



DEPARTMENT OF FIRE AND RESCUE SERVICES

	<h1>MEMORANDUM</h1> <p>2009.002</p>	
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Originating From	Issue Date	Revision Date	Attachments
Emergency Medical Services	1/15/2009		A

SUBJECT: Carbon Monoxide Evaluation Using the Masimo Rainbow SET RAD-57 Pulse CO-Oximeter

APPLICABILITY: All Operational Personnel

PURPOSE:

The mere presence of carbon monoxide (CO) detected in a structure or confined space can't accurately predict the amount of CO in an individual. Previously, the only means to determine the level of carbon monoxide in the bloodstream was to obtain a blood sample and use an arterial blood gas analyzer with co-oximetry capabilities. As a result, many patients that were exposed to CO in the field were transported to the hospital for measuring a CO level when in fact their levels may be negligible.

This policy is created to instruct EMS providers (EMT-P, EMT-I and EMT-B) on the use of the Masimo Rainbow SET RAD-57 Pulse CO-Oximeter and the interpretation of values found during standard operation.

1 Indications

1.1 The RAD-57 may be used on any adult, pediatric, or neonate where there's suspicion of carbon monoxide exposure.

2 Contraindications

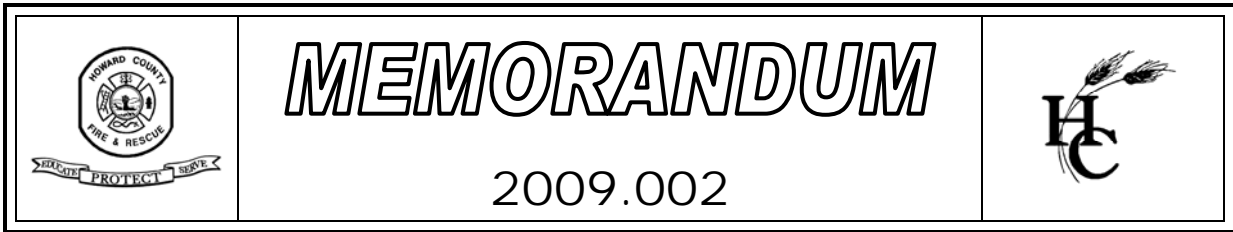
2.1 None

3 Potential Adverse Events

3.1 There is a potential for false positive readings under certain conditions such as improper probe placement on finger, weakened batteries, poor circulation/ cold extremity, etc. When in doubt attempt a second reading on a different finger.

4 Instructions for Use

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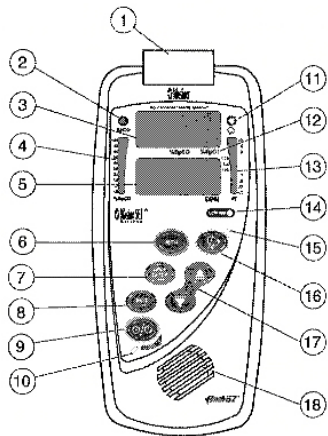
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4.1 The RAD-57 Rainbow SET Pulse-CO-Oximeter is a non-invasive, arterial oxygen saturation and pulse rate monitor. It features a multicolored LED display that continuously displays numeric values for SpO₂ and pulse rate, a Low Signal IQ Indicator (Low SIQ), LED indicator bars for Perfusion Index (PI), Carboxyhemoglobin saturation (%SpCO), alarm status, alarm silence, battery life, and SpCO sensor connected indicators.

