Clinical Practice Procedures:
Assessment/Capnography – waveform

Policy code	CPP_AS_CW_1224
Date	December, 2024
Purpose	To ensure a consistent procedural approach to capnography – waveform.
Scope	Applies to Queensland Ambulance Service (QAS) clinical staff.
Health care setting	Pre-hospital assessment and treatment.
Population	Applies to all ages unless stated otherwise.
Source of funding	Internal – 100%
Author	Clinical Quality & Patient Safety Unit, QAS
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Capnography – Waveform

December, 2024

Waveform capnography is the continuous quantitative measurement of exhaled carbon dioxide (CO_2). CO_2 concentration is displayed graphically as a capnogram (waveform) representing CO_2 levels throughout the respiratory cycle. CO_2 provides valuable information on ventilation, haemodynamics and metabolism in both intubated and non-intubated patients [1]. A 'normal' $EtCO_2$ is considered to be between 35–40 mmHg, however, results may be influenced by various physiological factors.

Measurement of $EtCO_2$ in the cardiac arrest patient is an effective, non-invasive indicator of chest compression quality (aim for greater than 20 mmHg) and the return of spontaneous circulation.

Waveform $EtCO_2$ monitoring is mandatory to confirm correct ETT placement and throughout subsequent patient ventilations.

The CO_2 capnogram comprises four key phases: [2]

Phase I (inspiratory baseline) – reflects inspired gas (devoid of CO_2)

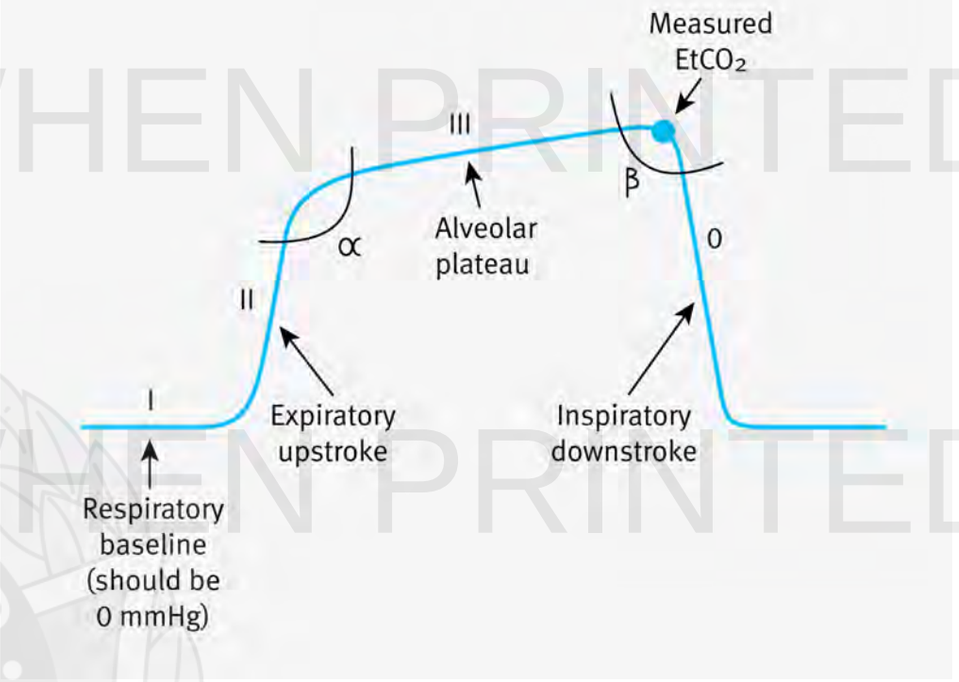
Phase II (Expiratory upstroke) – reflects transition of anatomical dead space and alveolar gas from the alveoli/bronchioles.

- alpha angle – reflects the transition between Phase II to III and can be used to assess ventilation perfusion of the lungs. V/Q mismatches will have an alpha angle greater than 90 degrees.

Phase III (Alveolar plateau) – reflect last of the alveolar gas being sampled.

- beta angle – reflects transition between Phases III to 0 and can be used to identify rebreathing. If rebreathing occurs, the beta angle will be greater than 90 degrees.

Phase 0 (Inspiratory downstroke) – reflects the beginning of inspiration.



