Paramedic – Evidence Based Medicine (P-EBP) Program

Paramedic CAT (Critically Appraised Topic) Worksheet

Title: Waveform Capnography for ROSC

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Clinical Scenario: Two medics working on a patient in cardiac arrest (CA) use their waveform capnograph to detect early return of spontaneous circulation (ROSC).

PICO (Population – Intervention – Comparison – Outcome) Question:
Does the use of waveform capnography improve early detection of ROSC and improve patient outcome for out of hospital CA?

That is, *in adult patients with out-of-hospital cardiac arrest (P), does the use of waveform capnography (I) versus no capnography (C) lead to early detection of ROSC (O)?*

Search Strategy: end-tidal CO2 OR Waveform capnography AND Cardiac Arrest AND ROSC

Search Outcome: 63 Titles

Relevant Papers: 3 papers were chosen as relevant for this CAT

AUTHOR, DATE	POPULATION: SAMPLE CHARACTERISTICS	DESIGN (LOE)	OUTCOMES	RESULTS	STRENGTHS/ WEAKNESSES
Asplin 1994	Adult non-traumatic OOHCA from September 1992 to October 1993. Study groups: patients	Level II	ETCO2 levels after 1 minute and 2 minutes of CPR, and the max ETCO2	27 patients with non-traumatic OHCA were studied. At 1 minute, ETCO2 was higher in patients with ROSC	Small group of patients were studied. Larger studies are needed to further define its effectiveness

	who had ROSC and patients who did not have ROSC		level attained.	compared to those without ROSC (23.0 vs. 13.2, p=0.002). At 2 minutes ETCO2 was also higher in patients with ROSC (26.8 vs. 15.4, p=0.019). The max ETCO2 during CPR was also higher in the ROSC group (30.8 vs 22.7, p=0.0154).	
Eckstein 2011	Adult non-traumatic OOHCA from January 1, 2006 to December 31, 2007 in Los Angeles CA. Only patients on whom resuscitated efforts were initiated by paramedics were included.	Level II	The primary outcome was ROSC in the field. Regression was used to determine which variables were associated with ROSC.	3,121 patients were included in the study. 1,689 (54%) were witnessed arrests and 516 (17%) were primary VF. The mean initial ETCO2 for all was 18.7 (95%CI = 18.2-19.3). ROSC was achieved in 695 (22%): mean initial ETCO2 27.6 (95%CI = 26.3-29.0). Patients who failed to achieve ROSC: mean initial ETCO2 16.0 (95%CI = 15.5-16.5). The following were significantly associated with ROSC: - witnessed arrest (OR = 1.51; 95%CI = 1.07-2.12), initial ETCO2 >10 (OR = 4.79; 95%CI = 3.10-4.42) - ETCO2 falling <25% of baseline (OR = 2.28; 95%CI = 2.01-3.97). The combination of male gender, lack of bystander CPR, unwitnessed arrest, non-VF arrest, initial ETCO2 ≤10 and ETCO2 falling >25% was 97%	Inaccuracy of data was possible; hand-written data records were used because electronic downloads was not available at the time. ROSC was used as the primary outcome variable, which is only a surrogate marker of survival.

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				predictive of failure to achieve ROSC.	
Heradstveit 2012	All Adult non-traumatic OHCA between January 2004 to December 2009 in Bergen, Norway.	Level II	If the following factors affect ETCO2 in OOHCA: cause of arrest, initial rhythm, bystander CPR and time. This service treated 918 OHCA patients and Capnography was present in 575 Patients.	575 OOHCA patients with ETCO2 used were included. Capnography distinguished well between patients with or without ROSC for any initial rhythm and cause of arrest ($p<0.001$). Clinical studies, ETCO2 >2.4KPa after 20 min has been shown to predict ROSC and Values <1.3KPa have been associated with no ROAC Cardiac arrests with respiratory cause had significantly higher levels of ETCO2 compared to primary CA ($p<0.001$). The impact of Bystander CPR affected the ETCO2 significantly ($p=0.003$). Initiation of bystander CPR within four minutes after the cardiac arrest resulted in higher values of ETCO2 while CPR started later resulted in lower values. Over time, the trend was decreasing values of ETCO2.	A weakness in the study is the method used for ETCO2 recordings. The anaesthesiologist only observed during the first 15 min after arrival on scene and then registered the values manually without any further validation of data. Since the tidal-wave capnograph had no automatic recordings, the registered minimum, maximum and average ETCO2 from each patient were based on the anaesthesiologist judgment

Comments:

Three studies were chosen. One study was over a twelve month time frame, the other was thirteen months and the last study was for a period of five years. The Asplin study found that patients who had ROSC has higher

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ETCO2 levels after 1 and 2 minutes of CPR, and higher ETCO2 levels overall, compared to patients without ROSC. The larger Eckstein study also found higher ETCO2 levels in patients who had ROSC, compared to patients who did not, as did the Heradstveit study, which also found ETCO2 levels differ between patients who have OOHCA due to a respiratory cause compared to other causes.

All three studies used a dichotomous model; (CO2>10 or ≤10) ETCO2 values. Initial ETCO2 of ≤10 mmHg is the strongest predictor of mortality on the setting of CA. This is from previous clinical studies where it reported a correlation with ROSC above and below these values. Patients with an ETCO2 >10mmHg were four times more likely to survive relative to those patients with ETCO2 <10mmHg (Eckstein 2011). An initial ETCO2 >10 is associated with almost five-fold higher rate of ROSC in OHCA. In addition, a decrease in ETCO2 during resuscitative events of >25% was associated with a significant increase in mortality, independent of other variables known to effect outcome.

Consider: *Why would you NOT change practice, based on this article?*
There is sufficient evidence that ETCO2 is important in detecting patients who may have ROSC. Paramedics need to have a full understanding of the factors that can complicate using ETCO2 measures to make this determination.

Clinical Bottom Line:
Quantitative ETCO2 measures are a valuable prognostic tool for use in OOHCA.

References:
Asplin BR, White RD. Prognostic value of end-tidal carbon dioxide pressures during out-of-hospital cardiac arrest. *Ann Emerg Med* June 1995; 25 (6):756-761.

Eckstein M, Hatch L, Malleck J, McClung C, Henderson S. *Prehosp Dis Med* 2011; 26(3):148-150.

Heradstveit BE, Sunde K, Sunde GA, Wentzel-Larsen T, Heltne JK. Factors complicating interpretation of capnography during advanced life support in cardiac arrest – a clinical retrospective study in 575 patients. *Resus* 2012; 83 (7) 813-818