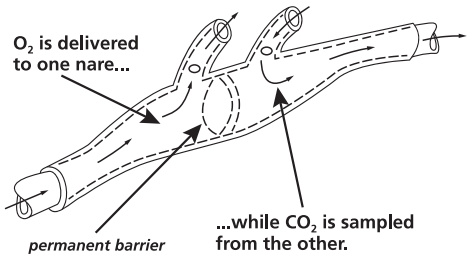
Accurate Capnography Highly Dependent on a Quality Sampling Line

A key to obtaining an accurate $etCO_2$ measurement and quality waveforms with any capnograph is the sampling line. Measurement technology can only report what is being delivered, so if the sampling line is not providing a representative CO_2 sample, the accuracy of the measurement is impacted.

CO_2 Sampling

The design of various exhaled CO_2 sampling lines varies significantly. A common design is to split sampling and oxygen delivery between the two nares, delivering oxygen to one nostril while sampling CO_2 from the other. This design may be limited in sampling and/or oxygen delivery in cases where one or both nares are blocked (e.g., deviated septum, sinus congestion, NG tubes, etc.).



In addition, oral sampling methodologies vary significantly. Many designs are nasal sampling only which could lead to obvious problems when the patient is a mouth breather. Mouth breathing is common when patients are in respiratory distress or while under sedation, two common scenarios for monitoring $etCO_2$. Most CO_2 sampling lines with oral sampling are designed with a single small tube that extends over the mouth.

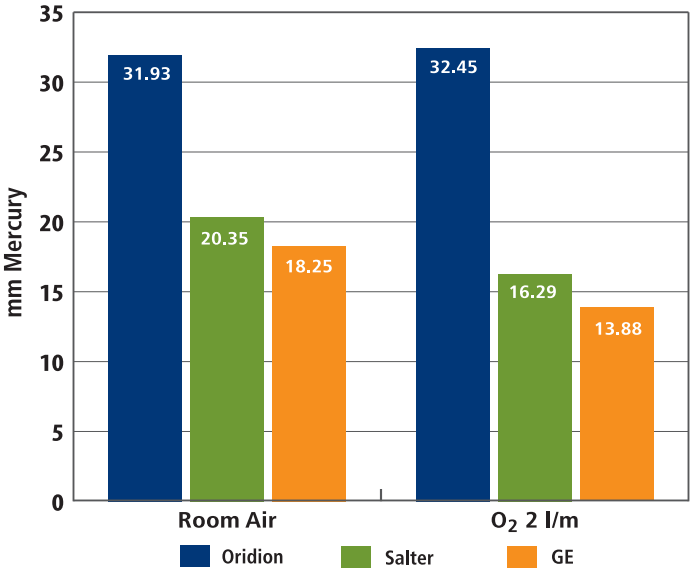
The Microstream® Smart CapnoLine® patient sampling line is designed with a patented Uni-junction™ technology and an oral scoop to obtain a quality sample of exhaled gas from either nare or the mouth.

The Smart CapnoLine patient sampling line is engineered to obtain a quality sample whether the patient is breathing from one or both nares, orally, or switching back and forth between nasal and oral breathing. The Uni-junction design senses pressure from each breath, causing only the source of breath (i.e. oral, nasal) with the greatest pressure to be sampled. The oral scoop is intended to optimally sample breath when the patient is mouth breathing. Increased surface area provides greater sampling accuracy in the presence of low tidal volumes.

In testing on 29 healthy patients, the Smart CapnoLine patient sampling line O_2 Plus, Salter Labs Oral-Trac™, and GE Medical systems CapnoFlex LF CO_2 Accessory were compared for accuracy during oral breathing.[1] All three are designed for oral/nasal sampling. The mean $etCO_2$ measurements across all participants during mouth breathing while on room air and on oxygen at 2 l/m are shown below (Figure 1).