4.2 The front panel controls are identified and described in the following diagram:

Rad-57 front panel controls

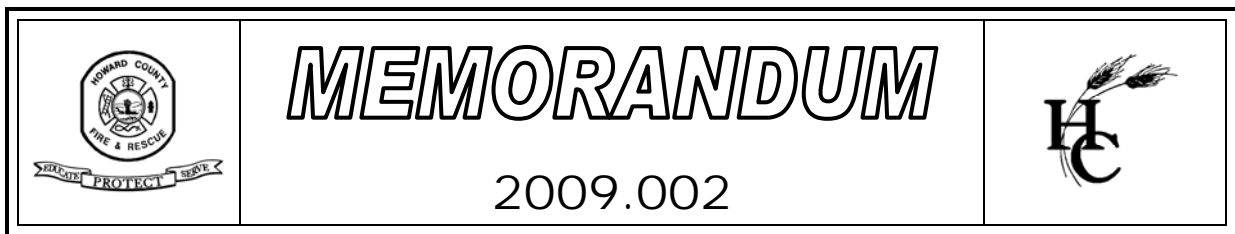


Rad-57

CONTROL / INDICATOR	DESCRIPTION
① Patient Cable Connector	Connects to Rainbow sensor or Rainbow Patient Cable
② SpCO indicator	Slow flashing indicator: The confidence in the SpCO value obtained is low. Fast flashing indicator: Flashes when an SpCO alarm condition exists.
③ Saturation (%SpO ₂) and Carboxyhemoglobin (%SpCO) Displays	The functional arterial hemoglobin oxygen saturation is displayed in units of SpO ₂ . When searching for a saturation and pulse, it will flash dashed lines. See <i>SpCO Button</i> description, below.
④ %SpCO Bar	Illuminates when SpCO capable sensor is attached. Bar will flash for SpCO alarm conditions. Continuously indicates the concentration of carboxyhemoglobin in 5% increments.
⑤ Pulse Rate Display	The pulse rate in beats per minute (bpm). When searching for a saturation and pulse, it will flash dashed lines.

CONTROL / INDICATOR	DESCRIPTION
⑥ SpCO Button	Pressing this button will display the numeric SpCO value for 10 seconds in place of the SpO ₂ numeric value. Pressing the Mode/Enter or Next button during this 10-second period will return to the SpO ₂ numeric value.
⑦ Mode / Enter Button	Used to enter the setup menus and to select/activate certain entries within the menu/setup system.
⑧ Next Button	Used within the menu/setup system to move through setup options. Not active during normal patient monitoring.
⑨ Power On / Off	Press to turn the unit on. Press-and-hold for 2 seconds to turn the unit off.
⑩ Battery Level Indicator	Four LED's indicate the status of the battery. When the final indicator begins flashing, replace the batteries.
⑪ Visual Alarm Indicator	Illuminates when any alarm condition exists. This indicator may not be turned-off or otherwise over-ridden.
⑫ %SpO ₂ / %SpCO Indicator	Indicator above label will illuminate to provide an additional visual indication of the value currently being displayed.
⑬ PI	Perfusion Index, or PI, is a relative assessment of the perfusion at the monitoring site. PI is displayed on a 10 segment LED bar, ranging from <1% (very weak perfusion) to >5% (strong perfusion). The highest LED will remain lit continuously to allow a PI level to be viewed. The Perfusion Index is the ratio of the AC (pulsatile) to DC (non-pulsatile) components of the IR (infrared) signal where the AC and DC components correspond to the pulsatile and non-pulsatile amounts of blood, respectively.
⑭ Low SIQ	Flashes to indicate low SpO ₂ Signal IQ. Refer to Section 4, <i>Low Signal IQ</i> .
⑮ Alarm Silenced Indicator	Flashes to indicate the alarm is temporarily silenced.
⑯ Alarm Silence Button	Push once to temporarily silence the alarm for 120 seconds. Push a second time to return the unit to standard alarm monitoring.
⑰ Up button Down button	During saturation monitoring, use these buttons to adjust the volume of the pulse beep tone. Within the menu/setup system, these buttons are used to select values within each menu option.
⑱ Speaker	Provides audible indication of alarm conditions, pulse tone and feedback for key-presses. Ensure the speaker is not covered or the unit is placed face-down on bedding or other sound absorbing surface.

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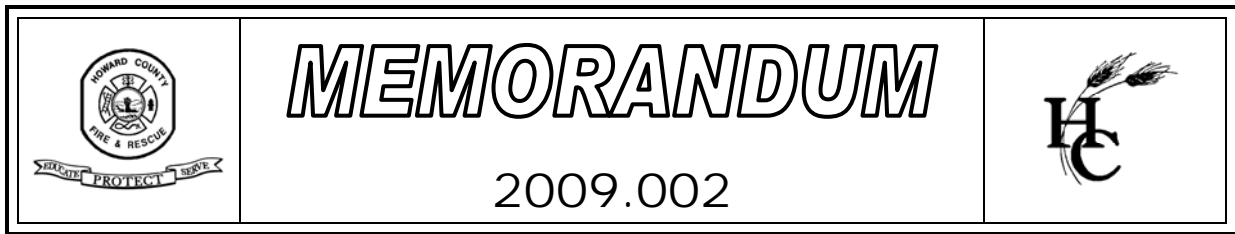


