GUIDELINE TITLE: Capillary Blood Sampling	**Document No:** **Version No:**

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Slainte Leanai Eireann
CHI
Children's Health Ireland

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1.0 GUIDELINE STATEMENT

Capillary blood gas (CBG) sampling is used as an alternative to arterial blood gas sampling for the analysis of adequacy of a patient's ventilation and estimating their acid-base balance (Evans, *et al.,* 2022). It is a procedure which can be carried out at the bedside for point of care blood gas measurement. It is an accessible procedure as blood samples can be yielded by staff without the skills for venepuncture or where there is an absence of either an indwelling arterial or venous line.

2.0 PURPOSE

The purpose of this guideline is to standardise the process around Capillary blood sampling across CHI.

3.0 SCOPE

This guideline applies to:

1. **All Nursing Teams at CHI**

    - All nurses who are involved in capillary blood sampling across CHI locations (Crumlin, Tallaght, and Temple Street) are required to follow this guideline. This includes registered nurses, clinical nurse managers, and nurse educators responsible for overseeing or performing the procedure.

2. **All Clinical Teams at CHI**

    - Clinical staff, including doctors and allied healthcare professionals involved in blood sampling, are expected to be familiar with this guideline. They must ensure the correct procedural steps are followed when capillary blood gas sampling is required.

This guideline covers:

- **Neonates, Infants, and Children** where capillary blood sampling is indicated.
- The use of capillary blood gas sampling as a substitute for arterial blood sampling in situations where venous or arterial access is unavailable or inappropriate.
- Staff responsibilities in performing the procedure safely and effectively, while minimising discomfort and complications.

4.0 ROLES and RESPONSIBILITIES

4.1 All Staff

Ensure compliance with this guideline while performing capillary blood sampling.
Maintain competence in the procedure and follow the appropriate protocols for infection control and patient safety.

4.2 Heads of Department

Oversee the adherence of their teams to the guidelines.
Facilitate access to necessary equipment and ensure staff are adequately trained.

4.3 Guideline Owner

Ensure the latest evidence-based practices are integrated and provide regular updates to staff.

5.0 OBJECTIVES

5.1 **Standardise the Process**:
Establish a consistent approach for capillary blood sampling across all CHI facilities.

5.2 **Enhance Patient Safety**:
Ensure that the procedure is performed safely with minimal risk of complications for paediatric patients.

5.3 **Improve Access to Blood Gas Measurement**:
Provide an alternative to arterial blood sampling, allowing easier and safer access to blood gas results, especially in cases where venous or arterial access is unavailable.

5.4 **Minimize Pain and Trauma**:
Employ techniques and devices that reduce pain and trauma, especially for neonates and children, and ensure appropriate pain management strategies.

6.0 EXPECTED OUTCOMES

6.1 **Reduction in Complications**:
The implementation of this guideline should lead to fewer complications such as infection, hematoma, and trauma during capillary blood sampling.

6.2 **Increased Efficiency**:
Nursing and clinical teams will be able to perform capillary blood sampling more efficiently, leading to faster diagnosis and treatment adjustments based on reliable blood gas results.

6.3 **Improved Patient Experience**:
Patients, especially children, will experience less pain and discomfort due to the use of proper techniques and devices, alongside improved communication and care from staff.

6.4 **Consistent Practice Across CHI**:
The standardised guideline ensures that all staff at CHI facilities perform the procedure in a consistent manner, reducing variability in care and enhancing patient safety.

7.0 GUIDELINE STEPS

Indications for Capillary Blood Gas Sampling

Capillary blood gas (CBG) sampling is indicated:

- To assess alterations in clinical status
- Monitoring the severity and progression of a disease process.
- To minimise the amount of blood sampling in preterm / neonates.
- Arterial/ venous access is not available for blood gas analysis.
- Assessment for commencing and alterations in invasive / non-invasive ventilation.

NB: Capillary pO2 is of little value in arterial oxygenation estimation (Evans *et al,* 2022)

Complications

- Infection (i.e. callous osteomyelitis and cellulitis)
- Haematoma or bleeding
- Scarring
- Pain / Distress
- Trauma
- Bone calcification
- Skin breakdown from repeated use of adhesive tape

NB: Proper technique when sampling can minimise the occurrence of complications
(Evans *et al.,* 2022; WHO, 2010)

Contraindications

- Site: Infection, red, bruised, swollen or oedematous, haematoma.
- Broken or open skin.
- Peripheral vasoconstriction, poorly perfused tissue

(EVANS *ET AL.,* 2022; WHO, 2010, FOLK, 2007)

Cautions

Discuss with senior nursing or medical staff before proceeding as these patients may require an additional plan for the procedure or an alternative sampling method.

