Title: Policy for Blood Gas Analysis

<table>
<thead>
<tr>
<th>Unique Identifying Index Number</th>
<th>LPPAPOC021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version number</td>
<td>5</td>
</tr>
<tr>
<td>Issue Date (this version)</td>
<td>March 2015</td>
</tr>
<tr>
<td>Document Type</td>
<td>Policy</td>
</tr>
<tr>
<td>Accreditation or Licensing Standard to which this applies</td>
<td>CPA Standard F2/F3</td>
</tr>
<tr>
<td>Review Interval</td>
<td>3 years</td>
</tr>
<tr>
<td>Author</td>
<td>Andy Craggs</td>
</tr>
<tr>
<td>Authorised By (individual or group)</td>
<td>Hazel Borthwick</td>
</tr>
<tr>
<td>Relevant Staff Groups to which document applies</td>
<td>All personnel concerned with Blood Gas Analysis</td>
</tr>
<tr>
<td>Copy No</td>
<td>1</td>
</tr>
</tbody>
</table>
| Location of Copies              | 1. Qpulse  
                                           2.  
                                           3.  
                                           4.  |

Relevant safety data, COSHH and risk assessments: -

Mark relevant procedures/policies

<table>
<thead>
<tr>
<th>VDU</th>
<th>Lifting/Handling</th>
<th>COSHH</th>
<th>Spillage</th>
<th>Disposal</th>
<th>Sharps</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

The above risk/safety assessments must be read and understood before carrying out this procedure. Details are recorded in the main text of the document.

Additional Standard cross references :-

Standard …CPA F2/F3………………………………
General Information

This Policy refers to arterial and capillary blood gas analysis.

There are currently 10 Point of Care blood gas analysers across the Trust, 5 on each of the main sites at Darlington and Durham (see Table 1). Due to the urgency of blood gas requests and the poor stability of measurable parameters, it is essential that analysis is carried out as soon as possible after obtaining the sample, thus the analysers need to be kept operational at all times. This is achieved through the universal use of IL GEM 4000+ analysers, which employ a removable, easily-changeable cartridge, and can be operated by ward staff with minimal outside intervention. Alongside this is an on-going quality control programme which helps ensure continuous acceptable performance and the provision of accurate and precise results for clinical decisions to be made.

The following steps should be followed to ensure gas analysis is run appropriately as a point of care test:

- Identify a ward blood gas analysis link nurse
- Identify staff that will participate in blood gas analysis and issue them with a user code and password when appropriately trained. All such staff are registered on GEMWeb.
- Monitor GEMWeb software to ensure update training takes place as appropriate
- Ensure enough staff know how to change cartridges to allow every shift to be covered
- Ensure continued participation of each analyser in an approved EQA scheme
- Ensure staff know how to report problems and access alternative analysers during downtime

The majority of blood gas analysis is carried out using arterial sampling. Arterial samples are preferred since they can be used to measure pO2 and pCO2 values prior to metabolism and therefore to assess lung function. The alternative to arterial sampling is capillary blood gas analysis. Capillary blood provides similar information to arterial samples and is less traumatic for the patient, but if samples are not collected correctly they can provide misleading results. It is therefore essential that all staff involved in capillary sampling are adequately trained in the sampling procedure and subsequent blood gas analysis.

Arterial samples are used in Emergency Admission Units, Medical wards and Intensive Care Units and use syringes containing balanced heparin.

Capillary samples are mainly used in blood gas analysis on neonatal wards and respiratory wards and in respiratory outpatient clinics. There are separate procedures for the capillary sampling of Neonates and Respiratory O2 assessment patients. Respiratory patients include those undergoing Acute Respiratory Assessment (ARAS) for home oxygen treatment and those whose lung function is being assessed by a standard protocol on the ward. Most will exhibit degrees of acid retention and will require acid-base assessment.