Indications

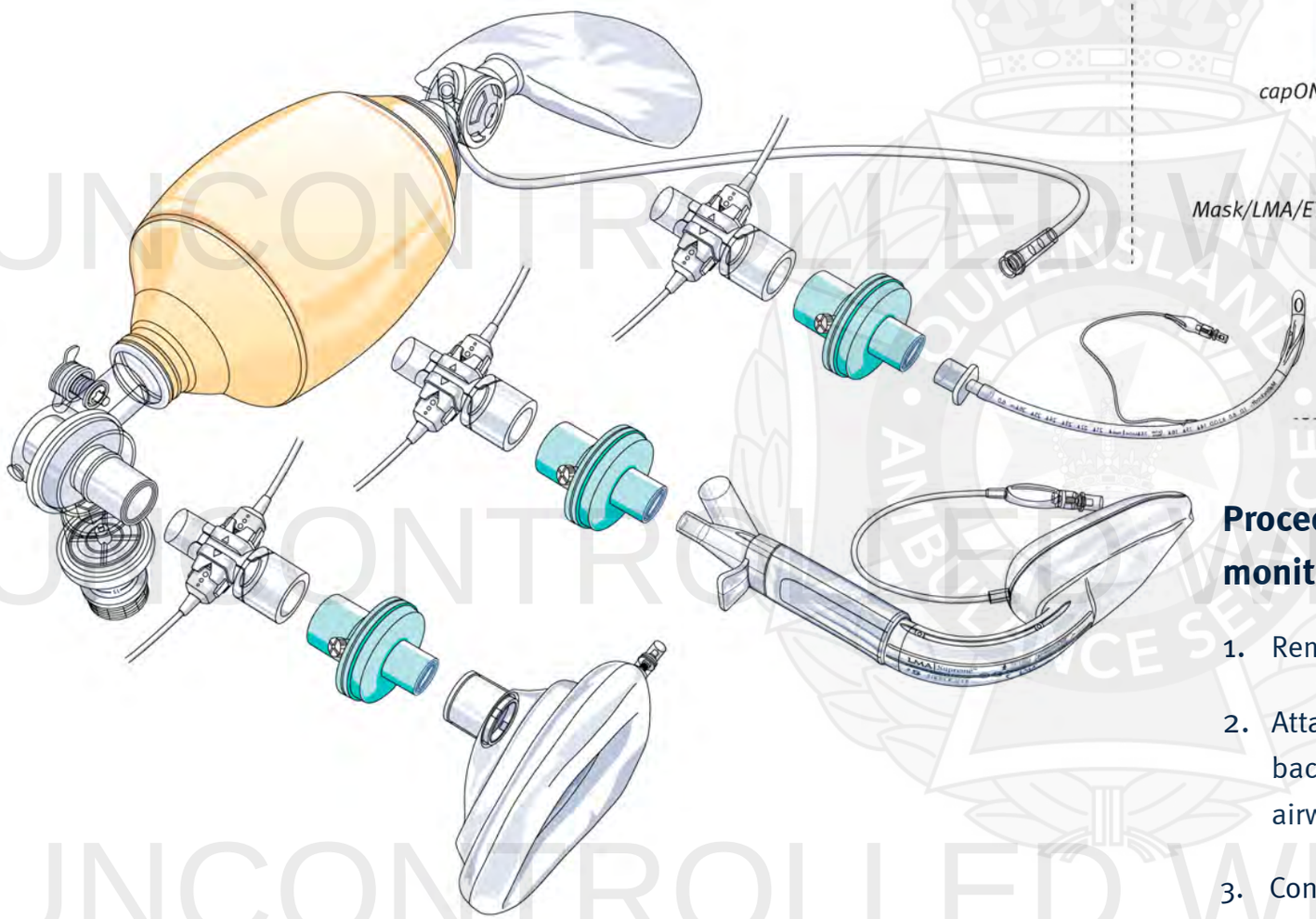
- CPR
- Sedation and procedural sedation
- Endotracheal intubation (placement confirmation)
- Ongoing monitoring of ventilation

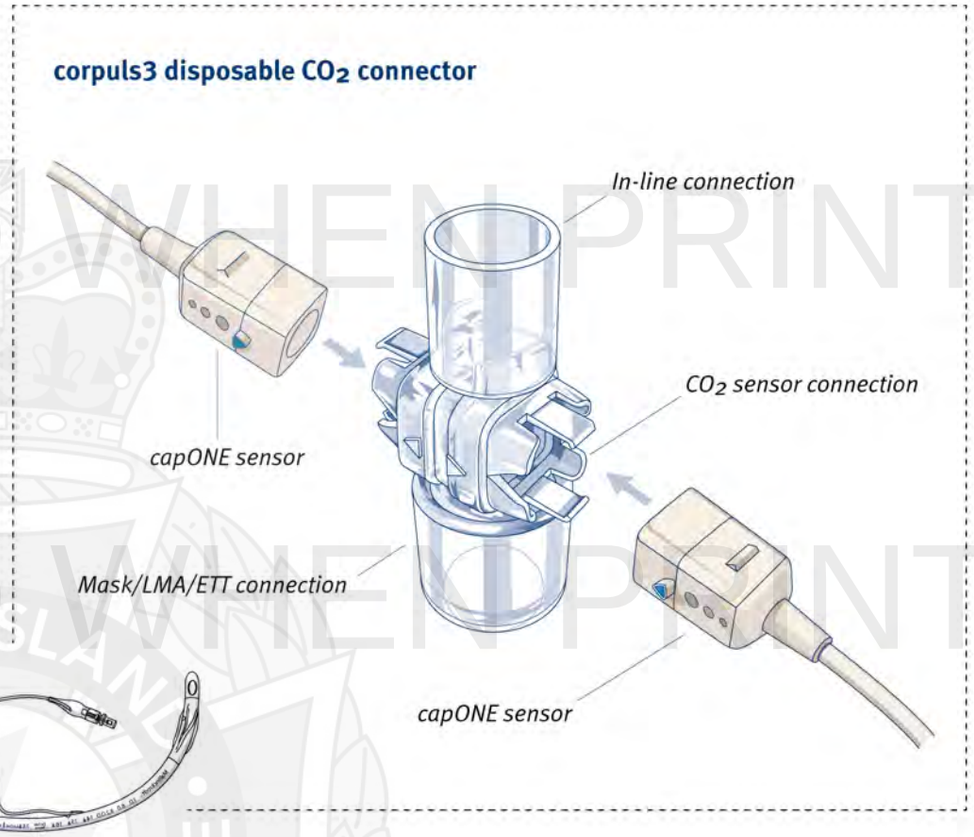
Contraindications

- Nil in this setting

Complications

- When performing effective CPR during cardiac arrest, $EtCO_2$ values must not be used to vary IPPV from the recommended rate.[3]