The following is not an exhaustive list

- Coagulopathy/anticoagulated patients due to risk of bleeding (Clinibee, 2024)

- Patients where there is a risk of instability with painful procedures or have poor tolerance with handling or stress (Cambell-Yeo et all (2022); Helsten, 2024, Schroedar, *et al.,* 2024; Brekle, *et al.,* 2023)
- Interpretation of results: Infants under 24 hours and infants and children with cyanotic heart defects or mixed circulation as the values for measuring gas exchange may be deranged due to ongoing or abnormal transition from foetal to normal circulation (Callow and Schieffer, 2019). In cardiac patients, results should be discussed with the Cardiology Consultant or SpR, in the case of PICU- The Intensive Care Team.
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8.0 SAMPLING PROCEDURE

8.1 Equipment

• 2% Chlorhexidine in isopropyl alcohol • Size appropriate automatic spring loaded incision device e.g Tenderfoot ® • Gauze swab x1 • Sharps Disposal Box • Small clean disposable tray • PPE (as per AT guidelines and HSE Point of Care Risk assessment) • Heparinised capillary tube appropriate to machine in use (see below) • Hospital ID label • Blood Gas Analyser	**Crumlin and Tallaght** **additional equipment** • Capillary caps x 2 • Mixing wire • Magnet (i.e. white board magnet) • Clot Catcher

Capillary Tube Selection

Radiometer ABL Flex Plus in Crumlin

- 45ul tube for all blood gas parameters.
- 70ul capillary tube minimum for the blood gas analyser in the isolation ward PICU 1 (older version of the current analyser)

Radiometer ABL Flex Plus in Tallaght:

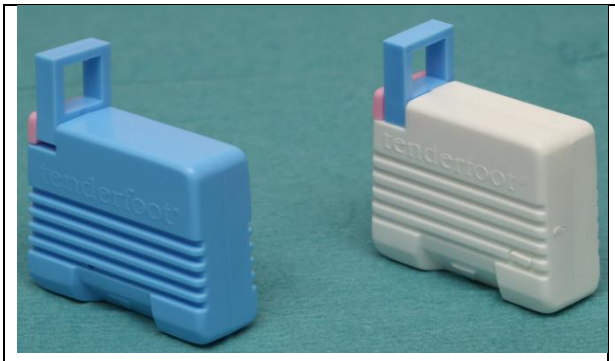
- 70ul capillary tube
- Guidance can also be sought locally from *"Instructions on performing capillary sample analysis on the ABL90 Flex analyser"* (Tallaght University Hospital, 2022)

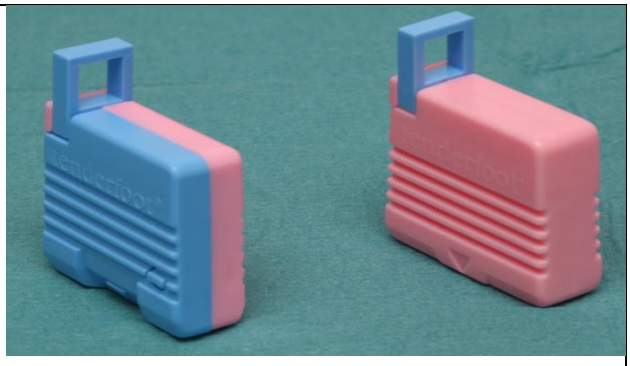
GEM analyser in Temple St

- Use a 65ul capillary tube

Tenderfoot selection

- An automated spring loaded device must be used as it is designed to puncture to the appropriate depth.
- No other puncture device, lancet or surgical blade should be used for the procedure as this can cause harm and increase in pain levels (Evans *et al*, 2022; WHO, 2010)
- The brand currently used in CHI is *Tenderfoot®*. If supplier changes and alternative spring loaded device is used in CHI, please follow manufacturer guidance.





