Advisory 22-04: LP15 Continuous $ETC0_2$ Monitoring

To: All ALS EMS Agencies and Providers

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Regional Medical Director

Date: May 25, 2022

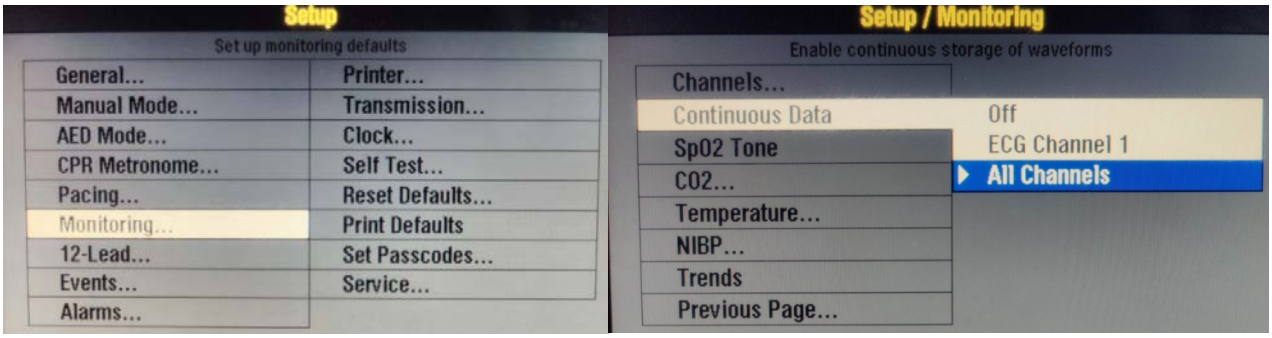
MLREMS Advisory 07-11 and ALS protocols require continuous waveform End Tidal Carbon Dioxide ($ETCO_2$) monitoring after placement of any advanced airway. A recent review by the Monroe-Livingston Regional Patient Safety and Quality Improvement Committee highlighted the need to be able to retrospectively review a monitor's continuous $ETCO_2$ waveform in addition to the static $ETCO_2$ numeric readings. While attempting to view a LP15's PCO file during this review, we have come to understand that the continuous waveform data is only captured if programmed by the user to do so and may not be set to capture this information on all LP15 monitors in our region.

Providers: When utilizing $ETCO_2$, you must display the $ETCO_2$ waveform (in either Channel 2 or 3 of the display screen) in order for the continuous data to be successfully captured. See attachment from the manufacturer.

Agencies: Please note that this issue requires immediate attention by your clinical team as numerous regional EMS agencies appear to be affected. Agencies should confirm the configuration of their LP15 enables continuous capnography data. The issue can be corrected by adjusting the setting in the monitor's configuration. For more information about this tool, see the LIFEPAK 15 monitor/defibrillator at www.physio-control.com.

To enter Setup mode:

1. With the device powered off, hold down OPTIONS and EVENT and press ON. Continue to press only OPTIONS and EVENT until the Setup / Enter Setup Mode Passcode menu appears.
2. Select Monitoring.
3. Select Continuous Monitoring and change from ECG Channel 1 to All Channels.