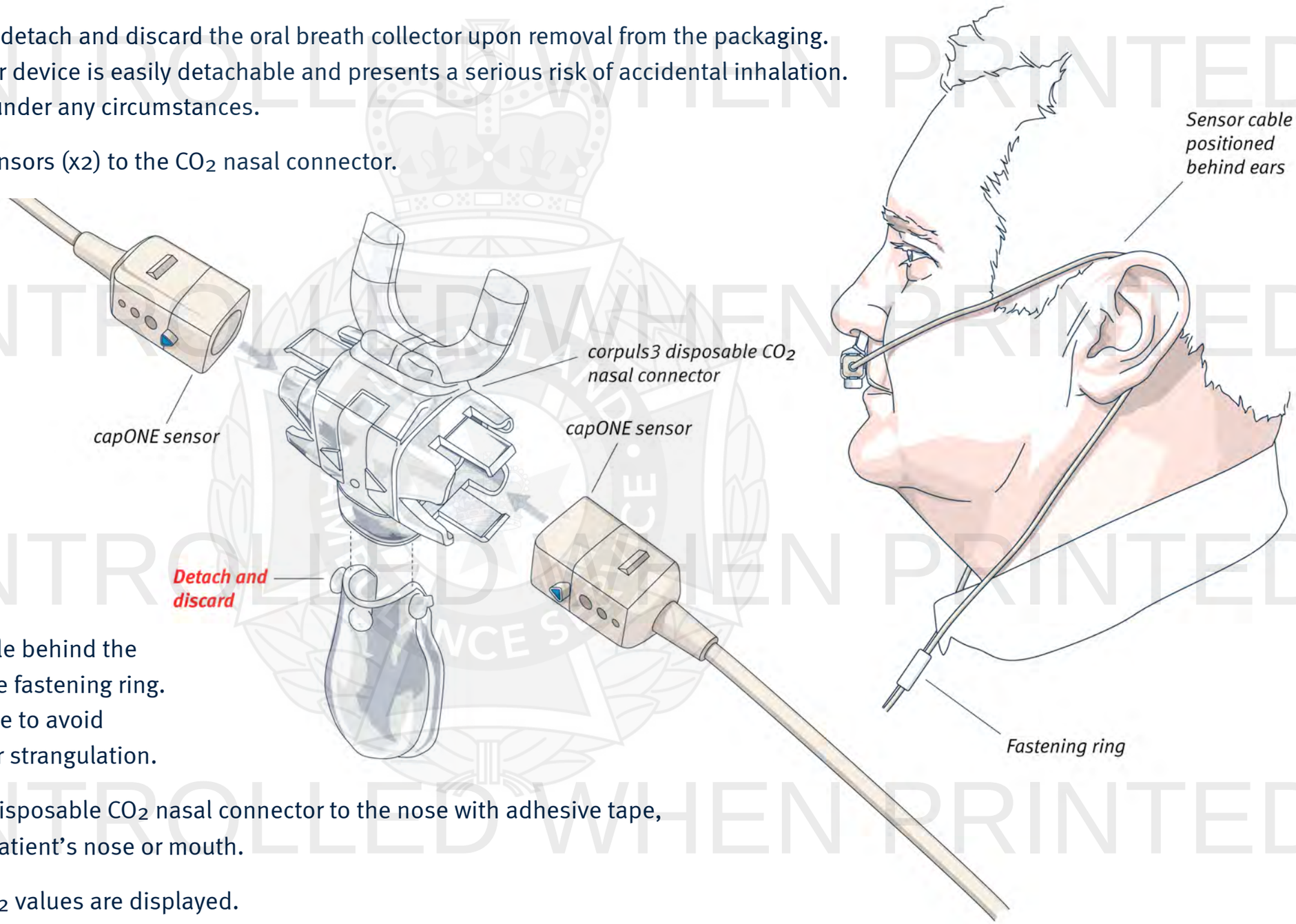


Procedure for corpuls3 in-line BVM/SAD/ETT capnography monitoring[1]

1. Remove the corpuls3 disposable CO_2 in-line connector from its package.
2. Attach the in-line connector to the breathing circuit. Ensure that a bacterial/viral filter is positioned between the connector and the airway adjunct (mask/SAD/ETT).
3. Connect the capONE sensors (x2) to the CO_2 in-line connector. Ensure all cables are free to avoid patient entanglement or strangulation.
4. Confirm appropriate CO_2 values are displayed.

Procedure for corpuls3 nasal capnography monitoring

1. Remove the corpuls3 disposable CO_2 nasal connector from its package.
2. If present, immediately detach and discard the oral breath collector upon removal from the packaging. The oral breath collector device is easily detachable and presents a serious risk of accidental inhalation. This must not be used under any circumstances.
3. Connect the capONE sensors (x2) to the CO_2 nasal connector.

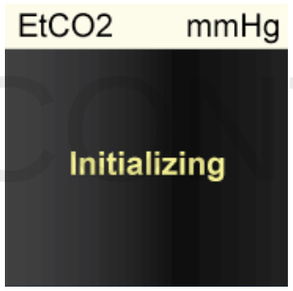


4. Position the sensor cable behind the ears and gently slide the fastening ring. Ensure all cables are free to avoid patient entanglement or strangulation.
5. Consider securing the disposable CO_2 nasal connector to the nose with adhesive tape, without occluding the patient's nose or mouth.
6. Confirm appropriate CO_2 values are displayed.

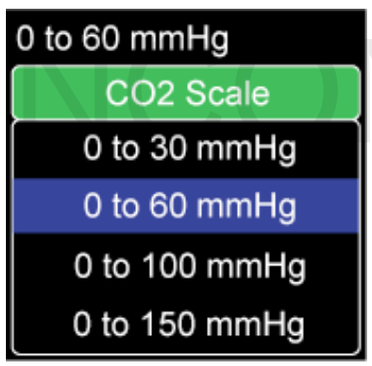
Procedure for ZOLL X Series® and X Series Advanced® in-line BVM/SAD/ETT capnography monitoring[1]

1. Remove the ZOLL X Series® or X Series Advanced® disposable CO_2 in-line connector from its package.
2. Open the CO_2 tubing connector door and connect the $EtCO_2$ sample tube by turning the tubing clockwise.
3. On the monitor, press the **CO_2 button** 