Untrained, unauthorised staff must not perform any aspect of blood gas analysis.
Table 1: Blood Gas Analysers in CDDFT

<table>
<thead>
<tr>
<th>Site</th>
<th>Department</th>
<th>GEM 4000 Serial No</th>
<th>Contact Name</th>
<th>e-mail</th>
<th>Ext</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHND ITU 1</td>
<td>ITU 1</td>
<td>14027295</td>
<td>Kay Stewart</td>
<td><a href="mailto:kay.stewart@cddft.nhs.uk">kay.stewart@cddft.nhs.uk</a></td>
<td>32049</td>
</tr>
<tr>
<td>UHND ITU 2</td>
<td>ITU 2</td>
<td>14027297</td>
<td>Kay Stewart</td>
<td><a href="mailto:kay.stewart@cddft.nhs.uk">kay.stewart@cddft.nhs.uk</a></td>
<td>32049</td>
</tr>
<tr>
<td>UHND Ward 1</td>
<td>Ward 1</td>
<td>14027296</td>
<td>Helen Bainbridge</td>
<td><a href="mailto:helen.bainbridge@cddft.nhs.uk">helen.bainbridge@cddft.nhs.uk</a></td>
<td>32911</td>
</tr>
<tr>
<td>UHND Ward 8</td>
<td>Ward 8</td>
<td>13066508</td>
<td>Linda Ibbetson</td>
<td><a href="mailto:linda.ibbetson@cddft.nhs.uk">linda.ibbetson@cddft.nhs.uk</a></td>
<td>32908</td>
</tr>
<tr>
<td>UHND A/E</td>
<td>A/E</td>
<td>14027305</td>
<td>Graham Holland</td>
<td><a href="mailto:graham.holland@cddft.nhs.uk">graham.holland@cddft.nhs.uk</a></td>
<td>32552</td>
</tr>
<tr>
<td>DMH ITU</td>
<td>ITU</td>
<td>14027272</td>
<td>Diane Cruickshank</td>
<td><a href="mailto:diane.cruickshank@cddft.nhs.uk">diane.cruickshank@cddft.nhs.uk</a></td>
<td>43212</td>
</tr>
<tr>
<td>DMH A/E</td>
<td>A/E</td>
<td>14017226</td>
<td>Carl Massingham</td>
<td><a href="mailto:carl.massingham@cddft.nhs.uk">carl.massingham@cddft.nhs.uk</a></td>
<td>43481</td>
</tr>
<tr>
<td>DMH Ward 44</td>
<td>Ward 44</td>
<td>14027273</td>
<td>Lee Hardy</td>
<td><a href="mailto:lee.hardy@cddft.nhs.uk">lee.hardy@cddft.nhs.uk</a></td>
<td>43445</td>
</tr>
<tr>
<td>DMH Labour Ward</td>
<td>13066506</td>
<td>Anne Hodgson</td>
<td>Anne Hodgson</td>
<td><a href="mailto:anne.hodgson@cddft.nhs.uk">anne.hodgson@cddft.nhs.uk</a></td>
<td>43449</td>
</tr>
<tr>
<td>DMH Biochemistry</td>
<td>14027259</td>
<td>John Fletcher</td>
<td>John Fletcher</td>
<td><a href="mailto:john.fletcher@cddft.nhs.uk">john.fletcher@cddft.nhs.uk</a></td>
<td>43695</td>
</tr>
</tbody>
</table>

Description of Policy

This Policy refers to both arterial & capillary blood gas analysis. The blood gas analyser itself is described in detail in LP/PA/POCT027

Reasons for request

Conditions where blood gas analysis is of value are categorised into 4 broad categories. Examples of clinical conditions are included within each category.

- **Metabolic Acidosis**
  
  Inability to excrete Hydrogen ions, as in renal failure
  
  Increased Hydrogen ion load or loss of bicarbonate, as in DKA, lactic acidosis, respiratory distress syndrome in the newborn and hypoxia during labour

- **Metabolic Alkalosis**
  
  Loss of hydrogen ions, as in vomiting
  
  Retention of bicarbonate, as in administration of bicarbonate

- **Respiratory Acidosis, both chronic and acute**
  
  Inhibition of the medullary respiratory centre, as in the effects of drugs such as opiates and oxygen in chronic hypercapnia
  
  Disorders of gas exchange, as in COAD, adult RDS, pulmonary oedema, asthma, pneumonia and pneumothorax
  
  When subject to mechanical ventilation
Respiratory Alkalosis

- Hypoxaemia, as in pneumonia and CCF
- Pulmonary disease
- Direct stimulation of the medullary respiratory centre, as in salicylate overdose
- When subject to mechanical ventilation

Specimen requirements and means of identification

The Trust uses specific sample syringes and capillaries for arterial blood gas and capillary blood gas analysis. All specimens must be adequately labelled to prevent errors, and any specimens being sent to the laboratory must include name, DOB and hospital/NHS number. A patient addressograph label attached directly to the sample container is the recommended method.

