changes at lower temperature the approximate PO<sub>2</sub> of ice water at 4 degrees C is 250 mmHg. Therefore if the blood sample has a PO<sub>2</sub> of 100 mmHg then the gradient for diffusion is greatly increased. This leads to an increased influx of oxygen into the blood sample. This diffusion does not occur with glass syringes. Because the blood cells continue to metabolize these studies recommend that in patients with leukocytosis or thrombocytosis a glass syringe should be used and placed immediately on ice.

The study by Mahoney et al. in 1991 looked at oxygen measurements of whole blood compared between iced plastic and glass syringes. They found that PO<sub>2</sub> changes were not significant for glass syringes stored on ice for 60 minutes. However, plastic syringes placed on ice produced significant changes in PO<sub>2</sub> within 10 to 30 minutes depending on the initial blood PO<sub>2</sub> values. There were several studies published in 1994 that looked at blood gas samples with high PO<sub>2</sub> values such as those used to calculate shunt fraction using the 100% oxygen method. The study by Pretto et al. showed that even the newer high density polypropylene syringes were not adequate under these high PO<sub>2</sub> situations and resulted in an overestimation of shunt by 0.6% per minute at room temperature with a significant overestimation occurring as quickly as 5 minutes. They found, like the above studies mentioned, that plastic syringes should not be iced because of the greatly increased solubility that occurs. The recommendation for collecting blood gas samples for shunt calculations were to use a glass syringe and place it on ice immediately and analyze the sample "as soon as possible". They did not specify a time in minutes. A similar study by Smeenk et al. in 1997 concluded that during the 100% oxygen shunt estimation glass syringes should be used, immediately iced and measured within 60 minutes. A study in 1999 by Beaulieu et al. showed that for blood with a PO<sub>2</sub> between 50 and 250 mmHg stored in plastic syringes on ice there were significant increases in PO<sub>2</sub> within 30 minutes while significant changes in pH or PCO<sub>2</sub> did not occur for 60 minutes. In 2003 a study by Woolley and Hickling using the Radiometer PICO 70 syringes determined that PO<sub>2</sub> was not significantly changed after 30 minutes either at room temperature or iced. The changes in PO<sub>2</sub> noted after 60 minutes was statistically significant but was probably not clinically significant. Recent research has started to look at the addition of metabolic inhibitory substances to blood gas syringes to stop the metabolism of the leukocytes to try to maintain more stable blood gas values at room temperature. However, the results so far are inconclusive and more research is needed.

Many hospitals are using pneumatic tube systems to send blood gas samples to a central area for analysis in an attempt to reduce turn around time and cut costs. Recently several studies have looked at the effects of these systems on the results. Sudden acceleration and deceleration and the shaking of the sample have been found to affect the results of the sample especially if the sample containing any air bubbles or foam. A 2001 study by Zaman et al. concluded that at a speed of < 4 m/s in the absence of any air bubbles or foam there were no significant effects on blood gas values. In the presence of air bubbles there was a significant change in PO<sub>2</sub> following transport via a pneumatic tube system. A study by Lu et al. in 2003 also found that air bubbles cause significant changes in PO<sub>2</sub> during pneumatic tube transport. Some authors have stated that pneumatic tube systems should not be used to transport blood gas samples while others state that as long as great care is exercised in removing all air bubbles and foam from the syringe then such transport is allowed. These studies have shown



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that pneumatic tube transport does not cause significant changes in pH or PCO<sub>2</sub>.

#### Recommendations

1. For everyday blood gas analysis a plastic syringe kept at room temperature and analyzed within 30 minutes is recommended. Documents from the CLSI (NCCLS) C-46 and H11-A4 recommend that blood gases be collected in plastic syringes and analyzed at room temperature within 30 minutes.
2. If samples cannot be analyzed within 30 minutes then glass syringes placed on ice should be used.
3. If a patient has an increased leukocyte or thrombocyte count then glass syringes placed on ice and analyzed within 10 minutes is recommended.
4. For blood gas analysis where the results will be used to calculate the patient's shunt fraction glass syringes placed on ice and analyzed within 10 minutes is recommended.
5. If your facility uses a pneumatic tube system to transport blood gas samples then great care should be exercised to remove all air bubbles and foam before the sample is sent. Plastic syringe at room temperature and analyzed within 30 minutes is recommended.

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might... but since this was a retrospective study, it is also plausible that having an NDE makes it more likely subsequently, that REM states will intrude into waking consciousness." Mark Mahowald, Director of the Minnesota Regional Sleep Disorders Center thinks this is a great study, adding, "The bottom line is that, unlike what most people think, sleep is not all or nothing. You can have bits and pieces of sleep intruding into bits and pieces of wakefulness, and that's where things get very interesting." What's fascinating is that someday the mechanisms for NDE experience or NDE-like experiences may be determined with physical testing (polysomnography) correlated with accounts of what the test subject perceives during the periods of REM intrusion.



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Nelson concedes that he doesn't believe REM intrusion will turn out to be the whole explanation for the near death experience. The most important aspect of this investigation is that it provides a testable hypothesis for clinical findings rather than paranormal rationales. The hypothesis predicts that NDE occurs under circumstances of peril and is most likely to happen in those with a prior history of REM intrusion. Since the brain's limbic system is activated during REM sleep, it would not be surprising for it also be activated during REM state intrusion, thus turning what would otherwise be dreams into waking hallucinations that take on paranormal, transcendental and emotional aspects.

The work is spiritually neutral according to Nelson and provides a reason for how the brain contributes to the formation of NDE but not why.