While each of the devices showed statistically equivalent values during nasal breathing, the Salter Labs and GE Medical devices showed dramatically lower measurements during mouth breathing. Comparing Hodges-Lehmann interval to the equivalence bounds for each of the three oral-nasal devices demonstrates that only the Smart CapnoLine O_2 Plus patient sampling line showed equivalent mouth to nose breathing results at equivalence bounds of Δ=15%. For both Salter Labs Oral Trac and GE Medical Oral Nasal Accessory, equivalence could not be demonstrated even at equivalence bounds of Δ= 20%, both having far lower mouth than nose breathing results.

Figure 1: Mouth Breathing $etCO_2$ Measurement

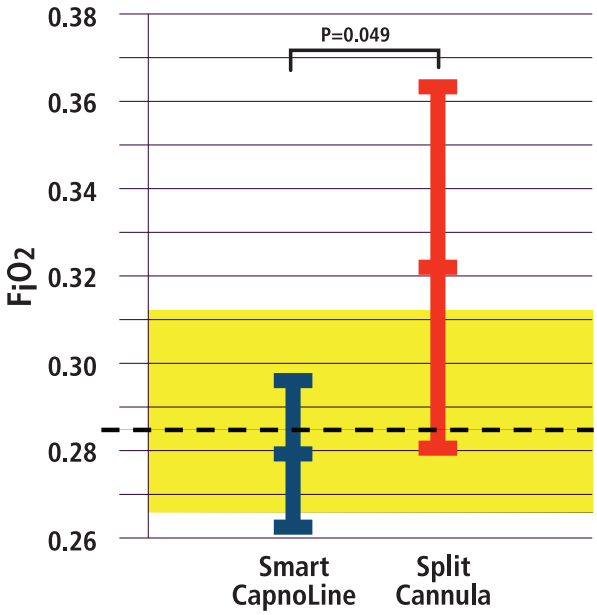


Oxygen Delivery

Likewise, the Smart CapnoLine® patient sampling line is designed to deliver oxygen to both nares and orally by producing an "oxygen cloud" in front of the nose and mouth. This is achieved with a series of small holes at the base of the nasal prongs and oral scoop that deliver oxygen. This design is also intended to minimize attenuation of the CO_2 sample by oxygen dilution.

In a study comparing two oxygen delivery designs, subjects were studied using oxygen delivery at 2.5 l/m using the CapnoLine® patient sampling line or Salter Labs split design.[2] The fraction of inspired oxygen (FiO_2) in the posterior pharynx was monitored. The results showed that the pharyngeal FiO_2 of the Smart CapnoLine patient sampling line is not different from the anticipated FiO_2 predicted from standard references and from the common FiO_2 calculation. The delivery of oxygen via the Smart CapnoLine patient sampling line provided a more consistent FiO_2 and was significantly different, as compared to a traditional split design at 2.5 l/m (Figure 2).

Figure 2: FiO_2 Consistency During O_2 Delivery at 2.5 lpm



Pharyngeal FiO_2 at 2.5 LPM Flow (shown Mean ± 95%CI).
Blue = Smart CapnoLine
Red = Split Cannula
Dashed = "Expected 0.285" value from calculation
Yellow = Range Mean ± 95% CI

Derived from Schacter et al, Crit Care Med 1980 – as used in Egan, Fundamentals of Respiratory Care 6th Ed.

Summary

When monitoring $etCO_2$, there are significant differences in the performance of different designs, both in CO_2 sampling and oxygen delivery. It is important to ensure that the sample line being used provides a quality sample of exhaled gas and delivers a consistent level of oxygen.

References

1. Colman Y, David U. Comparison of Capnography Filter Lines for Nose and Mouth Breathing of End Tidal Carbon Dioxide Sampling With and Without Supplemental Oxygen. STA Annual Meeting Abstracts, January 2009
2. Dungan G, Colman J, Lain D. Evaluation of oxygen delivery via a novel smart CapnoLine delivery system during simultaneous oxygen therapy and carbon dioxide monitoring. Presented at the Society for Technology in Anesthesia 2012 Conference, Palm Beach, FL.

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