Sample syringes for arterial blood gas analysis are standardised across the Trust via the Procurement Department. For this reason, the specific manufacturer etc is subject to change, but the following is current:

- PORTEX (Smiths Medical) 3ml Anaerobic Pulsator arterial blood gas sampling kit containing 20 IU/ml liquid sodium heparin, product reference 910/400/380. Used for measurement of pO2, pCO2, pH, co-oximetry, electrolytes (Ca 2+, Na+, K+, Cl-, Mg2+) and metabolites (Glu, Lact). Heparin is neutralised for Ionised calcium and is electrolyte balanced. The syringe is heparinised for anticoagulant effect.

Sampling kits for capillary blood gas analysis are less standardised, with different types being used in the North and South of the Trust.

- In the North, both neonatal & respiratory capillary blood gas analysis uses Protech 150 ul 1.9 x 100 mm plastic capillaries containing 100 IU/ml balanced lithium-heparin. The other consumables sometimes used are metal mixing sticks, capillary closing caps and clot catchers. Sampling kits containing all necessary materials are available from Pathology and are cross-charged. With the proximity of the analysers to the patients, it is anticipated that less ‘transportation’ of samples will be necessary, and the North will be able to operate with capillaries only, as in the South.

- In the South, capillary blood gas analysis uses Werfen Capillary Sample Kit 8217000, which contains only 170 ul capillaries. They are mixed by ‘finger and thumb’ rotation, and due to the extra space (length) available, capping is not necessary. Capillaries are filled for a full profile or half-filled for a micro profile.

All consumables are available through Cardea.
Each ward in the North has a magnet available for mixing the blood after sample collection & prior to sample aspiration into the gas analyser. Metal mixing sticks **must** be removed before aspiration.

**Sampling and transport procedure**

**Arterial Samples**

All blood gas requests are urgent due to rapid sample deterioration on standing.

- The blood gas sample should be taken from an appropriate arterial site (radial, brachial or femoral) via a Trust-standard heparinised syringe. See above

- The needle with shield is attached to the syringe. The syringe is held needle-up and the plunger drawn back and forth twice. Air is now expelled from the syringe. The syringe is inverted needle point downward and the syringe plunger pushed to expel all excess heparin. The needle shield is now removed.

- The needle is inserted into the chosen site at a flat angle. The blood will advance and is allowed to fill to at least 0.5ml and up to 3ml. The needle is discarded. Any residual air should be removed from the end of the syringe before it is sealed with the cap provided. The sample is mixed **thoroughly** for 10 seconds to prevent clot formation, and processed immediately. Care **must** be taken to correctly identify the patient at the analyser

- If the sample is to be processed elsewhere it **must** be labelled with patient name, date of birth & hospital/NHS number, ideally by attaching a patient addressograph label directly onto the syringe. The sample is transported in a sealable mini-grip bag along with the test request form. If any delay in measurement is anticipated (up to a maximum of 15 mins), the specimen **must** be transported on ice.

- Specimens **must not** be sent anywhere in the **air tube** due to adverse effects on the sample yielding **inaccurate results**.

**All** samples received in the laboratory **must** comply with Pathology guidelines. Requesting ward will be notified if the arterial blood gas sample is received in any of the following conditions:

- Unlabelled.
- Sample label & Request form details do not match.
- Leaking
- Air bubble present
- Delayed and/or ice melted
The requesting ward will be informed when results are phoned and a comment will be included on the lab report.

