Physio-Control Waveform EndTidal CO\textsubscript{2} (ETCO\textsubscript{2})

With the deployment of waveform end-tidal CO\textsubscript{2} in the Physio Control Lifepak 12, a number of operational issues have been raised. The purpose of this memo is to clarify some of these issues:

Q: All this technology is confusing; it takes our attention off the patient and focuses it on the device.

A: Agreed. Like any new technology, an overemphasis on the device may occur. MCEMS would like to stress that attention to the patient first, remains the highest priority. The device only assists your assessment; it does not take the place of the assessment. We would urge you to continue to evaluate the airway as you have been doing (i.e., 5-point check etc) and secure the airway. When you are convinced that the airway is in the correct location, you should utilized the end-tidal CO\textsubscript{2} monitor like you currently use the colorimetric device.

Q: What real value is the end-tidal CO\textsubscript{2} device? I was pretty happy with the colorimetric device.

A: The waveform end-tidal CO\textsubscript{2} device has two distinct advantages. In contrast to the colorimetric device, which provides only single point (i.e., one time) evaluation, this provides continuous monitoring of the CO\textsubscript{2} production of the patient. Because it is continuous, the waveform CO\textsubscript{2} enables the paramedic to detect a dislodged ET tube minutes before you note a change in the oximeter. Secondly, the waveform device provides quantitation of CO\textsubscript{2}, which directly correlates with cerebral perfusion (i.e., if too low CO\textsubscript{2} < 35, cerebral perfusion becomes impaired). This is critical in head injury patients or any other patients who have signs and symptoms of increased intracranial pressure.

Q: What clinical presentations require use the end-tidal CO\textsubscript{2} monitor?

A: Effective January 15, 2004, MCEMS will use ETCO2 on both awake and intubated patients. Please see MCEMS ETCO2 protocol for details.

Q: Should we use this device in cardiac arrest patients?

A: Yes. MCEMS was responsible for some of the confusion on this matter. The scientific literature on the utility of End-Tidal CO\textsubscript{2} in cardiac arrest is in its infancy. One of the primary challenges is to determine the location of the ET tube during cardiac arrest. MCEMS believes that the waveform end-tidal CO\textsubscript{2} can be helpful in this matter.

We suggest that the following decision tree be used:

- Cardiac arrest
- Perform 5-point check
- Apply esophageal detector device (EDD)
- Apply end tidal CO\textsubscript{2} detector
- If good waveform, tube is in correct location

If no waveform, recheck location of the tube by either manually re-visualizing the cord.

Q: Once we are assured that the ET tube is in the correct location, is there any other reason to use the End-Tidal CO\textsubscript{2} detector in cardiac arrest patients?
A: Yes, there is scientific literature to suggest that the End-Tidal CO2 is good at determining whether rescuers are obtaining perfusion during CPR. However, at this time, there is insufficient literature to suggest that if one does not get adequate end-tidal CO2 during the arrest, discontinuation of resuscitation should occur. Thus, continuation of the cardiac arrest sequence should not be changed in spite of any end-tidal CO2 value at this time.

Q: Should we use the End-Tidal CO2 with the Combitube?

A: Yes, all Combitube placements must use the end-tidal CO2 as well. If the rescuer does not obtain an adequate reading, the EMT/paramedic should recheck the location with the 5-point check. If there is still sufficient doubt, the other port of the Combitube should be checked with the end-tidal CO2 monitor. If still sufficient doubt and no reliable end-tidal CO2 (i.e., good waveform) is obtained from either port, the Combitube should be removed and the patient ventilated with BVM.

Q: What values and settings should we be watching for with this device?

A: Please see your protocol. You will need to make sure you get a good waveform, and a reliable reading from the peak value of the end-tidal CO2. You should attempt to keep the end-tidal CO2 between 35 to 40 in all patients except severe head injury patients who either are posturing or have a “blown pupil”. In that case, keep the values between 30 to 35.

Q: How should we chart the results of the end-tidal CO2 monitor?

A: The device will actually print out the results. You should chart the following: the waveform is good and end-tidal maintained between 35 to 40.

**Esophageal Detector Devices (EDD)**

Q: Why all the fuss? All of our tubes are always in the “right place.” The 5-point check always works.

