

# Local Guideline



John Hunter  
Children's Hospital  
CHILDREN, YOUNG PEOPLE AND FAMILIES



Health  
Hunter New England  
Local Health District

## Transcutaneous Oxygen/Carbon Dioxide Monitoring in NICU

<b>Sites where Local Guideline applies</b>	Neonatal Intensive care Unit.JHCH
<b>Target audience:</b>	NICU clinical staff, which provide care to neonatal patients.
<b>Description</b>	Guideline for clinicians to assess carbon dioxide and oxygen using a transcutaneous monitor
<b>This Local Guideline applies to:</b>	
1. <b>Adults</b>	No
2. <b>Children up to 16 years</b>	No
3. <b>Neonates – less than 29 days</b>	Yes Approval gained from the Children Young People and Families Network on 24/02/15
<b>Keywords</b>	blood gas, carbon dioxide, oxygen, oximetry, oxygen tension, transcutaneous
<b>Replaces Existing Local Guideline and Procedure</b>	No
<b>Registration Number(s) and/or name and of Superseded Documents</b>	N/A
<b>Related Legislation, Australian Standards, NSW Health Policy Directive, NSQHS Standard/EquiP Criterion and/or other, HNE Health Documents, Professional Guidelines, Codes of Practice or Ethics:</b>	
<ul style="list-style-type: none"> <li>• <b>Relevant Accreditation Criterion e.g. NSQHS Standards/EquiP Criterion and/or other:</b></li> <li>• NSW Health Policy Directive 2007_079 Clinical Procedure Safety <a href="http://www0.health.nsw.gov.au/policies/pd/2014/pdf/PD2014_036.pdf">http://www0.health.nsw.gov.au/policies/pd/2014/pdf/PD2014_036.pdf</a></li> <li>• NSW Health Policy PD 2005_406 Consent to Medical Treatment <a href="http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005_406.pdf">http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005_406.pdf</a></li> <li>• NSW Health Policy Directive PD 2007_036 Infection Control Policy <a href="http://www.health.nsw.gov.au/policies/pd/2007/pdf/PD2007_036.pdf">http://www.health.nsw.gov.au/policies/pd/2007/pdf/PD2007_036.pdf</a></li> </ul>	
<b>Prerequisites (if required)</b>	N/A
<b>Local Guideline Note</b>	This document reflects what is currently regarded as safe and appropriate practice. The guideline section does not replace the need for the application of clinical judgment in respect to each individual patient but the procedure/s <b>require mandatory compliance</b> . If staff believe that the procedure/s should not apply in a particular clinical situation they must seek advice from their unit manager/delegate and document the variance in the patients health record.
<b>Position responsible for the Local Guideline and authorised by</b>	Dr Paul Craven, Director of Newborn Services (Acting) JHCH
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<b>Date authorised</b>	
<b>This Local Guideline contains advice on therapeutics</b>	No
<b>Date of Issue</b>	24/02/15
<b>Review due date</b>	24/02/18

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**RISK STATEMENT**

*This local guideline has been developed to provide guidance to clinical staff in NICU to assist in monitoring transcutaneous oxygen and carbon dioxide and the procedure to set up and maintain quality readings. It ensures that the risks of harm to the infants whilst caring for an infant requiring transcutaneous monitoring are identified and managed.*

*Any unplanned event resulting in, or with the potential for injury, damage or other loss to infants/staff/family as a result of this management must be reported through the Incident Information management System and managed in accordance with the Ministry of Health Policy Directive: Incident management PD2007\_061. This would include unintended injury that results in disability, death or prolonged hospital stay.*

**RISK CATEGORY:** *Clinical Care & Patient Safety*

**OUTCOMES**

<b>1</b>	Continuous monitoring of infants blood oxygen and carbon dioxide levels to ensure appropriate management of the infant
<b>2</b>	Accurate trending of oxygen and carbon dioxide will minimise blood gas sampling