**Capillary samples**

**Neonatal capillary samples**

- The heel is the preferred site.
- Sampling site should be pre-warmed by hand to help obtain a free flow of blood and a continuous column of blood along the capillary tube.
- The site should be cleaned thoroughly with an alcohol wipe and dried using a cotton swab.
- Currently, a metal mixing stick is often placed inside the capillary prior to sample collection, but this may soon be phased out. The mixing stick is not necessary if the specimen is to be mixed by ‘finger and thumb’ rotation.
- The site is punctured using a Unistix 3 lancet & the blood collected directly into the capillary. Blood is collected up to around 1cm from the end of the capillary. A minimum quantity of 65 ul is required for the ‘micro’ profile.
- The blood is gently mixed by running the magnet alongside the length of the capillary, or by ‘finger and thumb’ rotation. The sample must be free of air bubbles to avoid the risk of sampling errors and maintain analytical integrity.
- If the specimen is to be ‘transported’ elsewhere for analysis, both ends are capped and the sample is labelled. If any delay in measurement is anticipated (up to a maximum of 15 mins), the specimen **must** be transported on ice.
- Before the specimen is analysed, the metal mixing stick (if used) **must** be removed from the capillary tube using the magnet.

**Respiratory capillary sampling**

The great majority of the patients in need of respiratory oxygen monitoring are adult.

- The ear-lobe is the preferred site for adult capillary sampling.
- The site may be pre-warmed by hand or using algipan cream.
- The rest of the sampling is as with Neonatal sampling.
Blood Gas Analysis

Analysis must be done as soon as possible after collection, and the sample must be gently mixed continuously between collection and analysis. Specific operational details of the IL GEM 4000+ analysers are described in detail in SOP LP/PA/POCT027. As all the Trust’s analysers are identical, if the user encounters one which is out of order or otherwise unusable, they should simply locate the nearest ‘working’ one and proceed as normal. See Table 1.

Blood gas reference ranges

For interpretative guidance of Blood Gas results please refer to the Consultant Chemical Pathologist or the Biochemistry Clinical Scientist.

Training Guidelines

It is essential that all operators of blood gas analysers receive appropriate training in the use of the device. Training may be provided by:

- The Werfen (IL) Company Training Specialist
- The POCT Coordinator
- The designated ward blood gas link staff

Role of the link staff

It is recommended that at least one link person per ward is nominated to coordinate the management of POCT blood gas on the ward, and that at least one member of staff per shift is trained to change reagent packs and run CVP. (See LP/PA/POCT027). The main roles and responsibilities of the link staff are:

- To cascade training and updates to all staff that perform blood gas analysis on the ward/department. This includes providing training to new operators and refresher training performed as necessary at competency assessment.
- To pass a record of all staff trained to the POC Co-ordinator, so that a user code and password can be assigned.
- To ensure that the analyser is maintained in accordance with Infection Control and Health and Safety Hospital Policies.
- To attend link trainer sessions as provided by the Trust.

The POC Co-ordinator will keep a record of all link staff.
Blood Gas Training

When the IL GEM 4000+ Analysers were first introduced into the Trust, Werfen training specialists conducted the training of all Link staff, and as many routine users as were available. Following on from this, Link staff are empowered to train all new starters and anyone else missed by the company specialists. The training will cover all the points in Appendix 1 (Page 9) and Appendix 2 (Page 10). Users may only use the analyser independently once in receipt of a personal user code and password.

Training Certificate/User Register

All staff issued with a Blood Gas Analyser user code and password appear on the GEMWeb database, and are deemed to be competent in its use for two years. All dates are recorded by the database, and no separate certificate will be issued. Staff whose certification date has lapsed will require refresher training by a Link person before renewal. Any query about who is entitled to use the analyser will be settled simply by reference to the GEMWeb database. No password means no use.

Blood gas analysis Pathology contact details

For all technical enquiries please contact the POC Co-ordinator on extension 44172, or via e-mail: andy.craggs@cddft.nhs.uk

References

All references in this document are available via Q-Pulse unless otherwise stated.
### Appendix 1

