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Rapid Brain Cooling is Enhanced with Active Compression-Decompression plus Inspiratory Impedance Threshold Device CPR in a Pig Model of Cardiac Arrest

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Introduction: The combination of active compression-decompression (ACD) cardiopulmonary resuscitation with an inspiratory impedance threshold device (ITD) increases vital organ blood flow >300% compared with standard CPR. Rapid, ice-cold saline flush enhances cooling in humans following CPR and return of spontaneous circulation, but successful cooling has not been reported with this technique during CPR.

Objective: We hypothesized that enhanced iced saline bolus perfusion with ACD + ITD CPR (ACD-ITD) would cool brain tissue more effectively than with standard CPR (S-CPR) during cardiac arrest resuscitation.

Results: 16 propofol anesthetized pigs (24 ± 3 kg) with cuffed tracheal tubes and ventricular fibrillation cardiac arrest induced x 8 min without intervention were randomized to receive either ACD-ITD CPR (n = 8) or S-CPR (n = 8). After 2 min of CPR, 30 ml/kg, 0° C. iced 0.9% saline was infused over the next 3 min of CPR via central femoral vein followed by transthoracic defibrillation attempts (150 J, biphasic waveform, Zoll) and ACLS resuscitation protocol. If fibrillation persisted, epinephrine (40 μg/kg) plus vasopressin (0.3 U/kg) was circulated with 2 min CPR and 3 more defibrillation attempts. All 8/8 (100%) ACD-ITD pigs survived vs. 3/8 (38%) S-CPR pigs ($p<0.05$, Fisher Exact). In survivors, brain temperature (° C.) measured at 2 cm depth in brain cortex 5 min after return of circulation decreased from 37.6 ± 0.2 to 35.6 ± 0.3 in ACD-ITD vs. 37.8 ± 0.2 to 36.3 ± 0.3 in S-CPR. Immediately prior to defibrillation right atrial systolic/diastolic pressures (mmHg) were 85 ± 19 / 4 ± 1) in ACD-ITD than S-CPR pigs (141 ± 12 / 8 ± 3, $p<0.01$, Wilcoxon Rank Sum). Coronary perfusion pressures were higher in ACD-ITD (77 ± 4 mmHg) than S-CPR pigs (27 ± 3 mmHg, $p<0.01$, Wilcoxon Rank Sum).

Conclusions: Use of ACD + ITD CPR, but not S-CPR, resulted in adequate coronary perfusion pressure, rapid cerebral cooling *during* CPR, and 100% survival. Survival was enhanced by lower right atrial pressures and higher coronary perfusion pressures during ACD + ITD CPR. A rapid ice-cold saline infusion and ACD-ITD resuscitation approach could be used during cardiac arrest and CPR to improve the efficacy of brain cooling and the chances for normal neurologic recovery.