**ABBREVIATIONS & GLOSSARY**

<b>Abbreviation/Word</b>	<b>Definition</b>
ABG	Arterial blood gas
PaO <sub>2</sub> /PaCO <sub>2</sub>	Partial pressure of oxygen and carbon dioxide
TcPO <sub>2</sub> /TcPCO <sub>2</sub>	Transcutaneous partial pressure of oxygen and carbon dioxide

## Transcutaneous Oxygen/Carbon Dioxide Monitoring **One Page Summary and Checklist**

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*Change the membrane on the transducer if calibration has failed twice or if the membrane appears scratched, wrinkled or bubbled.*

*Unscrew the protective cap from the transducer and hook the O ring remover under both O rings to remove them*

*Remove **both** the clear plastic membranes using your fingers*

*Clean the transducer head, including the groove and rim, with absorbent paper to remove all the old electrolyte solution (may cause incorrect values)*

*Apply 2 drops of electrolyte fluid and remove any air bubbles*

*Turn transducer head over and clip it into a new membrane kit, until it clicks*

*Inspect the transducer carefully, ensuring there are two O rings and no visible bubbles. If bubbles are noted, repeat the remembraning procedure*

*It is now necessary to calibrate the transducer*


### [Positioning the Transducer for Monitoring](#)

## **GUIDELINE**

This Guideline does not replace the need for the application of clinical judgment in respect to each individual patient.

## **Rationale**

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The analysis of arterial blood gases (ABG) provides an accurate result for PaO<sub>2</sub> and PaCO<sub>2</sub> however only for that time of collection. Transcutaneous monitoring (TCM) of TcO<sub>2</sub> and TcCO<sub>2</sub> is non-invasive and provides a continuous result which when compared with an ABG can be used to monitor a trend. The advantage is that it minimises blood collection from the infant. TcPCO<sub>2</sub> & TcPO<sub>2</sub> are not the arterial measurement of PaO<sub>2</sub> and PaCO<sub>2</sub>, it is a measurement of oxygen delivery from the lungs and carbon dioxide clearance via the blood into the tissue.

TCM measures the partial pressure of oxygen (TcPO<sub>2</sub>) & carbon dioxide (TcPCO<sub>2</sub>) which is the amount of oxygen and carbon dioxide dissolved in the tissue. This corresponds

reasonably well to arterial oxygen tension ( $\text{PaO}_2$ ) and carbon dioxide ( $\text{PaCO}_2$ ) when the skin underneath the sensor is heated to  $44^\circ\text{C}$ .

However as pulse oximetry is now considered the most accurate non-invasive form of monitoring oxygen levels, TCM is useful in monitoring  $\text{TcCO}_2$ . Correlation between  $\text{TcPCO}_2$  and  $\text{pCO}_2$  occurs due to a small difference between arterial and venous  $\text{pCO}_2$  and fast diffusion of  $\text{CO}_2$  in the tissues.

## How the TCM works

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The transcutaneous oxygen/carbon dioxide ( $\text{TcPO}_2/\text{TcPCO}_2$ ) transducer heats the skin, effectively increasing local blood perfusion so that  $\text{O}_2$  and  $\text{CO}_2$  can diffuse to the skin surface more easily (Poets & Bassler, 2008).

The transducer contains an electrolyte solution which is held in place by two gas permeable membranes. The  $\text{O}_2$  and  $\text{CO}_2$  diffuses out of the skin and passes through the membranes into the electrolyte solution where an electrochemical reactions take place (Poets & Bassler, 2008).

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## Benefits of Using a TCM

The TCM is useful when there is lack of arterial access or continuous monitoring is necessary to minimise blood collection.

It allows assessment of:

- oxygenation and/or ventilation status- rising  $\text{CO}_2$  may indicate the need for endotracheal suction
- response to therapeutic treatment e.g. nitric oxide administration
- weaning and extubation management based on  $\text{TcCO}_2$  levels- identification of accumulating  $\text{CO}_2$  is helpful in recognising infants with inadequate respiratory effort, before development of acidosis and bradycardia
- $\text{PCO}_2$  levels- hypercarbia is a potent vasodilator and has been implicated in the etiology of periventricular haemorrhage due to cerebral vasodilation. Hypocarbia has a vasoconstrictor effect & may reduce cerebral blood flow and contribute to ischaemic lesions of the brain.