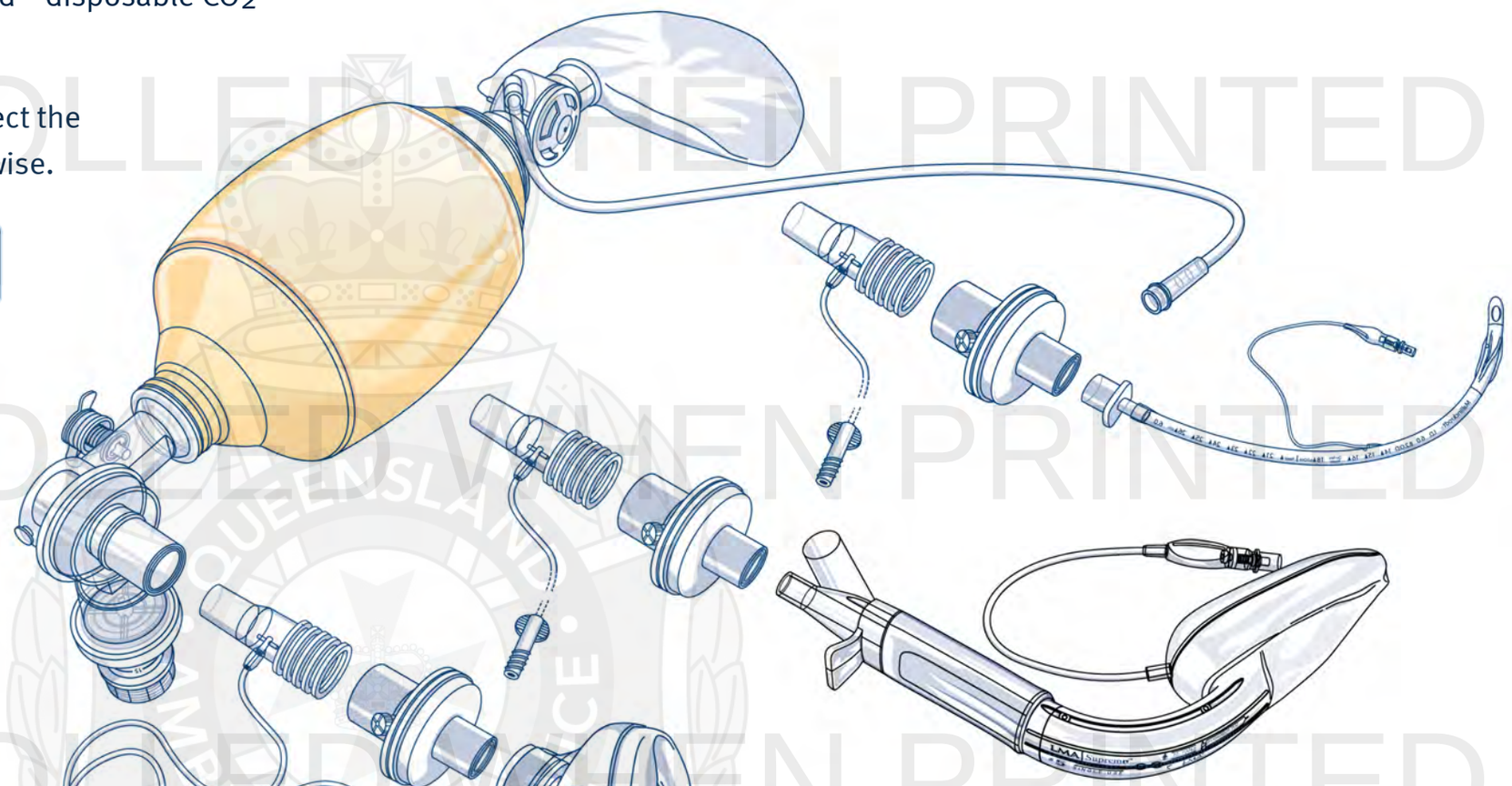
and the $EtCO_2$ will initialise *(see below)*.



4. Attach the in-line connector to the breathing circuit. Ensure that a bacterial/viral filter is positioned between the connector and the airway adjunct (mask/SAD/ETT).
5. Confirm appropriate CO_2 values are displayed. If required, change the CO_2 scale by using the  and keys.

