End Tidal CO₂ Measurements with Non-Invasive Ventilation

Non-invasive ventilation (NIV) is an emerging application for the use of capnography. Important applications include monitoring the effectiveness of CO₂ removal, maintaining adequate ventilation, airway management, and CO₂ re-breathing. NIV is delivered by a nasal or face mask, therefore eliminating the need for intubation or tracheostomy.

NIV is frequency driven by a bilevel positive airway pressure (BiPAP) or bilevel ventilator) device, or a continuous positive airway pressure (CPAP) device. CPAP is primarily used to maintain a patent airway and improve oxygenation, while BiPAP is initiated if CO₂ elimination needs to be improved. The experience is limited in monitoring EtCO₂ during NIV, but there is a clear understanding that this could offer important clinical information to rapidly maximize CO₂ elimination and decrease work of breathing.

To understand the technical aspects of end tidal CO₂ (EtCO₂) in the non-invasive ventilation (NIV) patient. A laboratory study was conducted to compare simultaneous EtCO₂ data from three different sample sites with commonly used patient interfaces, NIV modes, and varying patient leak rates.

The protocol included both CPAP and BiPAP modes at different pressures, patient leak rates (PL) and patient interfaces. EtCO₂ was recorded from the following three sites simultaneously: Nasal/oral cannula (NO), mask sample port (SP), mask and ventilator circuit connection (MC).

Results for EtCO₂ minute ventilation, and leak rate were recorded at each ventilator setting as described in the protocol. For each patient interface the following protocol was used on a normal subject.

Two ventilation modes: CPAP and Spontaneous Timed (BiPAP)

Standard pressure settings: CPAP – 5 and 10 cm H₂O BiPAP – EPAP of 5, IPAP of 10 and 15 cm H₂O

Two leak levels at each pressure setting: Optimal, best clinical setting; High, higher than optimal clinical setting.

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Methods

Two commonly used ventilator settings and patient leak rates.

Results

The data revealed there were significant variations in EtCO₂ results at the different sample sites. The nasal/oral (NO) sample site was very consistent throughout all settings and patient leak rates. In the ST mode the nasal/oral (NO) sample site was more reliable for appropriate EtCO₂ readings at different ventilator settings and patient leaks.

Equipment

- Ventilator: BiPAP
- Vision® (Respironics)
- Capnograph: Microcap® (Oridion)
- Sample Lines:
  - Nasal/oral sampling - Smart CapnoLine® H Plus (Oridion)
  - Mask port - FilterLine® (Oridion)
  - Mask connection - Microstream® Airway Adapter (Oridion)

This second graph shows the relationship between ETCO₂ and minute ventilation (solid line) at different patient leak rates.

Conclusion

The sampling site for CO₂ in NIV can greatly influence the reliability of the ETCO₂ value. The nasal/oral (Smart CapnoLine H Plus) sample line proved to be the most reliable in trending ETCO₂ with different ventilator settings and leak rates in the normal patient.