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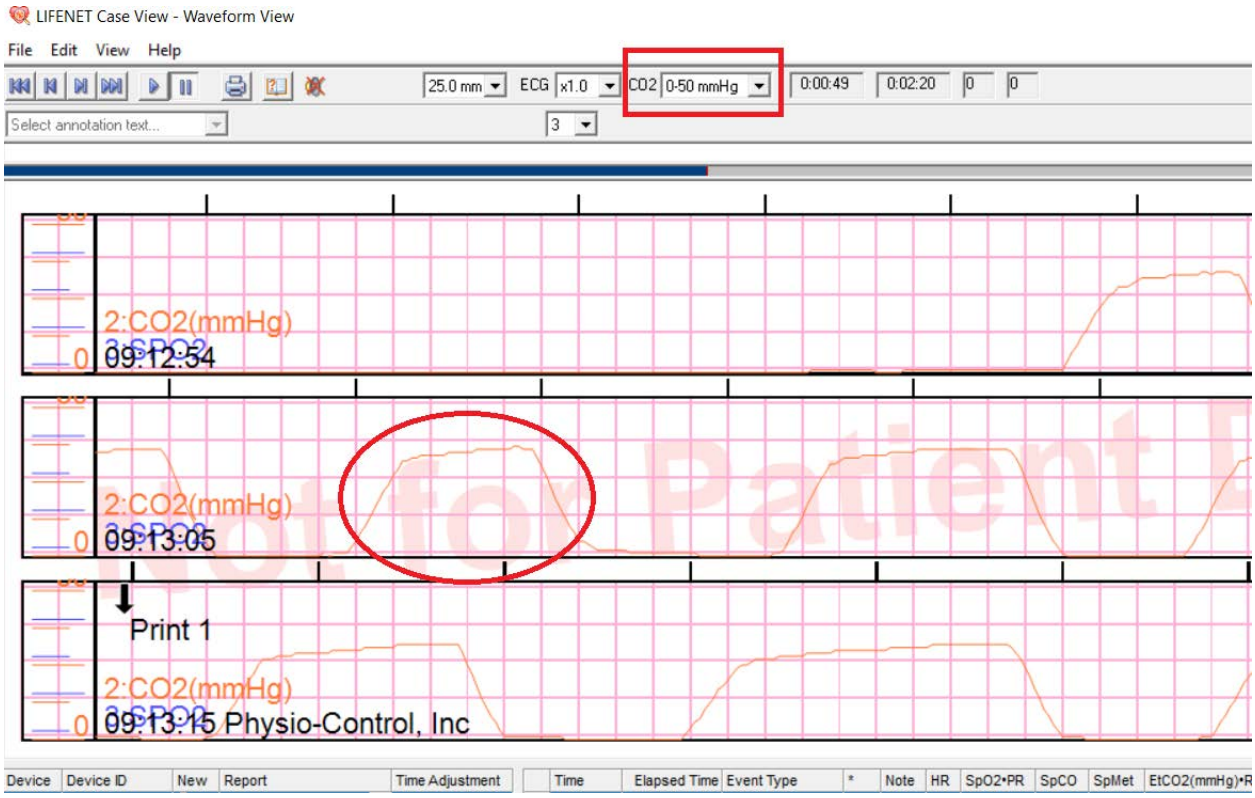
Once this configuration is complete, you will be able to view all of the data that is recorded by the LP15 with the LIFENET Case View. Seeing numeric $ETCO_2$ readings alone is not an indication that there is continuous waveform monitoring. However, the appearance of CO_2 as a red box indicates that $ETCO_2$ is present. You will then see the graphical waveform as indicated by the red circle in the image below.



We strongly encourage that you confirm your LP 15's monitors' ability to record and present the capnography waveform in the PCO file and not just the numerical value.

With any questions do not hesitate to contact this office.

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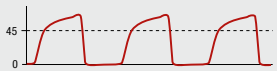
Examples of Waveforms

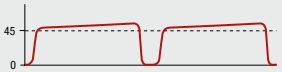
Plateau has curved, “shark-fin” appearance

- Bronchospasm
  - asthma
  - COPD



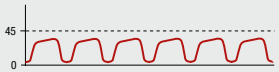
Slow rate with increased $EtCO_2$

- Hypoventilation
- Partial airway obstruction



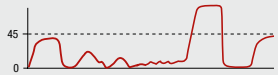
Rapid rate with decreased $EtCO_2$

- Hyperventilation
- Hypoperfusion



Decreased $EtCO_2$, variable waveform

- Intermittent apnea
- Patient is talking



CO_2 Detection

When CO_2 is not detected — waveform is either dashes “---” or flat solid line near bottom of scale — several factors must be quickly evaluated as possible causes:

Equipment issues

- Disconnection of the FilterLine set from the endotracheal tube (ETT)
- System is purging due to fluid in the patient/device connection from ET administration of medications, mucus or blood
- System is auto-zeroing
- Shock was delivered and system is resetting
- Loose FilterLine to device connection