- 4.3 Connect the sensor cable to the Patient Cable Connector of the oximeter. Make sure the connection is secure and the cable is not twisted, sliced, or frayed.
- 4.4 Remove any substances (nail polish, paint, etc) on the patient's second, third, or fourth digit that may interfere with the transmission of light between the sensor's light source and photo detector.
- 4.5 Attach the sensor to the patient, applying it to the index (second), middle (third), or ring (fourth) digits. Only these digits can be accurately used by the CO-Oximeter.
- 4.6 Press the Power button. The machine will go through a self-test procedure that will last approximately 10 seconds.
- 4.7 The device will default to displaying the pulse rate and SpO₂ when it is turned on. Verify that these are accurate readings by checking the patients pulse and clinical picture before continuing. The SpO₂ low alarm limit defaults to 90%.
- 4.8 Pressing the SpCO button will display the numeric SpCO value for 10 seconds in place of the SpO₂ numeric value.
- 4.9 Once monitoring is complete, remove the sensor from the patient and turn the device off. Wipe the sensor and device with a soft cloth dampened with mild soap and water. Never submerge the sensor or the monitoring device.

5 Considerations

- 5.1 Cyanide toxicity and methemoglobinemia cannot be readily determined by this, or any other currently available handheld device. The CO-Oximeter should be used in addition to clinical judgment. Normal readings in a patient with severe respiratory distress or cyanosis should not rule out significant oxygen-transfer deficit (cyanide toxicity, methemoglobinemia, sulfhemoglobinemia, or profound anemia) requiring aggressive airway management and high-flow oxygen. Always treat the patient first and not the reading on the RAD-57.
- 5.2 The device is **not** intrinsically safe and should not be used in the presence of flammable substances.
- 5.3 If the device indicates a "Low SIQ," this refers to a low signal IQ and flashes when the SpO₂ and SpCO measurements may be compromised. If this occurs:
 - 5.3.1 Reassess the patient.

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- 5.3.2 Check the sensor to ensure it is properly applied to the patient and inserted into the RAD-57 device.
- 5.3.3 Determine if an extreme change in the patient's physiology and blood flow at the monitoring site has occurred (e.g. an inflated blood pressure cuff, tourniquet, severe hypotension, hypothermia, or cardiac arrest).
- 5.3.4 After completing this check, if the "Low SIQ" indication occurs frequently or continuously, you cannot rely on the device for either SpO₂ or SpCO levels.

5.4 The Perfusion Index (PI) is a relative assessment of perfusion at the monitoring site. PI is displayed on a 10 segment LED bar on the right of the display ranging from <0.1% (very weak perfusion) to >5% (strong perfusion). The PI is shown as a "bouncing bar" indicator, where the peak of the bar coincides with the peak of an arterial pulsation. The highest LED will remain lit continuously to allow a PI level to be viewed. If evidence of low perfusion (<1%) is frequently displayed, find a better perfusion monitoring site and be sure the sensor is placed properly and there are no substances on the finger that could impede the emitter and photo detector. Very high ambient light situations can also produce falsely low PI. Should a low PI be persistent after these measures, review the procedure for "Low SIQ" above. If a low PI still persists you cannot rely on the device for either SpO₂ or SpCO levels.

6 Interpreting CO Values

6.1 Clinical situations which should raise the possibility of carbon monoxide poisoning include closed-space fires, any automobiles running in closed spaces, appliances that burn fossil fuels (heaters), or fossil fuel burning engines when used in closed spaces (power washers, generators).

6.2 Symptoms of CO toxicity may include: nausea, vomiting, dizziness, fatigue, headache, confusion, marked dyspnea, decreased or altered level of consciousness, or seizures.

6.3 Any patient with airway compromise or respiratory distress should be treated according to Maryland Medical Protocols regardless of their CO level.

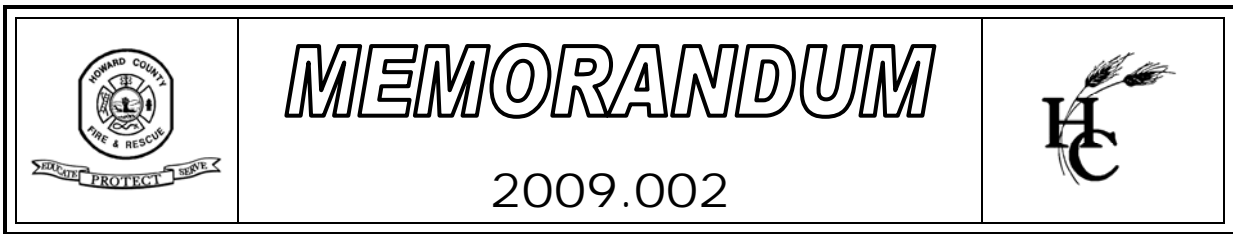
6.3.1 Patients with clinical situations noted in paragraph 1 and clinical symptoms described in paragraph 2 should be treated with the appropriate Maryland Medical Protocol: Poisoning by Inhalation, Trauma – Burns, or Hyperbaric Therapy Protocol.

