GUIDELINE

End Tidal Capnography Monitoring (ETCO2)

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 describe the principles, procedure, and interpretation of ETCO2 monitoring in ventilated neonates.

Risk

Not adhering to the policy could result in undetected hypocarbia and hypercarbia, resulting in morbidity and delay in detecting accidental extubation.

Background

- $ETCO_2$ is a type of non-invasive monitoring of carbon dioxide levels in ventilated patients [2]. It provides a constant surveillance of expired CO_2 in ventilated infants. $ETCO_2$ can be used to detect trends in $PaCO_2$ and $ETCO_2$ alarm limits can be used to maintain $PaCO_2$ within an acceptable range.
- Carbon dioxide (CO2) monitoring is vital during mechanical ventilation of newborn infants, as morbidity increases when CO2 levels are inappropriate [1].
- $EtCO_2$ and Transcutaneous CO2 ($TcCO_2$) monitoring have their own strengths and limitations and hence should be viewed as complementary technologies of assessing $PaCO_2$ in the NICU [1,2, 6]. In addition, regular correlation with $PaCO_2$ is important with either of the methods.
- Some studies have shown ETCO2 monitoring is possible even in very preterm infants during delivery room resuscitations [3].

ETCO2 Monitors

- There are two types of ETCO2 monitors: Mainstream and side-stream [4]. Side stream (Phillips Microstream) is the currently used system in the NICU.
- Both are placed in-line with the ventilator circuit, between the ETT and ventilator tubing. The difference between them is where the CO2 is analysed:
    - In side-stream capnographs, there is a sample line which exports exhaled gas to an infra-red analyser away from the ventilator circuit. There can be a slight time delay in reading due to the transit time of the CO2 molecules along the sample line to the infra-red sensor. Importantly, with the side-stream capnograph the waveform may be affected by water droplets within the sample line, which form as the side-stream tube is cooled outside the incubator, especially in extremely preterm infants who require high incubator humidity. However, studies have shown that in practice, side-stream capnography performs as well as the main-stream [5].
    - In mainstream capnographs, there is an infra-red sensor that sits in-line with the capnograph, and analysis is undertaken in real time.

Key points

- An important use of continuous $ETCO_2$ monitoring is for the immediate detection of accidental extubation.
- While a ‘good’ $ETCO_2$ trace and reading gives assurance that the ETT is in the airway, it does not provide information about the exact position of the ETT in the airway. The ETT could be too high or low (main stem bronchus) and still give an acceptable $ETCO_2$ trace and reading.
- TCMs should be re-membraned prior to use with each new patient and used in conjunction with End Tidal CO_2 monitoring.
- The module should not be used for 4 hours after administration of surfactant.
- $ETCO_2$ readings are not accurate if there is moderate to large leak around ETT.
- ETCO2 is not possible for infants on high-frequency oscillators or jet ventilators as the volume of each breath is less than dead space.

Inclusion Criteria

Use ETCO2 monitoring for all ventilated infants at PCH 3B, all ventilated NETS WA transfers, all ventilated infants being transferred between departments, e.g. operation theatre, radiology department.

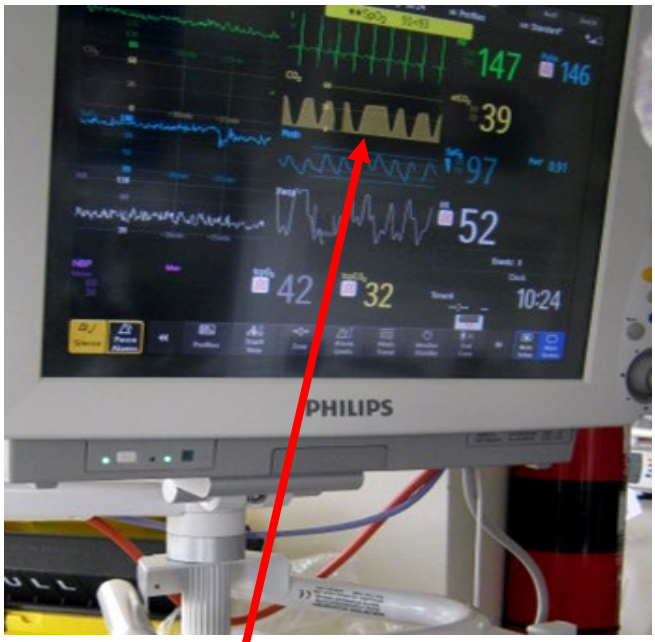
At KEMH, $ETC0_2$ monitoring in ventilated infants is at the Neonatologist’s discretion.

