

Capillary blood gas and the big picture

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Blood gases are measured from an arterial blood sample to evaluate the respiratory adequacy and oxygen status of the critically ill patient. For the adult patient, the arterial blood is sampled either by arterial puncture or from an indwelling catheter.

In neonates and children, the wish to minimize iatrogenic blood loss has made capillary blood a practical alternative to arterial blood. However, because capillary and arterial blood samples are not identical with respect to blood gases, results must be interpreted differently.

acutecare**testing.org** has talked to Lyn Morelli, senior staff member in Specimen Collection and Pauline Lowe, Clinical Midwife and senior educator in NICU at the Women's and Children's Hospital in Adelaide, South Australia about their local procedures for neonatal capillary blood gas sampling.

acutecare**testing.org:** What is the role of capillary blood gases compared to arterial samples, pulse oximetry and transcutaneous monitoring of blood gases?

Pauline Lowe: Capillary sampling is supplemental to continuous monitoring. It is used particularly in neonates that are considered stable enough not to require invasive monitoring.

In all cases (both capillary and arterial) the oxygen saturations are noted at the time of sampling and results are compared to the saturation.

acutecare**testing.org:** What are the typical indications for blood gas sampling?

Pauline Lowe: Both acute and routine blood gas samples are taken.

However, with the possibility of constant regular monitoring using transcutaneous monitors, manipulations of respiratory support are possible without the need for frequent sampling during the 4 hours of electrode application.

Lyn Morelli: In the level 3 nursery, acute samples are often performed as a baseline prior to initiating

ventilatory support, particularly if we cannot obtain an arterial stab sample.

Full panel samples are taken routinely every 24 hours with samples taken for the blood gas analyzer (pH, gases, electrolytes, oximetry, glucose, lactate and bilirubin), LFTs and CBP from the laboratory, plus lipids if the baby is on parenteral feeding. (LFT: Liver Function tests, CBP: Complete Blood Picture)

acutecaretesting.org: When are capillary samples requested as opposed to arterial sampling?

Pauline Lowe: At the NICU, we request capillary samples for neonates who have no arterial access or who are stable enough not to need invasive monitoring. We also require them prior to catheterization, mostly for STAT glucose measurements.

Lyn Morelli: When we are called from Specimen Collection, capillary sampling is only requested if there is no arterial or umbilical catheter, or if an arterial stab has failed.

acutecaretesting.org: Which parameters do you report from a capillary blood gas sample?

Pauline Lowe: All parameters are requested and used, providing the person taking the sample verifies the quality of the sample.

If the sample is compromised in any way, an alternative sample – usually by arterial stab – is taken for the pO_2 and pCO_2 .

Lyn Morelli: If sampling is difficult due to decreased peripheral blood flow, edema, infection or excess bruising, then parameters requested will be determined preferentially based on reliability of the expected result.

In these cases, quite often the pO_2 and pCO_2 will be dropped from the request.

acutecaretesting.org: How do you interpret the results?

Pauline Lowe: Samples are always classified as “capillary” for the patient record.

The hospital does have official reference ranges for capillary gases. pO_2 and K are always assessed carefully with particular note being taken of the oxygen saturation at the time of sampling. We do, however, rely on the pH and pCO_2 and act accordingly.

Lyn Morelli: The staff member looking after the neonate is always informed of the sample integrity and analyzer performance when results are handed to them following a capillary sample.

This ensures that they are completely aware of any potential problems associated with interpretation, should the analyzer or the sample be compromised in any way.

acutecaretesting.org: Describe your local procedure for capillary blood gas sampling.

Lyn Morelli: First, we check the request form and establish which tests are being required. Then we choose the sample tubes – capillaries and other collection devices.

Next step is to identify the patient through his or her ID band. A sample site is chosen, usually a fleshy area with the least wounds and no localized edema or infections. Site warming is no longer permitted at this hospital, so that is not part of our procedures.