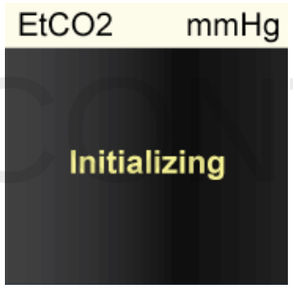


6. Ensure all cables are free to avoid patient entanglement or strangulation.

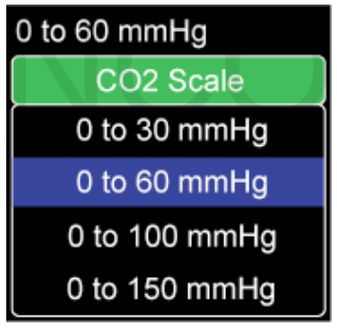


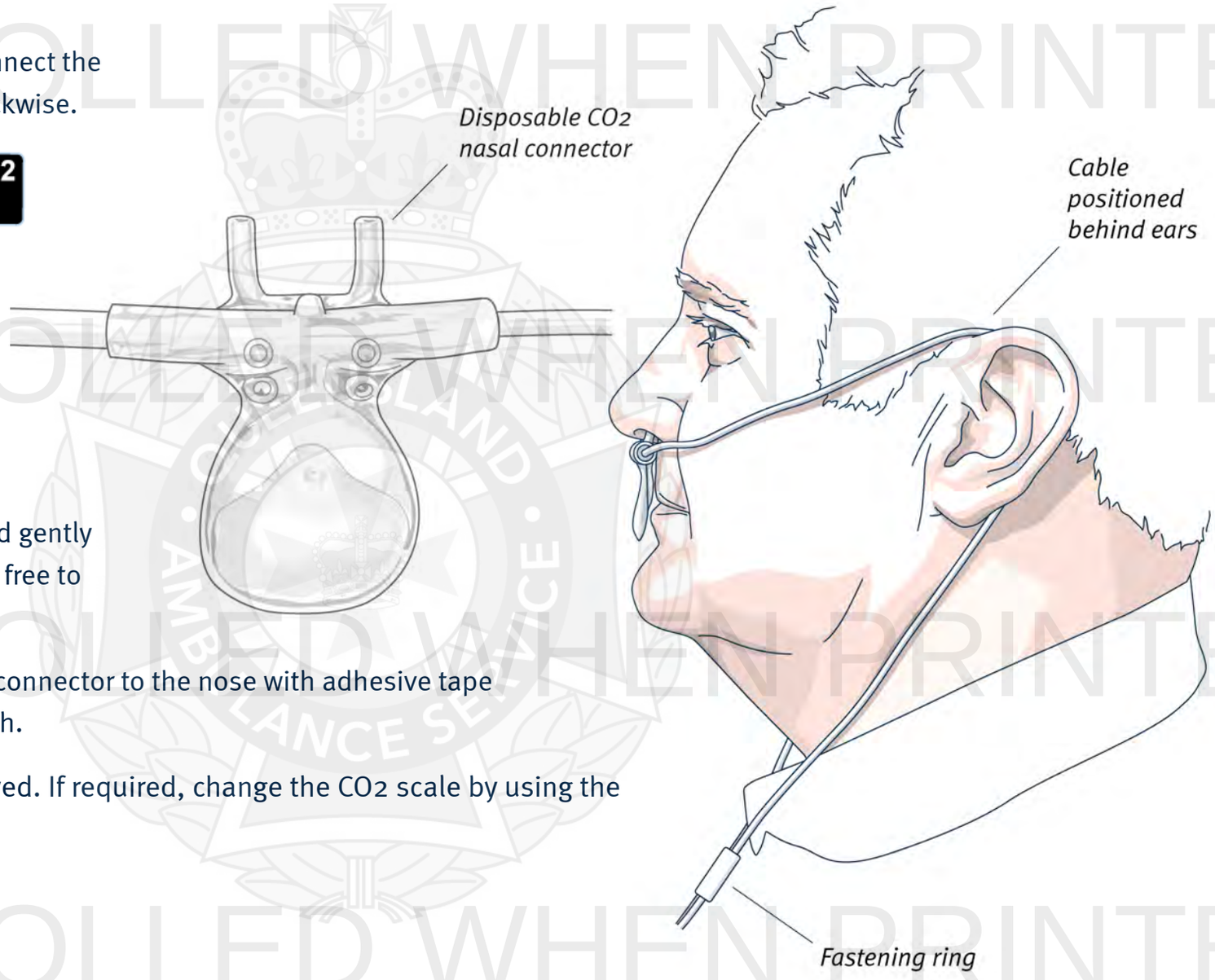
Procedure for ZOLL X Series® and X Series Advanced® nasal capnography monitoring

1. Remove the ZOLL X Series® or X Series Advanced® disposable CO_2 nasal connector from its package.
2. Open the CO_2 tubing connector door and connect the $EtCO_2$ sample tube by turning the tubing clockwise.
3. On the monitor, press the **CO_2 button** CO2 and the $EtCO_2$ will initialise *(see below)*.



4. Position the sensor cable behind the ears and gently slide the fastening ring. Ensure all cables are free to avoid patient entanglement or strangulation.
5. Consider securing the disposable CO_2 nasal connector to the nose with adhesive tape without occluding the patient's nose or mouth.
6. Confirm appropriate CO_2 values are displayed. If required, change the CO_2 scale by using the and keys.

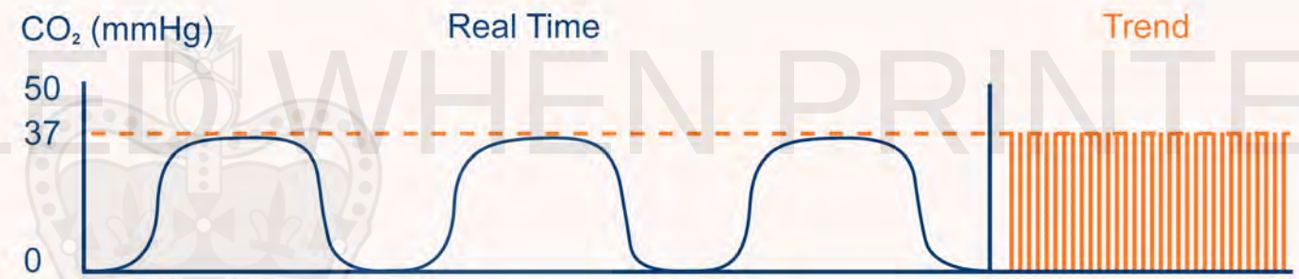




Additional information

- In cardiac arrest, tracheal placement of the ETT must be confirmed using capnography. If there is a complete absence of $EtCO_2$ (or if the capnography device becomes unserviceable) the ETT must be removed, and the failed intubation algorithm must be commenced.[3,4]
- In non-cardiac arrest situations, tracheal placement of the ETT must be confirmed and monitored continually with capnography. If the capnograph indicates that tracheal placement cannot be confirmed, the ETT must be removed and the failed intubation drill must be commenced.[4,6]
- In situations where IPPV is provided without an ETT, (i.e. when using a BVM or SAD), capnography is highly desirable and should be connected as soon as other urgent priorities allow.[7]
- QAS clinicians must be familiar with the operating instructions, with particular attention to warnings, alarms and troubleshooting.
- Corpuls3, ZOLL X Series® and X Series Advanced® $EtCO_2$ connectors are single-patient use only, and must be disposed of appropriately after use.