ETCO2 Application

- The end tidal device has a dead space of 0.5mL. End tidal CO2 Filter Line Sampling sets are single patient use and can last up to 72 hours. This time will be

reduced with increased ETT secretions and condensate. To reduce condensate accumulating in the Filter Line set, keep the sampling line facing upward as much as possible. If there is moisture condensation in the device, remove the device from the ETT (reconnect ventilator to the patient), air dry the unit and reinsert.

- The $ETCO_2$ module is attached to the X2 monitor. The sample line is positioned between the patient's ETT and the flow sensor of the ventilator and connects into the $ETCO_2$ module. Reading starts immediately, no calibration is required. A wave form is displayed on the monitor with an end tidal CO_2 value.
- If monitoring is required for patient transfer the X2 unit and Microstream extension is removed from the Monitor and placed in a MP50 (KEMH) or Mx450 (PCH). This allows reading of > 3 wave forms and provides a power source to run the Microstream extension unit.



End tidal CO_2 Microstream in X2 monitor, yellow CO_2 wave form and value displayed on monitor screen.

End tidal CO_2 Microstream inserted between ETT and ventilator flow sensor. Sample line facing upwards direction.

Interpretation of ETCO2 Trace

The graphs below are helpful while interpreting the ETCO2 traces [3] in ventilated neonates.

Figure 1: Carbon dioxide on *y*-axis with time on *x*-axis. The red trace depicts the capnography waveform. $PaCO_2$: arterial CO_2, $EtCO_2$: end tidal CO_2

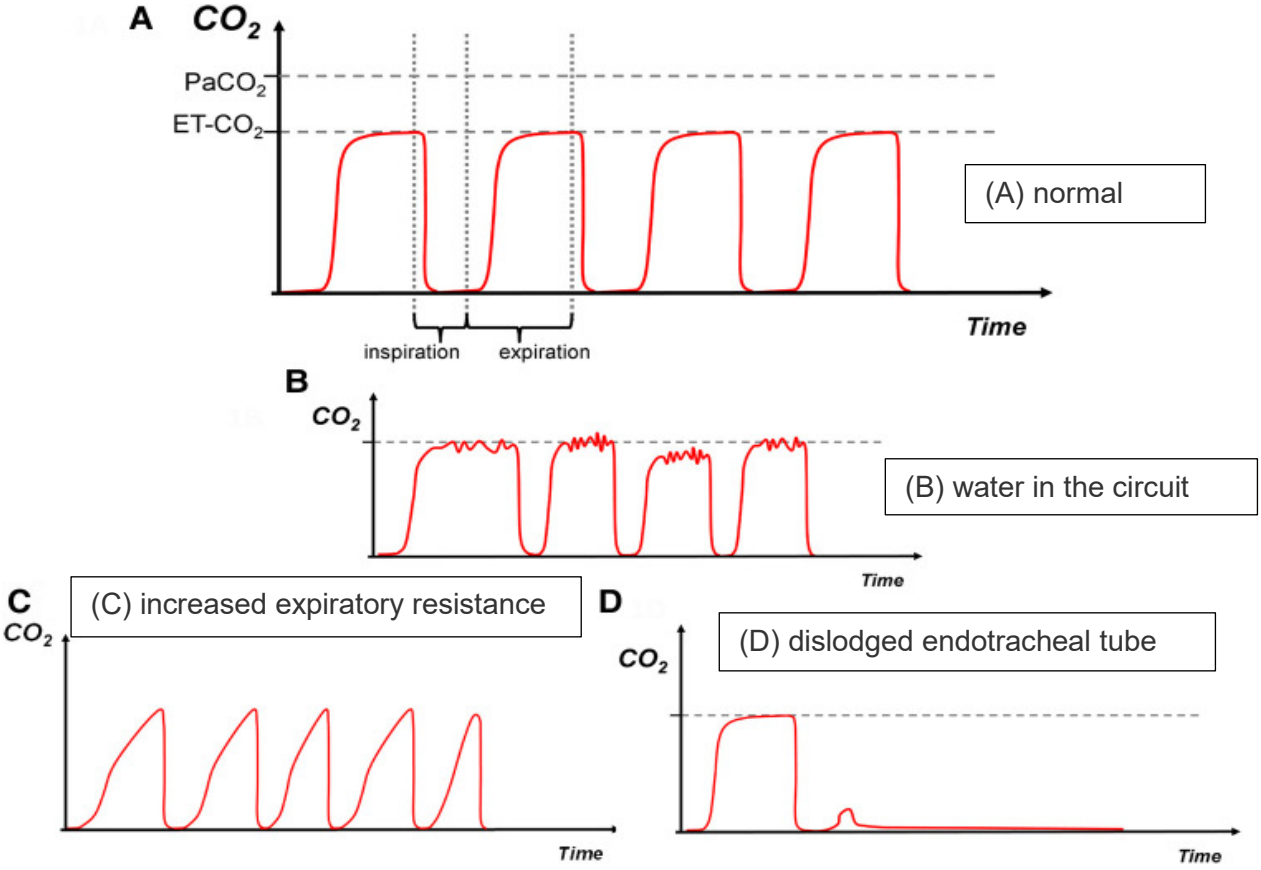
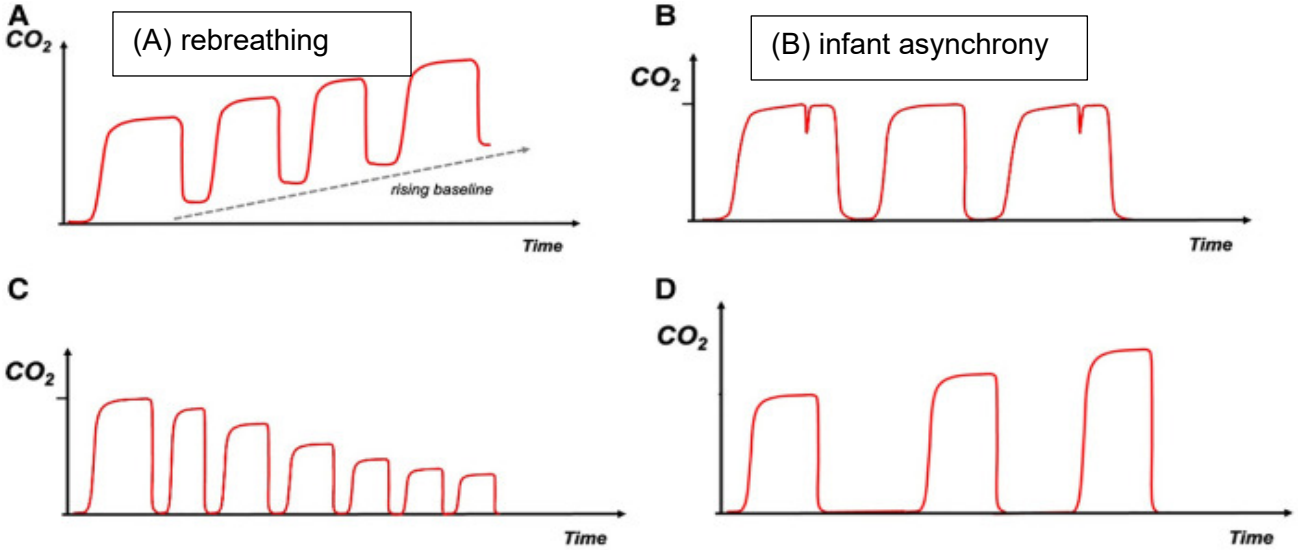