## Indications

- Any baby on mechanical ventilation
- Any baby whom the Neonatologist has requested  $>4$  gases in a day

## Caution with infants with poor skin integrity and poor perfusion such as

- Cooled babies
- Inotrope treatment

## Factors influencing TCM results

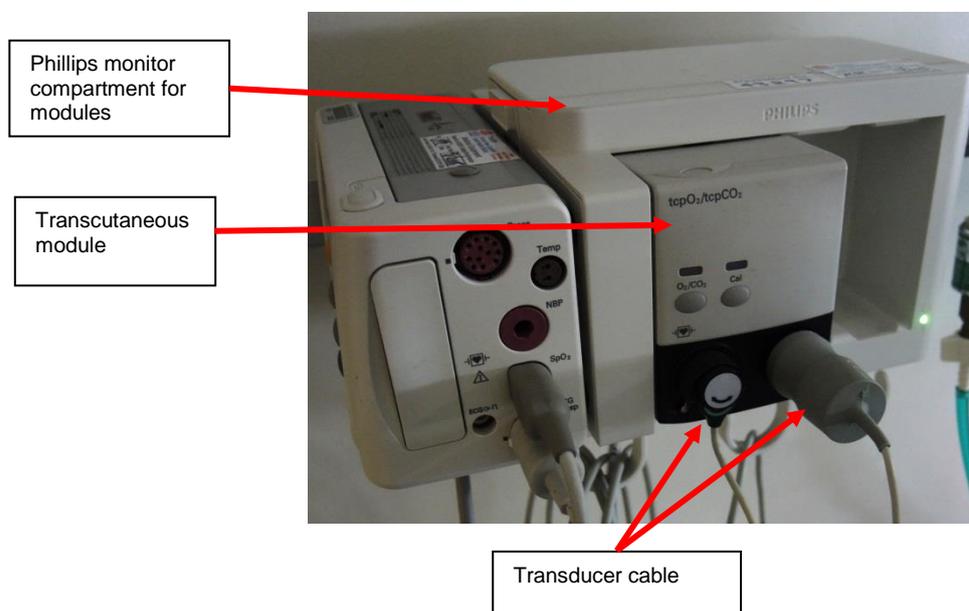
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- skin thickness
- sensor site
- temperature of electrode
- amount of contact gel used
- poor peripheral perfusion, blood flow & blood pressure.

## Requirements

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- Transcutaneous module, including transducer cable
- Re-membrating kit containing tools & supplies needed to apply new sensor membrane, if necessary-see page 7
- Calibration unit, containing gas mixture of 5% CO<sub>2</sub>
- Fixation rings
- Contact fluid



## Temperature Setting & Timer

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Set the transducer temperature according to the infant's age and gestation

- <43°C for infants born <27/40, and < 2 weeks of age.
- 43 - 44°C for all other infants.

A higher transducer temperature results in a better correlation of TcPO<sub>2</sub> (43-44°C) however TcPCO<sub>2</sub> measurement is reliable at lower temperatures (even down to 37°C) which allows for a longer period of set time. The sensor measuring TcPCO<sub>2</sub> at 37°C may remain on the skin for up to 8-12 hours which promotes minimal handling principles (Restrepo, 2012).

Adjust the transducer site timer on the monitor to **4 hours**; however an individual assessment must be made on each infant's gestation and the skin condition. The site timer helps guard against the risk of skin burn by ensuring the transducer is used at one site for no longer than a predetermined time.

## Calibration

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Calibration is required when:

- A new monitoring period is to commence.
- Transducer is remembraned.
- The transducer operating temperature has been changed.
- The **Tc CAL REQUIRED** message appears on the monitor screen.
- The accuracy of the measurement is in doubt.
- The monitoring site has been changed.