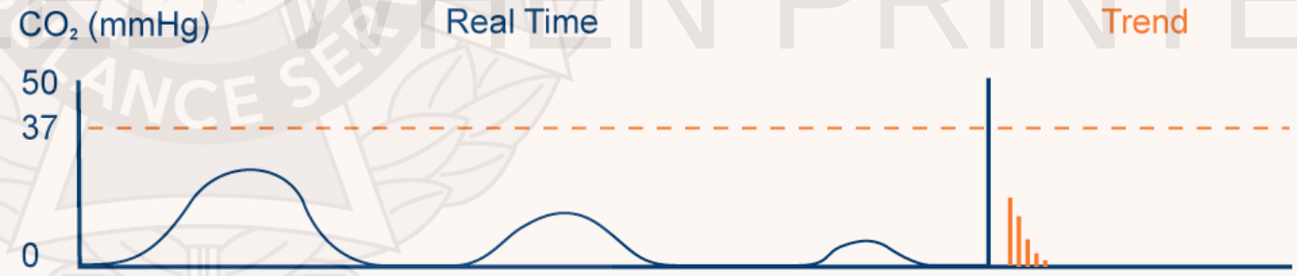
Normal capnography



A normal capnograph is present when the patient:

- *is spontaneously breathing or adequately ventilated*
- *has normal cardiac output*
- *has normal metabolic function*

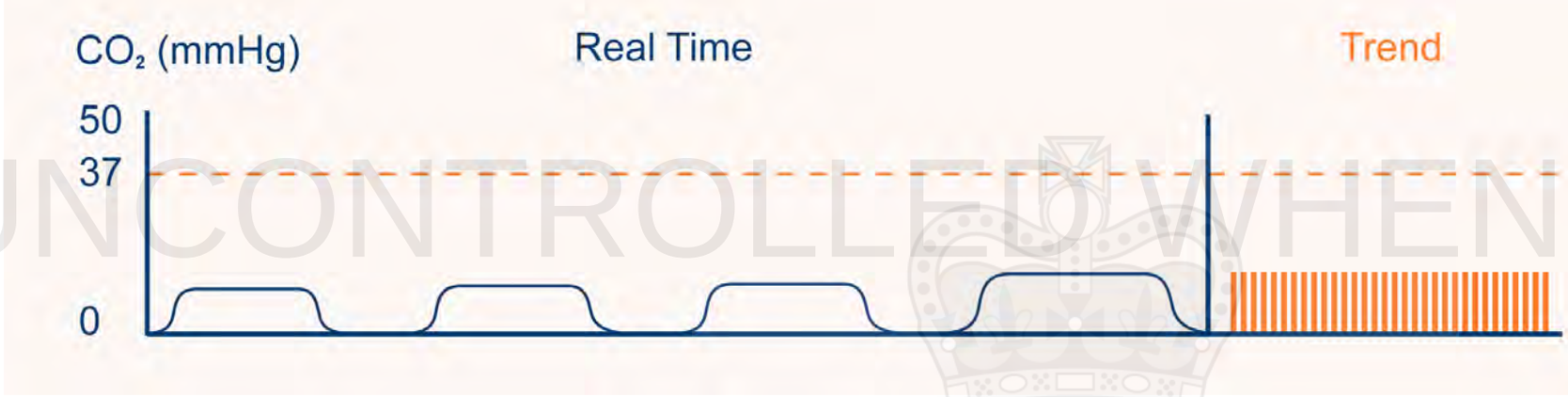
Endotracheal tube in the oesophagus



Oesophageal intubation may be confirmed by:

- *an absence of waveform and $EtCO_2$*
- *small transient diminishing waveforms*

Reduced $EtCO_2$ levels



Possible causes:

- *shock*
- *pulmonary embolus*
- *effective CPR being performed during cardiac arrest*

Sudden significant increase in $EtCO_2$

Possible causes:

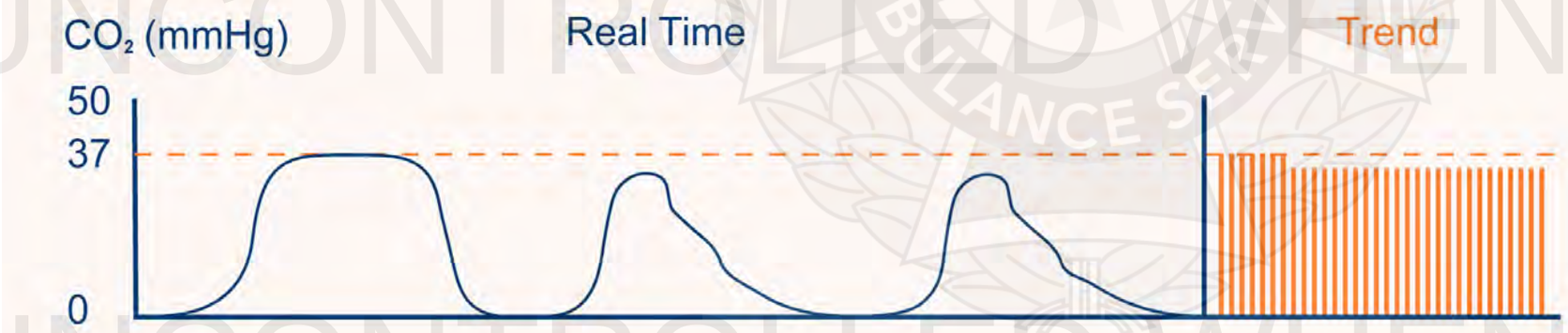
- *return of spontaneous circulation*

Absent EtCO2 levels and waveform

Possible causes:

- *no metabolic activity*
- *no CPR in cardiac arrest*
- *exsanguination / profound shock*

