



GUIDELINE

Transcutaneous Carbon Dioxide Monitoring (TCM)

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| Scope (Staff): | Nursing and Medical Staff |
| Scope (Area): | NICU KEMH, NICU PCH, NETS WA |

Child Safe Organisation Statement of Commitment

CAHS commits to being a child safe organisation by applying the National Principles for Child Safe Organisations. This is a commitment to a strong culture supported by robust policies and procedures to reduce the likelihood of harm to children and young people.

This document should be read in conjunction with this [disclaimer](#)

Aim

To monitor CO₂ values via transcutaneous monitoring in the neonate.

Risk

Not following the guideline could result in fluctuations in CO₂ values, which can lead to worsening of lung injury and brain injury in newborn infants, especially in very preterm and extremely preterm infants.

Background

Hypocarbia and hypercarbia in extremely preterm infants are associated with bronchopulmonary dysplasia, intraventricular haemorrhage, and cystic periventricular leukomalacia. Continuous monitoring of CO₂ levels helps in maintaining stable CO₂ values within an accepted target range. Although arterial blood gas CO₂ monitoring is more accurate, arterial lines will not be available for long periods. Furthermore, continuous assessment is not possible with blood gases. Transcutaneous carbon dioxide (TcCO₂) measurement overcomes these limitations and enables optimisation of ventilation. Continuous non-invasive monitoring of CO₂ decreases blood sampling, pain and discomfort, risk of infection, and the need for blood transfusions.

TcCO₂ makes use of the fact that CO₂ diffuses through body tissue and skin and can be detected by a sensor at the skin surface. By warming the sensor, a local hyperaemia is induced, which increases the supply of arterial blood to the dermal capillary bed below the sensor. The measurement usually requires several minutes of preheating. The disadvantages include heat-induced skin damage and burns from the electrodes but can be prevented by careful use and regular changes of the sensor location. Advantages of TcCO₂ over EtCO₂ are that it can be easily used for

continuous CO₂ monitoring in infants who are not ventilated and during non-invasive ventilation as well as during High Frequency Ventilation.

The disadvantage of TcCO₂ is that it cannot be used for confirming the ETT position in the trachea; another disadvantage is the time it takes for initial measurement because of the need for local preheating and calibration. Therefore, it cannot be used during neonatal resuscitation in the delivery room or the NICU.

Inclusion Criteria (Continuous TC Monitoring)

- All admissions requiring ventilation (particularly on HFOV or HFJV) / CPAP for the first 4 days
- All surgical infants for the first 4 hours postoperatively until medical review.
- All surgical infants **requiring respiratory support postoperatively** for the first 24 hours until medically assessed as stable for intermittent TCM
- All infants with a pneumothorax (+/- ICC).
- For the first 4 hours post extubation.

Inclusion Criteria (Intermittent TC Monitoring) i.e. Once Per Shift for 4 Hours

- All infants continuing to require respiratory support after the first 4 days of mechanical ventilation.
- All surgical infants continuing to require respiratory support and medically assessed as stable for intermittent TC Monitoring.

NOTE: TCM monitoring for full- term or near-term babies may be omitted if end tidal CO₂ monitoring is in use.

Key points

Due to the lack of keratin, all infants born < 27 weeks and < 2 weeks of age must have their transducer temperature set down at **41°C**, and the transducer rotated between 2 sites at **2 hourly intervals** to avoid causing skin burns.

- Position the infant so not laying on transducer or plastic disc as it will increase the risk of pressure injury.
- TCM measurements should not replace arterial blood gas monitoring. However, TCM can be used to substantially reduce the frequency of arterial sampling and to observe trends in arterial blood gases following changes to ventilation. To validate correlation, it is preferable for TCM to be **in situ** prior to blood gas sampling.
- Very high or low PaCO₂ values may compromise an infant's neurological outcome and are often a sign that ventilator management needs review.
- A rising CO₂ may be an indicator of:
 - Pneumothorax.
 - Deterioration (collapse, consolidation, oedema, sepsis).
 - Accidental extubation.

- Need for endotracheal suction.

Equipment

- TCM module & cable
- Calibration gases
- Remembraning kit
- Fixation ring
- Contact fluid

Transducer Temperature

Set the transducer temperature according to the infant's age:

- 41°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 as well as a shorter time delay from the change in arterial blood gas and its detection by the transducer.
- However, higher temperatures may increase the risk of skin burns.

Timer

Adjust the transducer site timer on the monitor. This is usually set at 4 hours, however an individual assessment must be made on each infant's skin and gestation and often site rotation needs to occur 2 to 4 hourly. 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.

For infants < 27 weeks and < 2 weeks of age the timer should be set at 2 hours so that the site is rotated every 2 hours

Re-membrane

- The membranes last approximately 1 week before a change is required. Change the membrane on the transducer if calibration has failed twice.
- Inspect the transducer carefully, ensuring there are two O rings and no visible bubbles. If bubbles are noted, repeat the re-membraning procedure.
- Membrane is to be replaced between patients.

Calibration

Calibration is required when:

- Re-membraned.
- 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.

- A new monitoring period is to commence.
- The monitoring site has been changed.


Positioning the Transducer

- Select a site for the transducer. Clean the skin with an alcohol wipe if vernix is present and allow 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 and instil several drops of contact fluid ready to attach the transducer. After attachment wait for the readings to stabilise.
- Ensure good positioning of the cable, with no kinks or tension on the cable. Ensure 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.
- Use standard precautions when decontaminating equipment between infants.

References and related external legislation, policies, and guidelines

1. Hochwald O et al. Continuous Noninvasive Carbon Dioxide Monitoring in Neonates: From Theory to Standard of Care. *Pediatrics*. 2019 Jul;144(1)
2. Mukhopadhyay S et al. Neonatal Transcutaneous Carbon Dioxide Monitoring--Effect on Clinical Management and Outcomes. *Respir Care*. 2016 Jan;61(1):90-7.
3. Bruschetti M et al. Transcutaneous carbon dioxide monitoring for the prevention of neonatal morbidity and mortality. *Cochrane Database Syst Rev*. 2016 Feb 13;2(2):CD011494.
4. Van Weteringen W et al. Novel transcutaneous sensor combining optical tcPO₂ and electrochemical tcPCO₂ monitoring with reflectance pulse oximetry. *Med Biol Eng Comput*. 2020 Feb;58(2):239-247.)

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