• **Micro-premmie** • (0.65mm, blue) • < 1 kg	• **Preemie** • (0.85mm, white) • > 1 kg	• **Newborn** • (1.00mm, pink/blue) • > 2.5 kgs.	• **Toddler** • (2.00mm, pink) • Older infants and toddlers

Figure 1: Tenderfoot® Devices: (OLCHC Medical Illustration 2016; Accriva Diagnostics, no date)

Site Selection

- Avoid areas of oedema, infected/inflamed and broken skin
- The site chosen should be rotated if there are repeated samples
- Do not puncture the same site twice to yield more sample.
- The area should be warm and well perfused. This can be helped by applying an extra blanket, socks or clothing, do not use heating devices this can cause burns and scalds (Ray, *et al.,* 2011). If already warm and perfused warming may not be required.

Evans, *et al.,* 2022, WHO, 2010, Brekle *et al.,* 2024

Neonate / Infant **(not walking)** Medial / lateral (inner and outer) planter aspects of a heel. Avoid previous puncture sites NB: Avoid posterior curvature of the heel as it can puncture the bone ***Take sample from shaded area*** (Medical Illustration, OLCHC, 2009) 	This increases the risk for bone damage, calcaneal puncture and osteomyelitis (Blumbenfeld *et al*., 1979)

Child **(walking)** Fleshy pads of middle and ring finger (non-dominant hand). Perform puncture across finger print (perpendicular to ridges) and not parallel. NB: Avoid thumb, index and little finger.  (Used with permission, Radiometer 2008) ***Optional*** Earlobe (WHO, 2010)	These areas are highly vascularised and are the only acceptable sites for finger pricks. Sides and tip of the finger should be avoided as the flesh is only half as thick, there are more nerve endings and bone is closer to the surface. Thumb should not be used due to the skin often being too thick/callous; index finger may be more sensitive. Little finger should be avoided as tissue is thin (WHO, 2010).

8.2 Performing the procedure

ACTION	RATIONALE EVIDENCE AND REFERENCE
Pre Procedure Assemble equipment. Explain the procedure to child and parents/guardians. Confirm positive patient identification	Allows for informed consent and a trusting relationship (HSE, 2022) Correct identification of the patient (CHI, 2023)
Pain relief Ensure adequate pain relief measures are available. Examples Neonates: • Comfort measures e.g Swaddling, Skin to skin • Non-Nutritive sucking with EBM, sterile water or sucrose 24% (as prescribed) (where appropriate) • Breastfeeding/EBM/bottle (where appropriate) Toddlers and Children: • Comfort measures • Distraction	The procedure is known to produce pain. Neonates can experience multiple painful procedures each day, this can have an effect on their stability, neurological development and overall comfort. (Shah *et al.,* 2023), (Evans, *et al.,* 2022) (Cambell-Yeo, et al., 2022) (Clinibee, 2024) This will depend on age and development of the child and their preference and interests. (Anderson and Herring, 2024)
Procedure preparation Wash hands and don PPE Adhere to Aseptic technique guidelines and follow hospital standard precautions and hand hygiene policies throughout the procedure. Ensure the site is warm. If already warm and well perfused warming may not be required For cooler feet wrapping of the site for 3-5 minutes with small blanket or may increase skin temperature prior to sampling. NB: Do not use heating devices.	Refer to your site specific guidelines To ensure adequate perfusion and thus blood flow in a cooler limb. However pre-warming does not have substantial evidence to show more accurate measurement of p02 values (Evans, *et al.,* 2022). Can lead to thermal injury (Brekle, *et al.,* 2023; Ray, *et al.,* 2011).
Performing Procedure (Appendix 1) Hold the infants foot with non-dominant hand. Use the forefingers and thumb to surround the heel. The fingers at the arch of the foot and the thumb supporting the heel.	To stabilise and support ankle and encourage blood flow