6.3.2 Patients with major trauma or burns should be transported to the appropriate specialty referral center.

6.3.3 Interpretation of RAD-57 readings:

6.3.3.1 0 - 4% without symptoms - No treatment required.

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- 6.3.3.2 5 -9% with mild symptoms – BLS care and treat with 100% oxygen with transport to local ED. Patients with severe symptoms, but low readings may require ALS care and consultation.
- 6.3.3.3 10 –19% with symptoms – ALS care and treat with 100% oxygen, cardiac monitor, and establish IV access at a minimum. Consult to determine appropriate facility.
- 6.3.3.4 >20% - ALS care and treat with 100% oxygen, cardiac monitor, and establish IV access at a minimum. Consult to determine appropriate facility (hyperbaric therapy likely required).
- 6.3.3.5 Other symptoms present at levels above 20% are listed in the table below:

Percent of total hemoglobin	Symptoms
20% to 30%	Headache, nausea, vomiting, and loss of judgment
30% to 40%	Dizziness, muscle weakness, vision problems, confusion, and increased heart rate and breathing rate
50% to 60%	Loss of consciousness
Over 60%	Seizures, coma, death

7 Special Circumstances

- 7.1 **Pediatric patients with SpCO readings >15%** ALS care and treat with 100% oxygen, cardiac monitor, and establish IV access at a minimum. Consult to determine appropriate facility (hyperbaric therapy likely required).
- 7.2 **Known pregnant patients with SpCO readings >15%** ALS care and treat with 100% oxygen, cardiac monitor, and establish IV access at a minimum. Consult to determine appropriate facility (hyperbaric therapy likely required).
- 7.3 **Any pediatric patient or pregnant female with symptoms** of carbon monoxide exposure and readings of <15% should be transported to a medical facility for evaluation. Medical consultation with local ED and a hyperbaric center is recommended.
- 7.4 **Smokers:** will have elevated levels of SpCO even if they are not actively smoking, or recently smoked a cigarette. On average one can expect the following:

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Non to Light Smokers	0-3% SpCO
Light to Moderate Smokers	4-5% SpCO
Moderate to Heavy Smokers	6-9% SpCO

7.5 All ALS patients transported to the hospital, or specialty center shall have a lavender top tube of blood drawn for evaluation of the Carbon Monoxide level. Present the tube to the hospital staff upon transfer of care report.

8 Ready Reference Card

8.1 The “ready reference cards” have been provided as Attachment A. They may be laminated, and used as a reference for the RAD-57.

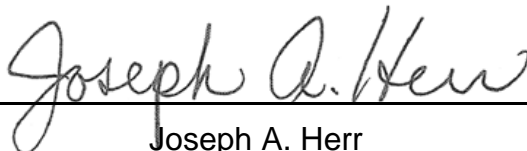
9 Documentation

9.1 Use of the RAD-57 and serially recorded SpCO levels should be documented accordingly in the narrative section of the MIR. It cannot be emphasized enough that the patient’s clinical presentation is what should drive routine medical care, and not the SpCO level observed. If there is ever doubt regarding the patient’s disposition, contact on-line medical direction.

10 Placement of the RAD-57

10.1 The RAD-57’s will be carried on P75, P95, P105, P115, EMS1, EMS 2, Safety1, and Unit 700. Corporate Volunteers Companies are authorized to purchase and use the RAD-57 device for their EMS units.

Approved:



Joseph A. Herr
Fire Chief

Rad57 CARBON MONOXIDE-CO _h b READY REFERENCE CARD		
CO _h b Level %	Signs & Symptoms	Pre-Hospital Treatment
0-4	Minor headache	Observe
5-9	Headache	100% Oxygen up to 4 hours
10-19	Dyspnea, Headache	100% Oxygen, transport
20-29	Headache, nausea, dizziness	100% Oxygen, ALS, transport, Consider HBO
30-39	Severe Headache, vomiting, ALOC	100% Oxygen, ALS, transport, HBO
40-49	Confusion, syncope, tachycardia	ABC's, 100% Oxygen, ALS, Air transport, HBO
50-59	Seizures, shock, apnea, coma	ABC's, 100 % Oxygen, ALS, Air transport, HBO
60-up	Coma, Death	ABC's, 100% oxygen, ALS, Air transport, HBO

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