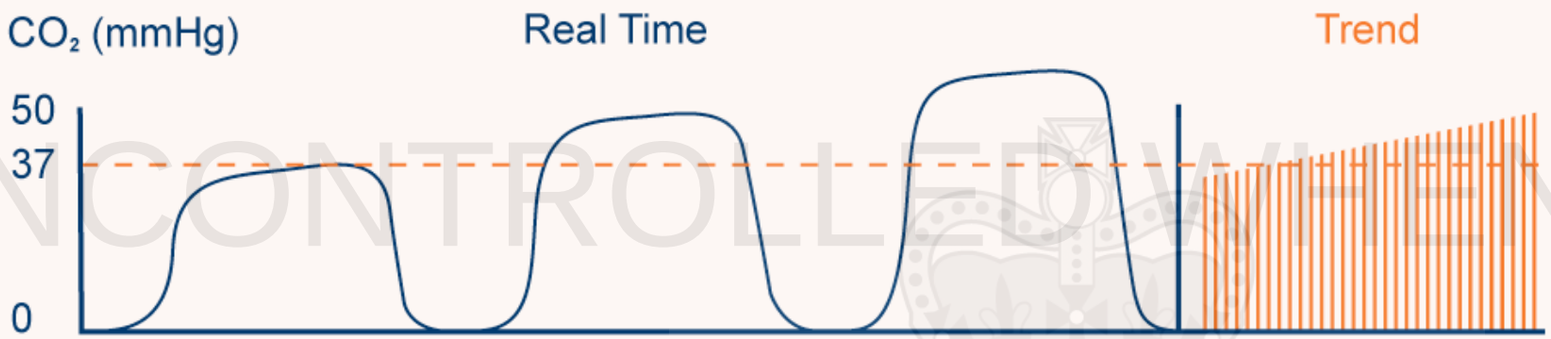
Inadequate seal around endotracheal tube



Possible causes:

- *a leaky or deflated endotracheal or tracheostomy cuff*
- *an artificial airway that is too small for the patient*

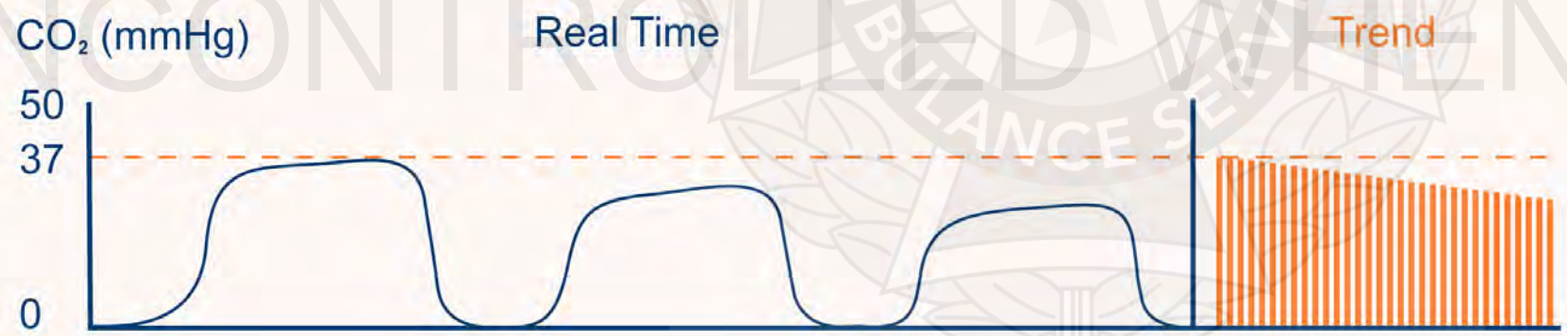
Increased $EtCO_2$ levels from normal



Possible causes:

- *respiratory depression/failure*
- *inadequate respiratory rate and/or tidal volume*
- *increased CO_2 production through increased metabolic rate or temperature or reperfusion of ischaemic tissue*

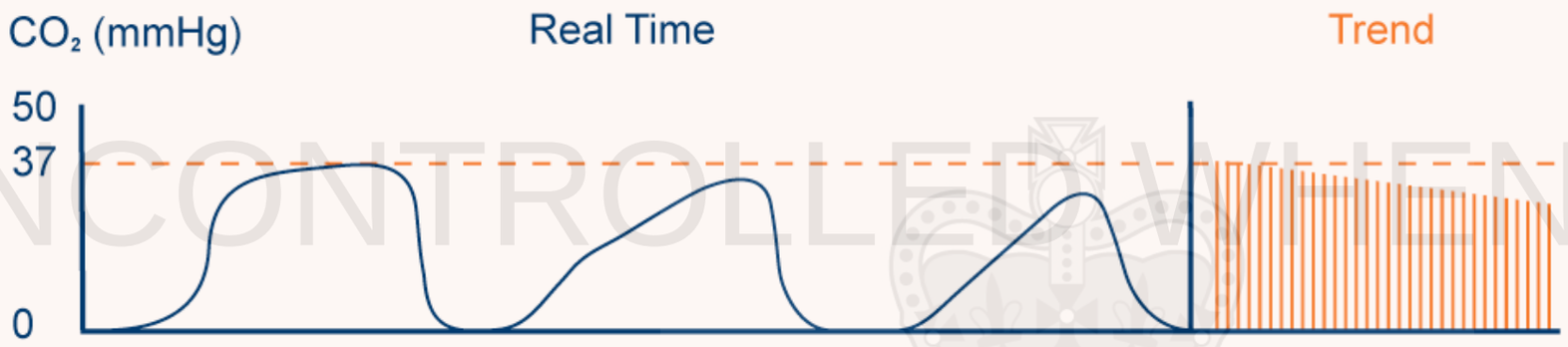
Decreased $EtCO_2$ levels from normal



Possible causes:

- *inadequate respiratory rate and/or tidal volume*
- *diminished CO_2 production through decreased metabolic rate*
- *falling cardiac output*