## Calibrating the transducer

- Insert transducer head into calibration chamber on the module
- Press O<sub>2</sub>/CO<sub>2</sub> on the TcPO<sub>2</sub>/TcCO<sub>2</sub> module

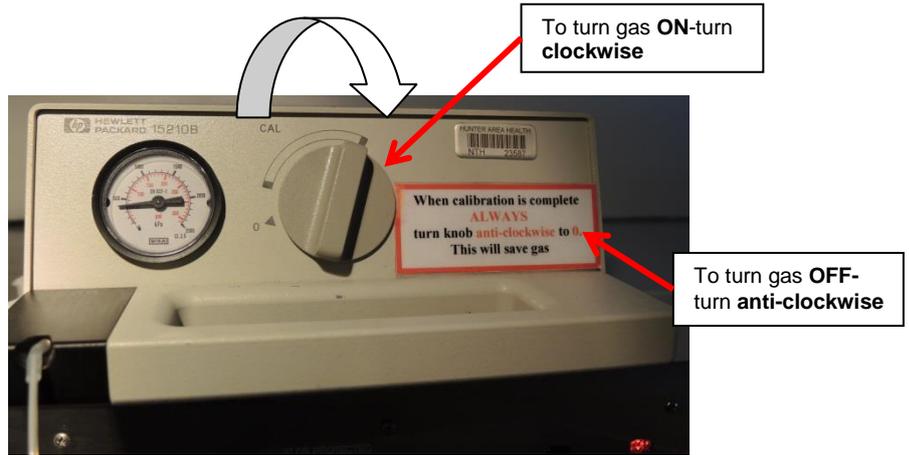


Phillips screen for calibration procedure

- Check and adjust the transducer temperature and the site timer on monitor
- Fit the gas tubing from the calibration unit to the inlet on the side of the monitor
- Turn the gas on at the calibration unit (see figure below)
- Press CAL on the module or Start Calibration on the monitor
- Wait for TcPO<sub>2</sub>/TcPCO<sub>2</sub> calibration complete before commencing monitoring
- Turn the gas off when calibration is completed