A: While we would like to think so, there are situations where determining the tube location is very difficult. An example is a very, very large patient (i.e., > 150 kg) where breath sounds are difficult to hear. Another example is the patient who has aspirated and the ET tube contains copious amounts of vomit etc. The following article illustrates some of the concerns on a national level.

_This issue has recently had “national attention due to the article by Katz SH, Falk JL. Misplaced endotracheal tubes by paramedics in an urban: emergency medical services system. Ann Emerg Med. January 2001;37:32-37._

Results: A total of 108 intubated patients were studied. On arrival in the ED, 25% (27/108) of patients were found to have improperly placed endotracheal tubes. Of the misplaced tubes, 67% (18/27) were found to be in the esophagus, whereas in 33% (9/27), the tip of the tube was found to be in the hypopharynx, above the vocal cords. Of the patients with misplaced tubes noted in the hypopharynx, 33% (3/9) died while in the ED. For the patients found to have tubes in the hypopharynx, 56% (5/9) had evidence of ETCO2 on ED arrival. For the patients found to have esophageal tube placement on ED arrival, 56% (10/18) died in the ED. Esophageal intubation was associated with an absence of expired CO2 (17/18, 94%) on ED arrival. The single patient in this subset with a recordable ETCO2 had been nasotracheally intubated with the tip of the endotracheal tube noted in the esophagus while spontaneous respirations were present. On patient arrival to the ED, 63% (68/108) of the patients had direct laryngoscopy in addition to ETCO2 determination. All patients had ETCO2 evaluation performed on arrival. All patients in whom an absence of ETCO2 was demonstrated on patient arrival underwent direct laryngoscopy. In cases in which direct
laryngoscopy was not performed, the attending physician documented the ETCO2 in conjunction with the presence of bilateral breath sounds.

Conclusion: The incidence of out-of-hospital, unrecognized, misplaced endotracheal tubes in our community is excessively high and may be reflective of the incidence occurring in other communities. Data from other communities are needed to clarify the scope of this alarming issue.

Esophageal Detector Device (EDD)

Q: Why did we deploy this device? Is not the End-tidal CO2 good enough?
A: The end-tidal CO2 is clearly superior device in a patient with a pulse and respiration. However, in the setting of some cardiac arrest patient, the end-tidal CO2 has its limitations. This is where the EDD detector may play a significant role.

Q: How does the EDD work?
A: The principle is actually quite simple. The trachea due to the presence of tracheal rings is like a hollow but non-collapsible tube. In contrast, the esophagus is like a balloon, which can collapse in the presence of a vacuum. When a vacuum pressure is applied to a tube in the esophagus, the esophagus literally collapses around the ET tube and prevents air from being aspirated from the tube (bulb does not fill). In the trachea, the tracheal rings prevent this collapse and air is easily drawn back (bulb fills).

Q: What is the sensitivity and specificity of the EDD detector?
A: The sensitivity and specificity in various studies range from 99% to 100%.

Q: What happens if the End-tidal CO2 waveform differs from the EDD detector?
A: If this situation occurs and you get a good End-tidal CO2 detector, you should ignore the finding of the EDD detector (assuming other clinical signs showing proper placement are present (i.e. good 5 point check, positive oximeter etc)

Q: What is the procedure we should use for the EDD and the End-tidal CO2?
A: Due to the manufacturer requirements, the EDD detector should be applied first. The problem with ventilation with the End-Tidal CO2 is the air in the stomach (secondary to bagging) may result in a false positive result with the EDD detector. This device DOES NOT REPLACE THE FIVE POINT CHECK AND GOOD JUDGEMENT. It is used as an assessment aid in the determination of the tube.

Q: What should we do when the EDD detector shows that the tube is in the esophagus?
A: If the patient has a pulse, and your 5-point check results in good breath sounds, you should attach the end-tidal CO2 monitor. You should immediately recognize a “good waveform”. If there is no end-tidal CO2 detected and you do not get a good waveform, then you should immediately remove the tube.

If the patient is in cardiac arrest and your EDD is either equivocal or negative and you are not sure about the presence of breath sounds, you should reexamine and visually verify the location of the tube (i.e. look in the oropharynx to determine proper placement.

Q: If we use End-tidal CO2 in the setting of a patient with cardiac arrest, can we use the values to discontinue resuscitation?
A: The answer is no (at this time). While there is preliminary published studies that would suggest that in a patient suffering a cardiac arrest, an End-tidal CO2 detector value of less than 10 mm Hg has a dismal prognosis.