Ensure the site is visibly clean. Wipe puncture / incision site with 2% Chlorhexidine in isopropyl alcohol and allow to dry thoroughly. Avoid any previous puncture sites. Place the disposable automated capillary sampling device on the selected site and activate the trigger and remove from foot. **Do not put pressure on the site as it is punctured** Wipe away the first drop of blood with a gauze swab, whilst holding the infants' heel and allowing blood drop to hang.	The puncture site must be clean and dry to prevent contamination. This may lead to infection due to bacterial contamination (WHO, 2010). The lancet has an automated spring and will puncture to the adequate depth. Pressure can deepen the puncture causing injury (Folk, 2007) The first drop of blood maybe contaminated with tissue fluid. This can also be repeated during the procedure if there is difficulty bleeding to eliminate any clot formation (Folk, 2007)
Filling the Capillary Tube (Appendix 2) Elevate puncture site during procedure and hold the capillary tube downwards Let the blood form a thick blood drop and place the capillary tube directly into the centre of the blood drop at the puncture site. To encourage blood flow: • **Do not** squeeze the site too hard. • Apply gentle intermittent pressure to surrounding tissues. • Intermittent pressure proximal to finger puncture site • Allow sufficient time between pressure for blood perfusion back into the heel / finger. If flow is stops, wipe the site with gauze and allow capillary refill to encourage bleeding, reassume hand position and gentle pressure. Fill completely avoiding any air bubbles in the tube. If air enters the tube it may be necessary to tip the filled end downwards to expel air until a blood drop forms. Remove tube when sufficient blood is obtained and the tube is filled	To allow the blood to flow via gravity Excessive squeezing will cause haemolysis of the blood sample and can slow down or prevent blood flow (WHO, 2010). To eliminate any clot formation at the site and to encourage bleeding (Folk, 2007) Air bubbles will be detected in the analyser and you will not get an accurate result. Also even small bubbles may seriously affect the pO2 value and result in increased values (Evans, *et al.,* 2022, Radiometer, 2024).

Dispose of sharp immediately following local sharps disposal guidelines	
CHI@Crumlin and CHI@Tallaght only: Capillary caps and mixing wire is used. Follow the above procedure with these additions Flint/mixing wire should be added to the sample, care must be taken to avoid introducing air to the sample. Seal the sample ends of the capillary tube immediately after obtaining sample, using purple caps.	There are some differences in procedure for CHI@Crumlin and CHI@Tallaght due to differences in manufacturer instruction (Radiometer, 2024) The purple caps help to avoid spills. **(Appendix 3)**
Mixing the Sample **CHI@Temple St** Hold the capillary tube between 2 fingers and invert continuously. Ensure sample reaches analyser as soon as possible **CHI@Crumlin and CHI@Tallaght:** Mix sample immediately with magnet by moving along capillary tube. Repeat gently using repeated strokes of the magnet until sample inserted into blood gas analyser. **Appendix 4** All sites- Dispose of Capillary tube into a sharps bin following local sharps disposal guidelines	To ensure uniform mixing with heparin in the tube. Recommendation from company (Radiometer 2024). To prevent haemolysis. Clots can cause incorrect results and block the sample pathway on the analyser. (Radiometer, 2024) To ensure uniform mixing with heparin in the tube. Recommendation from company (Radiometer, 2024). (Appendix 4)

2nd Nurse / Practitioner Apply pressure to the puncture site using gauze, until the bleeding has stopped. Avoid use of adhesive dressings where possible Remove gloves. Perform thorough hand hygiene. Ensure the infant/child is comforted and praised	Adhesive dressings keep the area moist and increase the risk of infection (Folk, 2007) To provide reassurance, comfort (WHO, 2010)

8.3 Post Procedure

ACTION	RATIONALE EVIDENCE AND REFERENCE
Blood Gas Analyser **When bringing the sample to the machine please bring** 1. Patient Label with barcode and details 2. The patient's temperature 3. Oxygen administration *(%Fio2 if being administered if on Airvo or The amount of oxygen being administered via nasal cannula)* **Follow the manufacturer's instructions and Near Patient Testing (NPT) guidance/training for the Blood Gas Analyser in your Local Area.** **For CHI@Crumlin and CHI@Tallaght:** Remove the caps from each end of the capillary tube and attach the clot catcher to one end. Insert into analyser using the end the clot catcher is attached to. Follow the manufacturer's guidance and local training when using the machine. **Appendix 5** If the wrong patient details have been added to the machine follow local policy	To input into the machine To prevent any clots getting into the analyser and to keep the inlet clean. Use of a clot catcher is recommended (Radiometer 2024). Appendix 5

ACTION	RATIONALE EVIDENCE AND REFERENCE
Hospital policy for doffing PPE, safe disposal of sharps should be followed. Perform hand hygiene follow standard precautions The Tenderfoot, once triggered and the incision occurs, the lancet retracts back into the device.	Follow local guidelines. (HPSC, 2024)

While this can minimise the risk of a needle stick injury it must still be disposed of in a sharps bin immediately post use.	