Once the site is clean and dry, we do an automatic lancing, wipe off the first drop of blood and collect the sample. We always use capillary tubes with end caps and mixing wires. The sample is mixed both during and after sampling.

All major POC areas have their own on-site analyzer, and pneumatic tubes are not used to transport the sample. The staff member doing the collection takes the sample directly to the analyzer.

The sample is not labeled. If glucoses are taken at a level 2 or 1 site, then these samples are labeled and may be

measured in small batches of two or three samples.

acutecaretesting.org: How did you develop this procedure?

Lyn Morelli: Sampling procedures have been developed using NCCLS guidelines combined with local knowledge and hospital safety requirements.

Two examples of local modifications refer to site warming and usage of mixing wires. As mentioned earlier, we no longer permit site warming in our hospital. We changed our procedures out of concern of burns on very small babies.

As for the mixing devices, we had a high incidence of clotting of capillary samples with our previous blood gas analyzer. When our present blood gas analyzer was installed, we went through intense training with the vendor who showed us how to use both the end caps and mixing wires.

The clotting incidence dropped dramatically with that and we were convinced that the sampling procedure had to reflect this. We also use mixing wires for our glucoses, because it makes the results more accurate.

acutecaretesting.org: Which staff groups will typically do the capillary sampling?

Lyn Morelli: The majority of capillary sampling is done by specialist collection staff or trained laboratory staff.

However, the nurses in both the level 2 and 1 nurseries and PICU have had vendor training, so they do most of their capillary sampling.

acutecaretesting.org: Do the staff find the procedure difficult?

Pauline Lowe: Level 3 staff is less skilled at obtaining a good capillary sample because of the low frequency of sampling.

Capillary sampling will often occur when a situation demands a sample being taken urgently. This adds pressure to staff with less practice.

Lyn Morelli: The level 2 nursery staff doing most of their sampling may every now and then have problems getting a "good" sample.

For example, if a neonate has a high hematocrit, compromised peripheral circulation or a combination of the two.

acutecaretesting.org: How do you meet these difficulties?

Lyn Morelli: Training, training and more training. Basically, the only way to stop these problems is to continue to train staff, both current and new, to increase their competency and improve their confidence.

The lab and collection staffs no longer have the time to do all the training associated with POC equipment, so we rely heavily on the manufacturer to do this for us and to keep us abreast of any new techniques and requirements.

acutecaretesting.org: How often is training provided?

Lyn Morelli: We receive continual training sessions as needed – usually every 3-6 months. Sessions can be both on general sampling techniques and on preventing preanalytical errors.

acutecaretesting.org: How do you avoid preanalytical errors?

Lyn Morelli: Training is a big part of our effort to reduce preanalytical errors.

In addition, we stress things such as selecting the site carefully so that expected blood flow is good, always wiping away the first drop of blood, squeezing the foot appropriately and making sure that air bubbles are not introduced in the sample.

Using end caps and mixing wires is also something we encourage, as well as watching the mixing wire move through the capillary tube to confirm that the sample is not clotted and using clot catchers on every capillary sample.

acutecaretesting.org: How do you eliminate the uncertainty of bias from preanalytical errors when interpreting results?

Pauline Lowe: By comparing results to those from the monitoring equipment and also to the patient history. Results are rarely seen as a one off, but more as a cumulative patient history.

Lyn Morelli: I always check the patient history, if results are out of the age-related reference range. Another thing is, if the pO_2 does not match the pulse oximeter, then this is brought to the attention of the attending staff member.

acutecaretesting.org: What are the most important steps in ensuring successful capillary sampling?

Lyn Morelli: Adequate training is again the basis for everything. Taking steps to avoid preanalytical errors also helps to ensure successful sampling. Some of these things we have already discussed.

In addition, it is important to mix the sample both during sampling (by inversion) and after (with a magnet) and do a prompt analysis of the sample to ensure its quality. It helps to have the analyzer as close to the patients as possible.

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