**ARTERIAL BLOOD GAS TRAINING PROTOCOL**

<table>
<thead>
<tr>
<th>Stages</th>
<th>Operator Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-sampling preparation</td>
<td>Locate site of arterial access. Clean site.</td>
</tr>
<tr>
<td>Sampling technique</td>
<td>Use of Pulsator syringe system&lt;br&gt;Preparation of syringe: needle attachment, expulsion of excess heparin.&lt;br&gt;Importance of time in obtaining sample.&lt;br&gt;No air bubbles in sample.&lt;br&gt;Sample 0.5-3ml blood.&lt;br&gt;Mixing of sample. Mixing ensures sample uniformity and helps avoid clotting. Mix after sample obtained and prior to analysis.</td>
</tr>
<tr>
<td>Transport of sample</td>
<td>Place tube in mini-grip sealable plastic bag&lt;br&gt;Patient addressograph label attached to the sample&lt;br&gt;Availability of ice, if delay (up to 15 mins) inevitable</td>
</tr>
<tr>
<td>Degree of procedural urgency</td>
<td>Rapid turnaround time required in technique and analysis.&lt;br&gt;For clinical reasons – eg: hypoxia (treatment adjusted on results)&lt;br&gt;To address issues of sample stability.</td>
</tr>
<tr>
<td>Pre-analytical preparation</td>
<td>Check analyser in ready mode&lt;br&gt;Final mix prior to sampling</td>
</tr>
<tr>
<td>Analysis</td>
<td>Perform test from READY&lt;br&gt;Enter user code/password on prompt&lt;br&gt;Introduce sample to sample syringe&lt;br&gt;Input any other essential information – temperature, treatment.</td>
</tr>
<tr>
<td>Blood gas results and documentation</td>
<td>What to do with the blood gas result printout&lt;br&gt;Documentation of results (Electronic patient record)&lt;br&gt;Action on results – critical values</td>
</tr>
<tr>
<td>Discarding sample and clinical waste</td>
<td>Sample syringe and accessories – discard to sharps&lt;br&gt;Other clinical consumables, including any discarded reagent packs, to clinical waste</td>
</tr>
<tr>
<td>Hand washing</td>
<td>After completion of procedure</td>
</tr>
<tr>
<td>Notices</td>
<td>Point out clinical notices in the testing area eg: not using Hb reading for blood transfusion purposes.</td>
</tr>
<tr>
<td>Routine maintenance</td>
<td>Changing reagent packs and printer paper as needed.&lt;br&gt;Running CVP for new packs.</td>
</tr>
<tr>
<td>Troubleshooting</td>
<td>Machine not in READY mode – awareness of instrument messages</td>
</tr>
</tbody>
</table>
### Appendix 2

#### CAPILLARY BLOOD GAS TRAINING PROTOCOL

<table>
<thead>
<tr>
<th>Stages</th>
<th>Operator actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-sampling preparation</td>
<td>Warm &amp; clean site, lancet use,</td>
</tr>
</tbody>
</table>
| Sampling technique                  | Filling tube from ear lobe/heel  
Lancet use, ensure easy flow of blood.  
Use of heparinised tube, mixing flea, capillary ends as required  
Importance of time in obtaining sample.  
No air bubbles in sample.  
Mixing of sample using magnet or ‘finger and thumb’ to ensure sample uniformity and help avoid clotting.  
Mix after sample obtained and prior to analysis. |
| Transport of sample                 | Place tube in mini-grip sealable plastic bag  
Patient addressograph label attached to the sample  
Availability of ice, if delay (up to 15 mins) inevitable |
| Degree of procedural urgency        | Rapid turnaround time required in technique and analysis.  
For clinical reasons – eg: hypoxia (treatment adjusted on results).  
To address issues of sample stability. |
| Pre-analytical preparation          | Check analyser in ready mode  
Final mixing* prior to sampling  
*Includes withdrawal of mixing stick and removal of capillary end-caps, if present. |
| Analysis of capillary blood gas     | Perform test from READY  
Enter user code/password on prompt  
**Always** aspirate capillary samples on micro-mode.  
Introduce sample to sample syringe  
Input any other essential information – temperature, treatment.  
Ensure sample has processed correctly |
| Blood gas results and documentation| What to do with the blood gas result printout  
Documentation of results (Electronic patient record)  
Action on results – critical values |
| Discarding sample and clinical waste | Sample syringe and accessories – discard to sharps  
Other clinical consumables, including any discarded reagent packs, to clinical waste |
| Hand washing                        | After completion of procedure |
| Notices                             | Point out clinical notices in the testing area eg: not using Hb reading for blood transfusion purposes. |
| Routine maintenance                 | Changing reagent packs and printer paper as needed.  
Running CVP for new packs. |
| Troubleshooting                     | Machine not in READY mode – awareness of instrument messages |