Calibration chamber

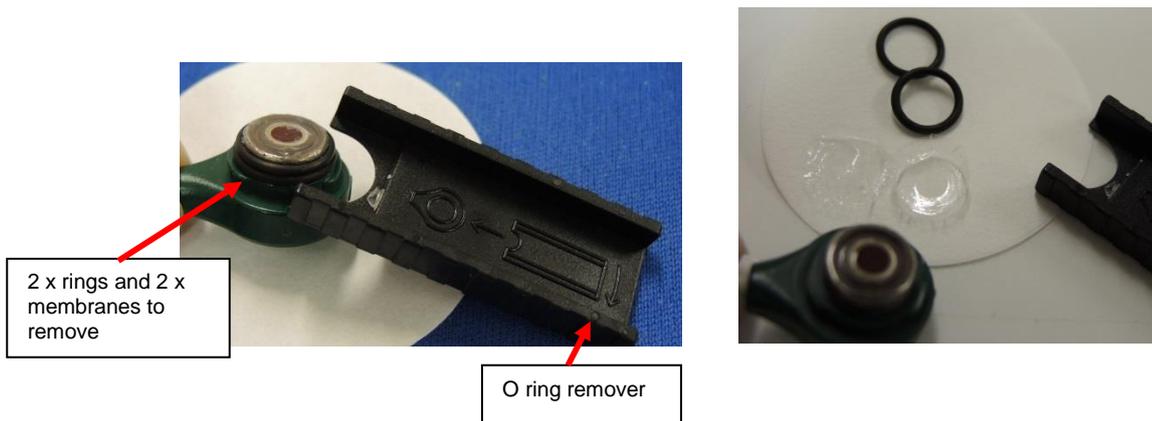


Calibration Unit

## Membrane replacement

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- Apply a new membrane for each new infant being monitored
- Membranes last approximately 1 week before a change is required
- Change the membrane on the transducer if calibration has failed twice or if the membrane appears scratched, wrinkled or bubbled.
- Unscrew the protective cap from the transducer and hook the O ring remover under both O rings to remove them.
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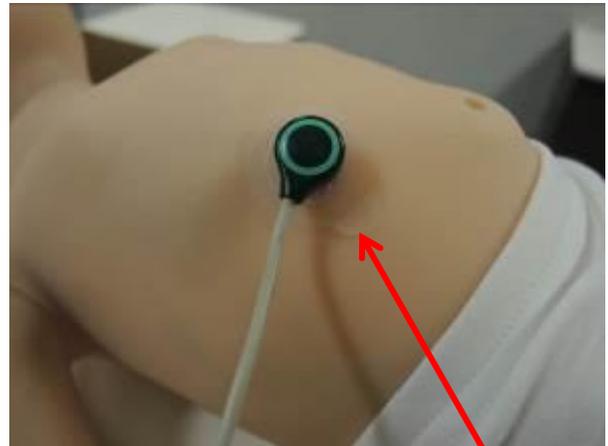
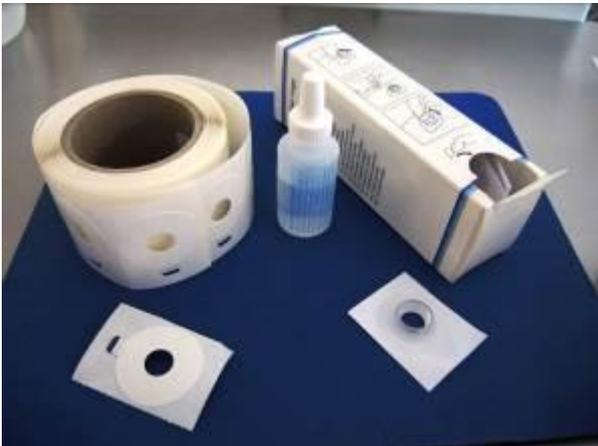


- Remove **both** the clear plastic membranes using your fingers
- Clean the transducer head, including the groove and rim, with absorbent paper to remove all the old electrolyte solution (may cause incorrect values)
- Apply 2 drops of electrolyte fluid and remove any air bubbles
- Turn transducer head over and clip it into a new membrane kit, until it clicks
- Inspect the transducer carefully, ensuring there are two O rings and no visible bubbles. If bubbles are noted, repeat the re-membraning procedure.
- It is now necessary to calibrate the transducer

## Positioning the transducer for Monitoring

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Select a site for the transducer. Clean the skin with an alcohol wipe if vernix is present and allow it to dry. Sites used include the abdomen, chest and back, avoiding any bony prominences. The anterior thigh can also be used. Optimum measurement is obtained from a site that has high blood flow and capillary density, thin epidermis (avoid the nipple).



Apply the fixation ring the **first** time directly to the skin. To ensure good positioning of the lead ensure the tag is facing downwards.



On subsequent times, in the interest of waste minimisation, attach the same fixation ring to the Tc sticker (on roll) and apply to a different area on body.



Instil 3-5 drops of contact fluid into the centre of the ring. Insert the transducer head into the ring, with the lead direction over the tab and turn it approximately  $\frac{1}{4}$  of a turn clockwise to fasten. After attachment, wait for the readings to stabilise.

Ensure good positioning of the cable, with no kinks or tension on the cable and check the infant is not positioned on the cable.

Remove the transducer from the infant when the specified monitoring time has elapsed. Prolonged continuous monitoring at one site may cause skin irritation, reddening, blistering or burns.

Remove the fixation ring ***very carefully*** particularly in preterm infants to reduce the incidence of epidermal stripping and/or bruising.



This is an example of incorrectly using 2 rings to alternate sites- Do not use more than one ring on the baby and move to completely new site to protect the skin.

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## FEEDBACK

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