Loss of airway function

- Improper placement of ETT
- ETT dislodgment
- ETT obstruction

Physiological factors

- Apnea
- Massive pulmonary embolism
- Exsanguination
- Inadequate CPR
- Loss of perfusion

Critical Points of Information

1. A waveform is displayed when any CO_2 is detected, but CO_2 must be > 3 mmHg (for LIFEPAK 12 devices) or > 3.5 mmHg (for LIFEPAK 15 and LIFEPAK 20e devices) for a numerical value to be displayed, and the CO_2 must be at least 8 mmHg for a valid breath and respiratory rate (RR) to be detected and the apnea alarm to function.
2. The CO_2 waveform is compressed (displayed at 12.5/mm/sec sweep speed) to provide more data in the 4 second screen. There is a slight delay between when the breath occurs and when it appears on the screen. Printouts are at 25mm/sec. Continuous print may be changed to 12.5mm/sec, if desired.
3. The monitor shows the maximum CO_2 value over the last 20 seconds. If the $EtCO_2$ values are increasing, the change can be seen with every breath. However, if the values are continually decreasing, it will take up to 20 seconds for a lower numerical value to be displayed in the CO_2 area. As such, the $EtCO_2$ value may not always match the CO_2 waveform.
4. The Oridion® capnography module performs self-maintenance within the first hour of monitoring and once an hour during continuous monitoring. This self-maintenance includes “auto-zeroing.” Self-maintenance is also initiated if the surrounding temperature changes 8°C or more or the surrounding pressure changes > 20 mmHg.
5. The CO_2 module is reset after a shock and the CO_2 waveform reappears in less than 20 seconds.
6. The CO_2 function is activated when the gold ring of the FilterLine connector contacts the device CO_2 port. It is possible for the FilterLine to become loose and still have an $EtCO_2$ value and CO_2 waveform, but they may be invalid. Make sure the FilterLine is firmly seated and tight.

See device Operating Instructions for complete directions for use, indications, contraindications, warnings, precautions and potential adverse events.

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Capnography

An Objective Tool for Assessing Respiratory Status

Maximizing Capnography Monitoring in LIFEPAK® 12, 15 and 20e Defibrillator/Monitors

End-tidal CO_2 ($EtCO_2$) is the measurement of carbon dioxide (CO_2) in the airway at the end of each breath. Capnography provides a numeric reading value and graphic display (waveform) of CO_2 throughout the respiratory cycle.

Capnography is an objective monitoring tool for any patient who might have metabolic, circulatory or ventilatory problems. It is used to confirm, monitor and document ET tube intubation. A nasal-oral cannula is used to assess, monitor and document the respiratory status of the non-intubated patient. $EtCO_2$ monitoring with LIFEPAK defibrillator/monitors may be used on patients of any age.

Physio-Control ▪ 1.800.442.1142 ▪ www.physio-control.com

Getting Started

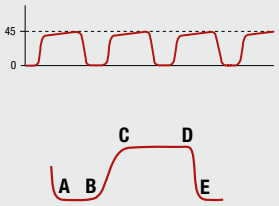
1. Turn LIFEPAK 12, 15 and 20e defibrillator/monitor ON. If CO_2 is not already displayed, select channel 2 or 3 to monitor the CO_2 waveform.
2. Attach the FilterLine® to the monitor and turn clockwise until FilterLine is firmly seated.
3. Attach the FilterLine to the patient.

$EtCO_2$ Value: Maximum $EtCO_2$ value over last 20 seconds.
Waveform: Real-time monitoring of CO_2 throughout respiratory cycle.
CO_2 Alarms: Indicators of possible abnormalities in CO_2 values.