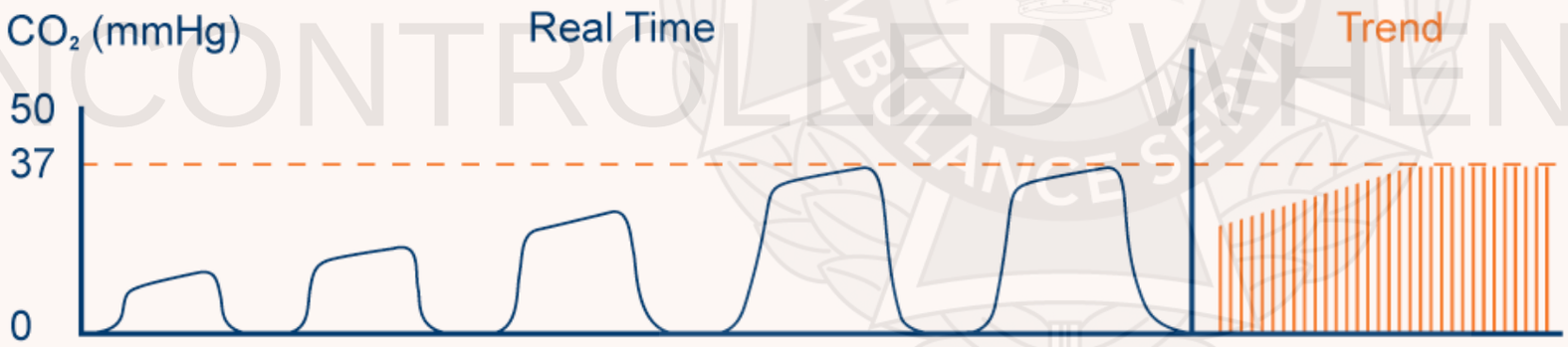
Obstruction in breathing circuit or airway



Possible causes:

- *obstruction in the expiratory breathing circuit*
- *presence of a foreign body in the upper airway*
- *partially kinked or occluded artificial airway*
- *bronchospasm*

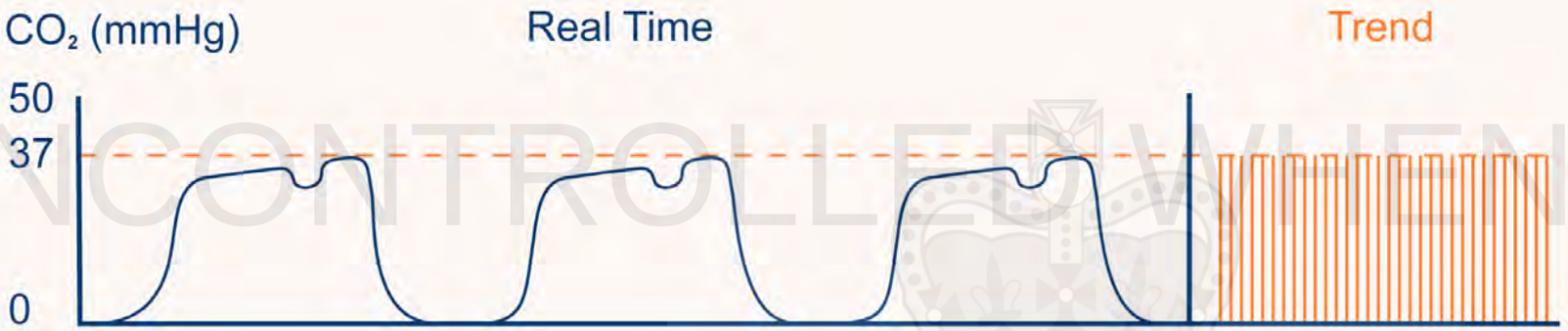
Increased $EtCO_2$ values towards normal



Possible causes:

- *restoration of normal respiratory rate and/or tidal volume*
- *cardiac output improved*
- *improved integrity of airway seal (BVM/SAD/ETT)*

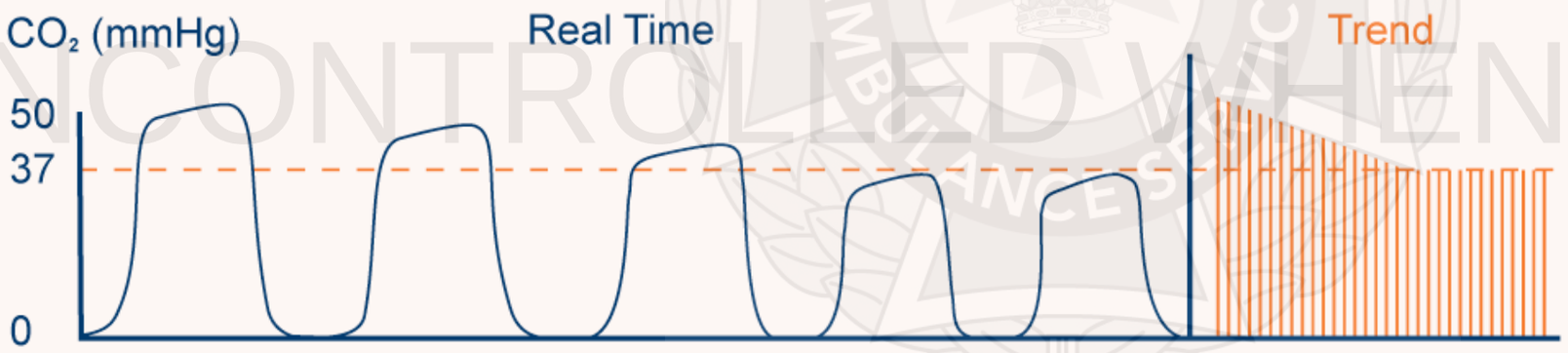
Curare cleft



Possible causes:

- *inadequate or 'lightening' of paralysis*

Decreasing $EtCO_2$ levels towards normal



Possible causes:

- *restoration of normal metabolism/CO_2 production*
- *normalised respiratory rate and/or tidal volume*