Use of waveform capnography during cardiac arrest was recommended in the 2010 International Consensus on Cardiopulmonary Resuscitation (CPR) Science with Treatment Recommendations. A primary benefit includes confirmation that a tracheal tube (or other airway device) has been placed correctly and is providing ventilation of the lungs. Capnography is considerably more reliable than either clinical assessment by auscultation or observation of chest wall movement. The recent 4th National Audit Project of The Royal College of Anaesthetists and Difficult Airway Society examined Major Complications of Airway Management in the UK. It did not focus on airway management during cardiac arrest, but it included 11 instances where failure to use or correctly interpret capnography led to unrecognised oesophageal intubations during cardiac arrest, most of which led to avoidable death or brain injury. We can assume that the incidence of unrecognised oesophageal intubation is higher when waveform capnography is not used during cardiac arrest. There is strong evidence to support the use of waveform capnography in this situation (CPR will generate an attenuated, but not absent, end-tidal CO2 trace), with data demonstrating 100% sensitivity and 100% specificity in identifying correct tracheal tube placement. In contrast to waveform capnography, studies of alternative devices to determine correct tube placement (such as colorimetric end-tidal CO2 detectors, syringe aspiration oesophageal detector, self-inflating bulb oesophageal detector and non-waveform end-tidal capnometers) have been shown to have accuracy that is not substantially better than clinical assessment.

During cardiac arrest, waveform capnography may also be used to guide the effectiveness of chest compressions and to provide an early indication of return of spontaneous circulation (ROSC). However, there is currently insufficient evidence to recommend the use of end-tidal CO2 monitoring as a method of prognostication during cardiac arrest.

In this issue of the journal, Heradstveit and colleagues from the Emergency Medical Service of Haukeland University Hospital in Bergen, Norway, present data that suggest capnography may become a more useful tool for optimising and individualising ALS in patients experiencing of out-of-hospital cardiac arrest (OHCA). A retrospective observational study was performed using data collected routinely from 918 OHCA patients. Of these, 194 were excluded and 149 did not have capnography data recorded. Data were analysed from the remaining 575 patients. Based on all available clinical evidence, the cause of cardiac arrest was considered to be cardiac in 58%, respiratory in 20%, pulmonary embolism (PE) in 2% and unknown in 19%. Patients who developed cardiac arrest from a respiratory (excluding PE) cause were observed to have significantly higher end-tidal CO2 values compared with those of other causes. The authors suggest that this is because these patients have a period of rising CO2 from reduced or absent ventilation prior to cardiac arrest, rather than having a better cardiac output during CPR. In contrast, the few patients developing cardiac arrest from pulmonary embolus had significantly lower end-tidal CO2 values, presumably because of reduced blood flow through the pulmonary circulation, despite effective CPR. End-tidal CO2 values also varied with the person performing chest compressions. The authors propose using end-tidal CO2 values to optimise the quality of CPR and indicate when poor technique or rescuer fatigue may be compromising effective compressions; they suggest that a fall in end-tidal CO2 may be an indication for a different person to take over. Interestingly, patients who gained ROSC had significantly higher end-tidal CO2 values compared to those who did not have ROSC, regardless of the initial cardiac rhythm or cause of the arrest. Importantly, the authors caution the use of specific cut-off values of end-tidal CO2 to prognosticate during cardiac arrest. They correctly state that there are several confounding factors that affect the end-tidal CO2 value. These are demonstrated in the study findings and include the cause of cardiac arrest, the initial rhythm, effectiveness of bystander and first responder CPR, and time from cardiac arrest to initiation of end-tidal CO2 monitoring.

Heradstveit and colleagues also discuss the important limitations of their study. The average, highest and lowest end-tidal CO2 recordings were estimated by the attendant anaesthetist. This may have lead to recording errors and also introduces the possibility of (unintended) bias. During cardiac arrest, patients’ lungs were manually ventilated by the anaesthetist and while this may have led to over or under-ventilation the impact of this on end-tidal CO2 in a ‘low-flow’ state is surprisingly small. However, hyperventilation during cardiac arrest decreases coronary perfusion pressure and, based on animal data, decreases survival. Determination of the cause of cardiac arrest is difficult and incorrect categorisation of the type of cardiac arrest may influence the data. The authors acknowledge that the number of cardiac arrests of unknown cause is high and had no post-mortem results to confirm or refute any presumed pre-hospital diagnosis. In particular, only 12 patients had a presumed diagnosis of PE (based on clinical history and an initial rhythm of pulseless electrical activity or asystole), which was much lower than previously reported. This confirms that diagnosis of PE is difficult during cardiac arrest. The fact that significantly lower end-tidal CO2 values were reported in patients with PE compared with patients with other causes of cardiac arrest is an interesting finding but should be interpreted with caution.
Waveform capnography during cardiac arrest is now well established in clinical practice. It has a recognized role in determining correct airway placement and pulmonary ventilation. Defibrillators are appearing that incorporate continuous capnography monitoring. It is useful for assessing effectiveness of chest compressions, and for early detection of ROSC. However, it must be emphasized that end-tidal CO₂ is currently much more of use in determining confirmation of tracheal tube placement and ventilation, rather than the additional uses described in this paper. The study by Heradstveit and colleagues asks more questions than it answers. The next step is to undertake high quality prospective studies to determine whether robustly recorded end-tidal CO₂ monitoring during cardiac arrest can provide the clinician with robust information about diagnosis of cause, appropriate interventions and prognosis.

Conflict of interest statement

The authors have no conflict of interests to declare.

References


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