



NEW TRENDS IN CAPNOGRAPHY

By Stephanie Richardson

Just over a year ago, consulting firm Frost & Sullivan issued a report stating that the capnography equipment market is positioned to grow by more than 5 percent annually due to the increased need of patient monitoring outside of operating rooms. In 2006, North American capnography revenues tallied up to \$71.2 million, and it is estimated that will increase to \$108.4 million by 2013.

Although capnographs are primarily used in ORs to detect end-tidal carbon dioxide levels, other hospital areas such as emergency rooms, critical care units, post-anesthesia care units, recovery rooms, intensive care units, and labor and delivery rooms are beginning to use these devices, too. The Frost & Sullivan report called upon manufacturers to increase their investment in research and development to expand the scope of capnography applications outside the OR and provide more portable and accurate devices.

Multi-parameter monitors in pre-hospital care

The ability to measure EtCO₂ concentration through capnography gives pre-hospital care providers such as emergency medical technicians useful information about ventilation and perfusion.

Endotracheal intubation is a common lifesaving procedure that must be managed properly in the pre-hospital setting. Unrecognized

esophageal intubation can result in catastrophic hypoxia, which is a major cause of morbidity and mortality. Capnography is a superior way to detect endotracheal intubation, and combination capnography is useful during this procedure.

Multi-parameter capnography has been proven to successfully detect ET tube placement verification. Multi-parameter monitors can provide waveform trend data, detect breathing irregularities and monitor procedural sedation monitoring. Devices utilizing sidestream design allows clinicians to use capnography with intubated and non-intubated patients.

Common features of multi-parameter capnography devices that are used in the field include:

- Measures EtCO₂, inspired CO₂, respiration rate, SpO₂ and heart rate
- Four-hour waveform trending
- Handheld device as light as 2 pounds.
- Single-use, disposable filters
- Rechargeable lithium ion battery with 8-hour use life
- Sample flow rates as low as 50 mL/min
- Full-feature capnography previously limited to full-size monitors.

Capnography also can be used to gauge the efficacy of cardiopulmonary resuscitation in the pre-hospital theater. EtCO₂ has been shown to correlate to cardiac output, coronary perfusion pressure, efficacy of cardiac compression and survival. Additionally, EtCO₂ could be potentially useful in determining when to terminate CPR.

During cardiac arrest, EtCO₂ levels quickly fall to low levels and increase following effective CPR. Initial EtCO₂ readings have shown to be markedly elevated and then decrease to low levels during CPR finally increasing at spontaneous circulation. This is because carbon dioxide accumulates in the lungs after respiratory arrest and before to cardiac arrest.

A measurement of at least 10 mm HG EtCO₂ in the first 20 minutes of CPR has been associated with the time for return of spontaneous circulation. EtCO₂ of 10 mm HG or less at 20 minutes predicted death and concluded that CPR could be reasonably terminated.³

Microstream in critical care

Improvements in capnography technology are allowing critical care providers a more accurate way of measuring end-tidal CO₂ in critical care patients. While mainstream and sidestream capnography have shown fundamental limitations in the



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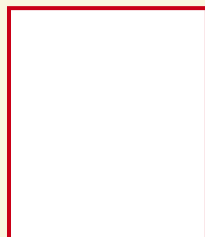
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past, newer microstream capnography helps clinicians overcome those drawbacks.

Microstream technology offers clinicians the flexibility to monitor intubated and non-intubated patients in all patient populations (neonates through adults). It is capable of measuring EtCO₂ in patients with high respiration rates and low tidal volumes. It operates in low- to high-humidity environments, at the bedside or in transport. Microstream devices also offer improved moisture handling to eliminate problems caused by clogged sample lines.

Microstream technologies offer some of the following benefits to critical care providers:

- Sample flow rates as low as 50 mL/min
- Quick response time
- Clear waveforms
- Moisture handling with an integrated water separation filter in each connector
- Multi-port airway adapter design
- No cross-sensitivity to other gases
- No routine calibration.

Often microstream technology is available as an add-on package for capnography. These extensions can provide real-time waveform and numeric values for CO₂. They are lightweight, plug-and-play accessories that attach to the bedside monitor. During transport, the unit stores patient demographics and up to eight hours of patient trend data, as well as calibration and measurement settings.

One area where microstream capnography has made inroads is in the NICU. Traditionally, EtCO₂ monitoring proved difficult in this population because of their small tidal volumes and high respiratory rates. However, with low-flow sampling rates, microstream devices can monitor EtCO₂ in most neonates and children. To reduce sample flow to as low as 50 mL/min for neonates, microstream capnographs combine small diameter filters with a low measuring cell volume with an efficient CO₂ sensor. It also should be noted that the ability to detect low flow rates is more reliable for ETCO₂ sampling when nasal cannulas are used for non-intubated children.

Patient safety in anesthesia

Patients receiving controlled anesthesia and resting in post-anesthesia units can benefit from continuous CO₂ monitoring. Additionally, the American Society of Anesthesiologists requires continual monitoring for the presence of EtCO₂ for all patients receiving general anesthesia.

In 2006, the American Patient Safety Foundation set a goal that no patient should be harmed by ventilatory depression following surgery requiring anesthesia. The APSF urged health care providers to improve patient safety with continuous monitoring of oxygenation and ventilation in individuals receiving post-operative patient-controlled anesthesia.

As a result, some capnography manufacturers responded by integrating microstream technology into devices suited for anesthesia units. These monitors allow clinicians to simultaneously measure ventilation, EtCO₂ and true respiratory rate. Studies have indicated that capnography indicates a change in a patient's breathing status earlier than measuring with pulse oximetry alone.

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