The Role of Capnography in the 2010 American Heart Association Guidelines for CPR and ECC

**CPR Quality**
- Push hard (≥2 inches [5 cm]) and fast (≥100/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Avoid excessive ventilation
- Rotate compressor every 2 minutes
- If no advanced airway, 30:2 compression-ventilation ratio

- **Quantitative waveform capnography**
  - If Petco2 <10 mm Hg, attempt to improve CPR quality

- **Intra-arterial pressure**
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality

**Return of Spontaneous Circulation (ROSC)**
- Pulse and blood pressure
- Abrupt sustained increase in Petco2 (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

**Shock Energy**
- Biphasic: Manufacturer recommendation (120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.

- **Monophasic:** 360 J

**Drug Therapy**
- **Epinephrine IV/IO Dose:** 1 mg every 3-5 minutes
- **Amiodarone IV/IO Dose:** First dose: 300 mg bolus. Second dose: 150 mg.

**Advanced Airway**
- Supraglottic advanced airway or endotracheal intubation
- Waveform capnography to confirm and monitor ET tube placement
- 8-10 breaths per minute with continuous chest compressions

**Reversible Causes**
- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypo-/hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

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Using Capnography Waveforms during Resuscitation

![Capnography tracing](image)

**Figure 1 – Capnography to confirm endotracheal tube placement** This capnography tracing displays the partial pressure of exhaled carbon dioxide (PETCO₂) in mm Hg on the vertical axis over time when intubation is performed. Once the patient is intubated, exhaled carbon dioxide is detected, confirming tracheal tube placement. The PETCO₂ varies during the respiratory cycle, with highest values at end-expiration.

**Advanced Cardiac Life Support (ACLS) Capnography Recommendation**

**2010:** Continuous quantitative waveform capnography is now recommended for intubated patients throughout the peri-arrest period. When quantitative waveform capnography is used for adults, applications now include recommendations for confirming tracheal tube placement and for monitoring CPR quality and detecting ROSC based on end-tidal carbon dioxide (PETCO₂) values.

**Why:** Continuous waveform capnography is the most reliable method of confirming and monitoring correct placement of an endotracheal tube. Although other means of confirming endotracheal tube placement are available, they are not more reliable than continuous waveform capnography. Patients are at increased risk of endotracheal tube displacement during transport or transfer; providers should observe a persistent capnographic waveform with ventilation to confirm and monitor endotracheal tube placement.

Because blood must circulate through the lungs for CO₂ to be exhaled and measured, capnography can also serve as a physiologic monitor of the effectiveness of chest compressions and to detect ROSC. Ineffective chest compressions (due to either patient characteristics or rescuer performance) are associated with a low PETCO₂. Falling cardiac output or re-arrest in the patient with ROSC also causes a decrease in PETCO₂. In contrast, ROSC may cause an abrupt increase in PETCO₂ (Figure 2).

![Capnography tracing](image)

**Figure 2 – Capnography to monitor effectiveness of resuscitation efforts** This second capnography tracing displays the PETCO₂ in mm Hg on the vertical axis over time. This patient is intubated and receiving CPR. Note that the ventilation rate is approximately 8 to 10 breaths per minute. Chest compressions are given continuously at a rate of slightly faster than 100/min but are not visible with this tracing. The initial PETCO₂ is less than 12.5 mm Hg during the first minute, indicating very low blood flow. The PETCO₂ increases to between 12.5 and 25 mm Hg during the second and third minutes, consistent with the increase in blood flow with ongoing resuscitation. Return of spontaneous circulation (ROSC) occurs during the fourth minute. ROSC is recognized by the abrupt increase in the PETCO₂ (visible just after the fourth vertical line) to over 40 mm Hg, which is consistent with a substantial improvement in blood flow.

**Pediatric Advanced Life Support (PALS) Recommendations for Monitoring Exhaled CO₂**

**2010:** Exhaled CO₂ detection (capnography or colorimetry) is recommended in addition to clinical assessment to confirm tracheal tube position for neonates, infants, and children with a perfusing cardiac rhythm in all settings (e.g., prehospital, ED, intensive care unit, ward, operating room) and during intrahospital or interhospital transport (Figure 1). Continuous capnography or capnometry monitoring, if available, may be beneficial during CPR to help guide therapy, especially the effectiveness of chest compressions (Figure 2).

**Why:** Exhaled CO₂ monitoring (capnography or colorimetry) generally confirms placement of the endotracheal tube in the airway and may more rapidly indicate endotracheal tube misplacement/displacement than monitoring of oxyhemoglobin saturation. Because patient transport increases the risk for tube displacement, continuous CO₂ monitoring is especially important at these times.

Animal and adult studies show a strong correlation between PETCO₂ concentration and interventions that increase cardiac output during CPR. PETCO₂ values consistently <10 to 15 mm Hg suggest that efforts should be focused on improving chest compressions and making sure that ventilation is not excessive. An abrupt and sustained rise in PETCO₂ may be observed just before clinical identification of ROSC, so use of PETCO₂ monitoring may reduce the need to interrupt chest compressions for a pulse check.