

End-Tidal CO₂ monitoring to guide treatment during cardiac arrest

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Introduction

- Cardiac arrest is a common presentation to the emergency care system.
- The decision to terminate cardiopulmonary resuscitation (CPR) is often challenging to health care providers “there is no Criteria”
- Nolan JP, Laver SR, Welch CA, Harrison DA, Gupta V, Rowan K. Outcome following admission to UK intensive care units after cardiac arrest: a secondary analysis of the ICNARC Case Mix Programme Database. *Anaesthesia* 2007;62:1207–16

Introduction cont'

- factors that influence survival chance including:
 - the patient pre-morbid physiological reserves,
 - the circumstances of the cardiac arrest,
 - the length of the resuscitation efforts,
 - various bedside investigations such as:
 - blood gas analysis,
 - lactate levels
 - the results of echocardiography
- O. Touma, M. Davies .The prognostic value of end tidal carbon dioxide during cardiac arrest: A systematic review. *Resuscitation* 84 (2013) 1470– 1479

Predictor & Capnography

- predictor unfortunately does not exist and decisions to discontinue resuscitation efforts are heavily dependent on subjective clinical assessment and judgement.
- The utility of capnography during cardiac arrest has been the centre of multiple studies in recent years. Capnography involves continuous monitoring of the partial pressure of the end tidal carbon dioxide (ETCO₂).
- O. Touma, M. Davies .The prognostic value of end tidal carbon dioxide during cardiac arrest: A systematic review. *Resuscitation* 84 (2013) 1470– 1479
- Nunn JF. Ventilation and end-tidal carbon dioxide tension; a study during routine anaesthesia. *Anaesthesia* 1958;13:124–37.

ETCO₂

- ETCO₂ has therefore been used to reflect the efficacy of chest compressions during CPR and as an early indicator of return of spontaneous circulation (ROSC)
- Kalenda Z. The capnogram as a guide to the efficacy of cardiac massage. *Resuscitation* 1978;6:259–63.
- Pokorna M, Necas E, Kratochvil J, Skripsky R, Andrlik M, Franek O. A sudden increase in partial pressure end-tidal carbon dioxide (P(ET)CO₂) at the moment of return of spontaneous circulation. *J Emerg Med* 2009;38:614–21.

Main questions

- Does ETCO₂ have prognostic value during cardiac arrest?
- Can the possible prognostic value of ETCO₂ be used to facilitate decision making regarding the termination of CPR?
- O. Touma, M. Davies .The prognostic value of end tidal carbon dioxide during cardiac arrest: A systematic review. *Resuscitation* 84 (2013) 1470– 1479
- Nunn JF. Ventilation and end-tidal carbon dioxide tension; a study during routine anaesthesia. *Anaesthesia* 1958;13:124–37.

Evidence

- There is a growing body of evidence to suggest a relationship between ETCO₂ values and the outcome of cardiopulmonary resuscitation. Several studies have shown that CPR ETCO₂ measurements were significantly higher in patients who later developed ROSC compared to patients who did not and for patients who survived to hospital discharge compared to patients who did not.
- Kolar M, Krizmaric M, Klemen P, Grmec S. Partial pressure of end-tidal carbon dioxide successful predicts cardiopulmonary resuscitation in the field: a prospective observational study. *Crit Care* 2008;12:R115.
- Grmec S, Krizmaric M, Mally S, Kozelj A, Spindler M, Lesnik B. Utstein style analysis of out-of-hospital cardiac arrest–bystander CPR and end expired carbon dioxide. *Resuscitation* 2007;72:404–14.
- Lah K, Krizmaric M, Grmec S. The dynamic pattern of end-tidal carbon dioxide during cardiopulmonary resuscitation: difference between asphyxial cardiac arrest and ventricular fibrillation/pulseless ventricular tachycardia cardiac arrest. *Crit Care* 2011;15:R13.
- Mally S, Jelatancev A, Grmec S. Effects of epinephrine and vasopressin on endtidal carbon dioxide tension and mean arterial blood pressure in out-of-hospital cardiopulmonary resuscitation: an observational study. *Crit Care* 2007;11:R39.
- Grmec S, Lah K, Tusek-Bunc K. Difference in end-tidal CO₂ between asphyxia cardiac arrest and ventricular fibrillation/pulseless ventricular tachycardia cardiac arrest in the prehospital setting. *Crit Care* 2003;7:R139–44.
- Ahrens T, Schallom L, Bettorf K, et al. End-tidal carbon dioxide measurements as a prognostic indicator of outcome in cardiac arrest. *Am J Crit Care* 2001;10:391–8.
- Salen P, O'Connor R, Sierzenski P, et al. Can cardiac sonography and capnography be used independently and in combination to predict resuscitation outcomes? *Acad Emerg Med* 2001;8:610–5.
- Mauer D, Schneider T, Elich D, Dick W. Carbon dioxide levels during pre-hospital active compression–decompression versus standard cardiopulmonary resuscitation. *Resuscitation* 1998;39:67–74.
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- Steedman DJ, Robertson CE. Measurement of end-tidal carbon dioxide concentration during cardiopulmonary resuscitation. *Arch Emerg Med* 1990;7:129–34.
- Krep H, Mamier M, Breil M, Heister U, Fischer M, Hoeff A. Out-of-hospital cardiopulmonary resuscitation with the AutoPulse system: a prospective observational study with a new load-distributing band chest compression device. *Resuscitation* 2007;73:86–95.
- Heradstveit BE, Sunde K, Sunde GA, Wentzel-Larsen T, Heltnøe JK. Factors complicating interpretation of capnography during advanced life support in cardiac arrest—a clinical retrospective study in 575 patients. *Resuscitation* 2012;83:813–8.
- Eckstein M, Hatch L, Malleck J, McClung C, Henderson SO. End-tidal CO₂ as a predictor of survival in out-of-hospital cardiac arrest. *Prehosp Disaster Med* 2011;26:148–50.

The ability of ETCO₂ in prediction

- For predicting ROSC, initial ETCO₂ cut-off value of 1.33 kPa has been shown to have a sensitivity of 100% in three large pre-hospital studies
- **BUT**
- initial ETCO₂ value of less than 1.33 kPa appears to be a strong predictor of mortality
- Grmec S, Klemen P. Does the end-tidal carbon dioxide (EtCO₂) concentration have prognostic value during out-of-hospital cardiac arrest? Eur J Emerg Med 2001;8:263–9.

Limitations of studies

- none of the studies reported the 95% confidence interval of the estimated 100% sensitivity to establish its precision.
- Furthermore, all these studies were done in pre-hospital settings, limiting the generalisability of such results to cover intra-hospital cardiac arrests or cardiac arrests arriving into the ED.

Conclusion

- There is growing evidence in the literature demonstrating a correlation between ETCO₂ values during CPR and the outcome of resuscitation, and therefore, ETCO₂ values appears to be prognostic for short term outcome.
- **BUT**
- the ability of ETCO₂ cut-off values to reliably predict the outcome of resuscitation with high accuracy is not established

Conclusion

- ETCO₂ values during cardiac arrest are potentially a better predictor of mortality as opposed to a predictor of survival due to the relative high sensitivity for ETCO₂ cut-off values to predict ROSC and short term survival.