Fig 2: Carbon dioxide on y-axis with time on x-axis. The red trace depicts the capnography waveform.



Related CAHS internal policies, procedures and guidelines

Transcutaneous Carbon Dioxide Monitoring (health.wa.gov.au)

Ventilated Neonate: Nursing Care of (health.wa.gov.au)

References and related external legislation, policies, and guidelines

1. Williams E, Dassios T, Greenough A. Carbon dioxide monitoring in the newborn infant. Pediatr Pulmonol. 2021 Oct;56(10):3148-3156.
2. Hochwald O, Borenstein-Levin L, Dinur et al. Continuous Non-invasive Carbon Dioxide Monitoring in Neonates: From Theory to Standard of Care. Pediatrics. 2019 Jul;144(1):e20183640.
3. Hawkes GA, Kenosi M, Finn D, et al. Delivery room end tidal CO2 monitoring in preterm infants <32 weeks. Arch Dis Child Fetal Neonatal Ed. 2016 Jan;101(1):F62-5.
4. Williams E, Dassios T, Harris C, Greenough A. Capnography waveforms: basic interpretation in neonatal intensive care. Front Pediatr. 2024 Apr 4;12:1396846.
5. Williams E, Dassios T, Greenough Aet al. Assessment of sidestream end-tidal capnography in ventilated infants on the neonatal unit. Pediatr Pulmonol. 2020 Jun;55(6):1468-1473.
6. Chandrakantan A, Jasiewicz R, Reinsel RA, et al. Transcutaneous CO2 versus end-tidal CO2 in neonates and infants undergoing surgery: a prospective study. Med Devices (Auckl). 2019 May 6;12:165-172.

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