9.0 COMMUNICATION AND TRAINING

9.1 This guideline will be disseminated to all nursing staff

9.2 A memo will be circulated to all relevant personnel informing them how to access this guideline and procedure

9.3 Education and information about the guideline will be disseminated through internal CHI structures.

10.0 COMPLIANCE MONITORING

10.1 This procedure will be reviewed and updated by the owner or his/her designee within a three-year cycle, or earlier if required due to updated guidance, evidence or legislation.

10.2 Compliance with the key principles or procedures described within this guideline will be audited on an annual basis

11.0 APPROVAL:

Proposed: Nurse Practice Committee (Name & Title)	24/6/2024 (Date dd/mm/yyyy)
Concurred: Nurse Executive Board (Name & Title)	02/07/2024 (Date dd/mm/yyyy)
Approved: Grainne Bauer Chief Director of Nursing (Name & Title)	02/07/2024 (Date dd/mm/yyyy)

12.0 VERSION CONTROL HISTORY:

Date: dd/mm/yyyy	Revision Number	Summary of changes/ Reason for change	Section ref:	Author:

13.0 REFERENCES:

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14.0 APPENDICES:

14.1 Appendix I: Guideline Development Group/Key Stakeholders

14.2 Appendix II: Performing the procedure

14.3 Appendix III: Correct filling of capillary tubes

14.4 Appendix IV: Mixing wire for Radiometer Blood Gas Analyser

14.5 Appendix V: Using a clot catcher at the Radiometer Blood Gas Analyser

Appendix I: Guideline Development Group/Stakeholders

Development Group/ Key Stakeholders
1. Jenny Dunne, CNM 3 Neonatal service CHI Crumlin/ Temple street
2. Bickay Lee O Reilly, Clinical Nurse Education Facilitator, Michaels B Temple Street
3. Neonatal Guidelines Committee, CHI
4. PICU Education teams CHI@ Crumlin and CHI@Temple St
5. Conor Sheehan, Near Patient Testing Medical Scientist
6. Phyllis Reilly, NPT Teams
7. Sandra Chiwanza, Near Patient Testing Medical Scientist
8. Warren O Brien, NPDC, CHI Crumlin
9. Fionnuala O Neill, NPDC CHI
10. Caitriona Dennehy, NPDC, CHI Tallaght
11. Nurse Practice Committee, CHI
12. Dr. Niamh O'Sullivan, Consultant Microbiologist
13. Dr Meghan Cotter, Consultant Microbiologist

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Original authors and revisors- 2010- 2018

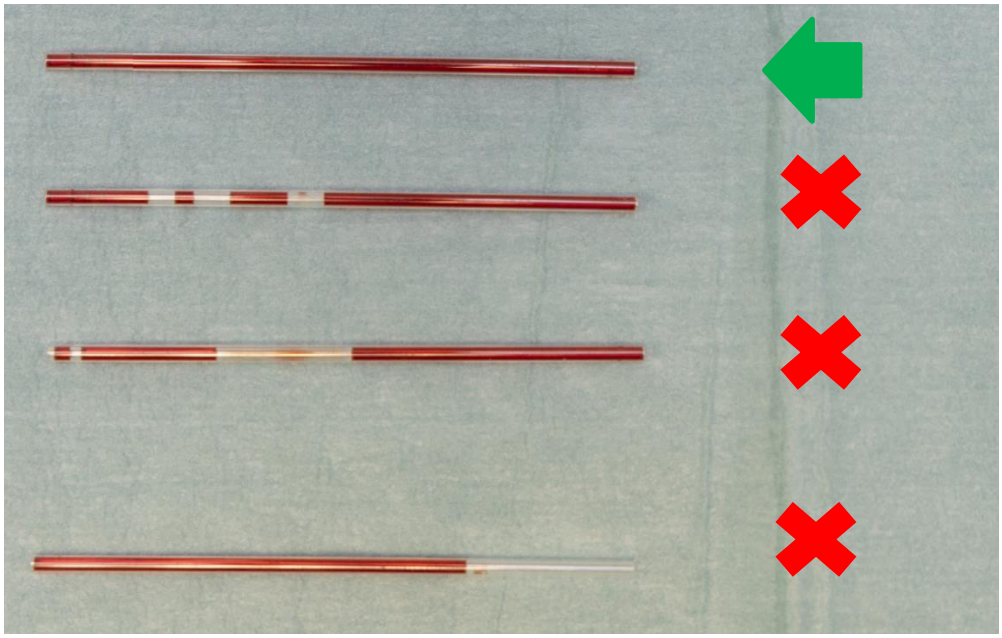
1. Kathryn McDermott, CNM 2, PICU 1
2. Maggie Synordski, CNM 2, PICU 2
3. Eileen Tiernan, Clinical Coordinator Graduate Diploma Critical Care Nursing (Children)