Normal Ranges:

Arterial $PaCO_2$	38–45 mmHg
Airway $EtCO_2$	35–45 mmHg (4–6 Vol. %)

Normal Waveform:



A–B Respiratory baseline
B–C Expiratory upslope
C–D Expiratory plateau
D End-tidal value—peak CO_2 concentration—at the end of exhalation
D–E Inspiratory downstroke

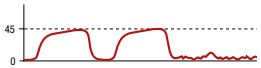
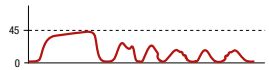
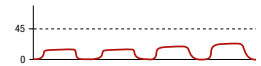
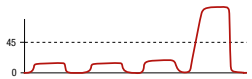
Applications for Non-intubated Patients

- Ventilatory compromise
  - COPD
  - hyper and hypoventilation
  - apnea or inadequate breathing
  - monitoring during sedation
  - monitoring of $EtCO_2$ during head injury
- Metabolic compromise
  - diabetic ketoacidosis
  - hypermetabolic states
- Circulatory compromise
  - all types of shock

Applications for Intubated Patients

- Verification of ET tube placement
- Monitoring ET tube and determination of tube dislodgement
- Determination of effective CPR during cardiac arrest
- Early detection of ROSC

Troubleshooting Tips

Observation	Possible Cause	Corrective Action
ALARM APNEA message appears and waveform is solid line at or near zero. 	A valid breath was initially detected and then no breath has been detected for 30 seconds. FilterLine connection to device is loose. FilterLine is disconnected from patient or ETT.	• Check the patient. See Critical Point 1. • Twist FilterLine connector clockwise until tight and firmly seated. • Check ventilation equipment (if used) for leaks or disconnected tubing.
CO_2 FILTERLINE OFF message appears and waveform is ---.	FilterLine set disconnected or not securely connected to device.	• Connect FilterLine set to device port. • Twist FilterLine connector clockwise until tight and firmly seated.
CO_2 FILTERLINE PURGING message appears and waveform is ---.	FilterLine set is kinked or clogged with fluid or rapid altitude change occurred.	• Disconnect and then reconnect the FilterLine set. • Twist FilterLine connector clockwise until tight and firmly seated.
CO_2 FILTERLINE BLOCKAGE message appears and waveform is ---.	The message appears after 30 seconds of unsuccessful purging. FilterLine set is kinked or clogged.	• Disconnect and then reconnect the FilterLine set. • Change FilterLine set. • Twist FilterLine connector clockwise until tight and firmly seated.
CO_2 INITIALIZING message appears and waveform is ---.	FilterLine set just connected to device. Defibrillation shock delivered.	• None. • None. System resets automatically within 20 seconds
AUTO ZEROING message appears and waveform is ---.	Module is performing self-maintenance. Defibrillation shock was delivered.	• None. System resets automatically within 20 seconds. See Critical Points 4 and 5.
$EtCO_2$ values are erratic 	FilterLine connection to device is loose. A leak in the FilterLine set. A mechanically ventilated patient breathes spontaneously or patient is talking.	• Twist FilterLine connector clockwise until tight and firmly seated. • Check for connection leaks and line leaks to patient, and correct, if necessary. • No action required. • Check the patient.
$EtCO_2$ values are consistently higher than expected	Physiological cause (e.g. COPD). Inadequate ventilation. Patient splinting during breathing. Improper calibration.	• None. • Check ventilator, increase ventilatory rate/ bagging. • Supportive measures (e.g. pain relief). Check waveform for elevated baseline. • Contact qualified service personnel.
$EtCO_2$ values are consistently lower than expected 	FilterLine connection to device is loose. Physiological cause. Hyperventilation. Improper calibration.	• Twist FilterLine connector clockwise until tight and firmly seated. • See CO_2 Detection - Physiological Factors • Check ventilator, decrease ventilatory rate/bagging. • Ventilator malfuncton, contact qualified service personnel.
CO_2 waveform stays elevated for several seconds.	Expiration is prolonged due to bagging technique.	• Release bag reservoir completely with expiration. • Check waveform for elevated baseline.
Sudden extreme increase in $EtCO_2$ 	Return of spontaneous circulation.	• None.
xxx appears instead of $EtCO_2$ value	CO_2 module failed. CO_2 not successfully calibrated.	• Contact qualified service personnel.

Note: To decrease the likelihood of FilterLine connection becoming loose during use, hand-straighten the tubing after removal from the package before connecting to patient or device.