[C-27] End-Tidal directed cardiopulmonary resuscitation results in increased survival rates

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Introduction: Neonatal cardiopulmonary resuscitation (CPR) requires the delivery of optimal chest compressions to maximize the chance for return of spontaneous circulation (ROSC) and minimize neurologic injury from cardiac arrest. Current guidelines for neonatal resuscitation suggest that compressions be performed at a rate of 100 per minute and to a depth of 1/3 the anteroposterior (AP) chest diameter. Estimating an infant's AP diameter and delivering compressions to 1/3 this depth is technically difficult with proper rate and interposing appropriate ventilations. Adult and pediatric studies have demonstrated that this is frequently not achieved.
End-tidal carbon dioxide (ETCO2) detection is a commonly available, noninvasive, monitoring technique that provides an estimation of cardiac output during CPR. American Heart Association (AHA) guidelines indicate that ETCO2 monitoring is an indicator of cardiac output during CPR but that "further research is needed to define the capability of ETCO2 monitoring to guide more aggressive interventions". There are no reports of using ETCO2 levels to guide the performance of chest compressions or other resuscitation efforts.
ETCO2-directed chest compression describes a novel technique that uses these levels to guide the rescuer to vary the rate, force, depth, or hand position during chest compressions to achieve maximal ETCO2 levels (surrogate of blood flow) during CPR. We hypothesize that ETCO2-directed will be at least as effective as optimized-standard CPR.
Methods: Piglets were divided equally into an ETCO2-directed and an optimized standard group. Piglets weighing 2.5–4.0 kg and 4–12 day-old piglets underwent 14 minutes of asphyxia. Ventricular fibrillation was induced for a "no-flow" state for 6 minutes. Basic life support (BLS; compressions/ventilations) was carried out for 10 min followed by 10 min of advanced life support (ALS; compressions/ventilations, epinephrine, and defibrillation).
For ETCO2-directed CPR, rescuers maximized their chest compression depth, force, rate, and hand placement to achieve the maximum ETCO2 level. This strategy was compared to standard chest compressions optimized by using a depth marker, video input, and verbal input from a second rescuer to provide the AHA recommended rate of 100/min and depth of 1/3 the AP diameter.
Results: Twenty-eight animals were studied (14 in each group). ROSC was the primary outcome (survival) and was defined as 20 min of native heart rate and blood pressure. Resuscitation results from our preliminary data are shown in the Table. ROSC percentages for ETCO2-directed chest compressions were significantly better than those for optimized-standard CPR in this model of more severe injury ($p = .043$). The injuries seen on autopsy were similar in both groups.
Conclusion: ETCO2-directed chest compressions prove to be superior with improved survival when compared to optimized-standard CPR in a piglet model with a severe hypoxic arrest.

Table	Resuscitation findings			Injuries on autopsy		
Group	ROSC	Defibrillation Attempts	# Epi doses	Liver laceration	Epicardial hemorrhage	Hemo-thorax
$ETCO_2$-directed	7/14 (50%)	3.6	2.3	0/14	10/14	3/14
Optimized-standard	2/14 (14%)	4.0	2.7	0/14	3/14	1/14

ROSC=Return of spontaneous circulation, Epi=epinephrine