Appendix 1 Performing the procedure

1		2	
	Hold the infants foot with non-dominant hand. Encircle the heel between the thumb and forefingers.		Wipe puncture / incision site allow to dry
3		4	
	Prepare the lancet by taking off the safety cap		Place the disposable automated capillary sampling device on the selected site and activate the trigger and remove from foot immediately. Do not put pressure on the site as it is punctured

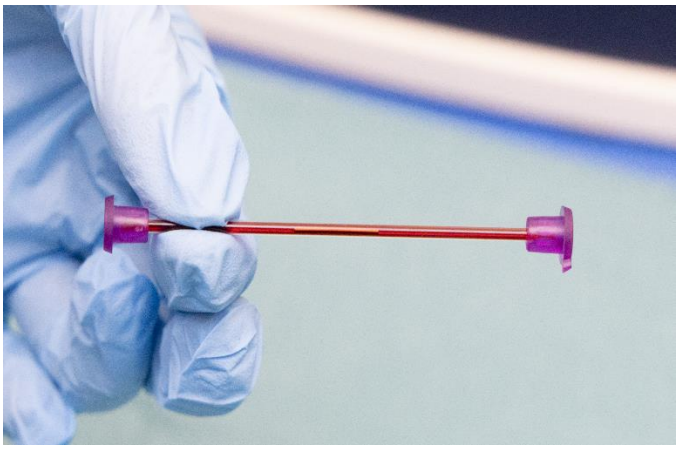
(Medical Illustration, CHI@Crumlin 2024)

Appendix 2: Correct filling of capillary tubes



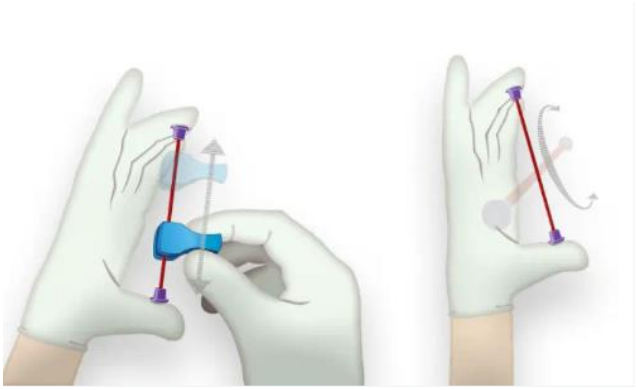
(Medical Illustration, CHI@Crumlin 2024)

Appendix 3- Mixing wire for Radiometer Blood Gas Analyser



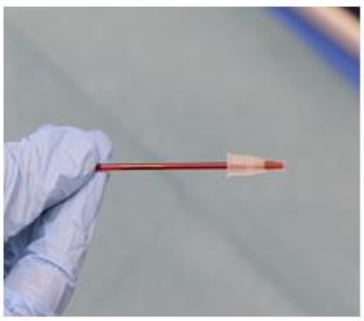
(Medical Illustration, CHI@Crumlin 2024)

Appendix 4- Mixing the Sample using the mixing wire and magnet



Used with Permission (Radiometer, 2024)

Appendix 5 Using a clot catcher at the Radiometer Blood Gas Analyser

1.		2.	
	Bring the sample to the gas machine Follow the manufacturer's guidance and local training when using the machine.		Begin to remove caps
3.		4.	
	Insert a clot catcher		Insert into the Blood Gas Analyser via the clot catcher.

(Medical Illustration, CHI@Crumlin 2024