

Title: CARDIAC RESUSCITABILITY AND NEUROLOGIC RECOVERY AFTER CLINICALLY RELEVANT CARDIAC ARREST OF 20 MIN WITH CARDIOPULMONARY BYPASS VS. CARDIOPULMONARY RESUSCITATION, IN DOGS

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Introduction. Clinically feasible emergency cardiopulmonary bypass (CPB) by veno-arterial pumping via oxygenator without thoracotomy, primed with plasma substitute, has demonstrated superior cardiovascular resuscitability from and survival after prolonged ventricular fibrillation cardiac arrest (VFCA) than standard external cardiopulmonary resuscitation (CPR)-advanced life support (ALS) (1,2). In preparation for new trials of cerebral resuscitation potentials (3), we conducted this study with a new clinically relevant dog model of prolonged VFCA (no flow) followed by prolonged CPR. We compared cardiac resuscitability and neurologic outcome following CPR-ALS vs. CPB.

Methods. 27 male coon hounds of similar weight and age, while under light anesthesia, received the following insult: VFCA (no flow) of 10 min, followed by CPR-BLS of 5 min (with standard external CPR and IPPV with room air). This was followed by CPR-ALS with IPPV O₂ 100%, epinephrine and NaHCO₃ i.v., according to Amer. Heart Assoc. standards. In alternating sequence, dogs of the CPB group (n=14) received CPR-ALS from min 15 to 20, when CPB was started, and then the first countershock for defibrillation attempt at 22 min. CPB without thoracotomy included hemodilution to hct of about 25% (priming with plasma substitute), heparinization, and a standardized deliberate hypertensive bout by norepinephrine. Pumping was from venae cavae via oxygenator to femoral artery. CPB was for controlled circulation during the first 3 min or longer until restoration of spontaneous heart beat by defibrillation, and then continued as assisted circulation for 4h, with the heart beating to vent the left ventricle. In the CPR-ALS control group (n=13), the first countershock was already at 17 min, since the efficacy of CPR-ALS to restore adequate spontaneous circulation was not known. CPR-ALS was then continued as necessary. The total insult time (no flow plus low flow time) was deliberately longer in the CPB group, to simulate the time required for cannulation to initiate CPB after a failure of CPR-ALS. Both groups received standardized intensive care with IPPV to 20h, weaning to spontaneous breathing at 20-24h, and intensive care to 96h. Outcome was measured as overall performance categories (CPC) #1 (normal), #2 (moderate disability), #3 (severe

disability), #4 (coma), and #5 (death); as Neurologic Deficit (ND) scores 0% (best) - 100% (worst); and as canine coma scores (CCS) 15 (best) - 3 (worst).

Results. There were no significant differences in pre-arrest and post-arrest life support variables. Restoration of spontaneous circulation attempts by CPR-ALS in the control group failed in 2 of 13 dogs; and succeeded in all 14 dogs of the CPB group with 1-5 countershocks. 10 dogs in each group survived in protocol to 96 h. For reasons mentioned in "methods", the CPB survivors had a mean total ischemia time 4.6 min longer than the CPR-ALS survivors ($p < 0.001$). Coronary perfusion pressure at the time of defibrillation, i.e., at 17 min of VF in the CPR-ALS control group vs. 22 min in the CPB group, was 40 ± 10 mmHg vs. 59 ± 16 mmHg ($p < 0.005$). OPC #1 (normal) at 96h was achieved by 6 of 10 dogs in the CPB group vs. 5 of 10 in the CPR-ALS control group (NS). Mean ND scores at 96h were $14 \pm 19\%$ in the CPB group vs. $20 \pm 20\%$ in the CPR-ALS control group (NS). CCS were 13 ± 3 in the CPB group vs. 12 ± 3 in the CPR-ALS control group (NS).

Discussion-Conclusions. In a clinically relevant prolonged cardiac arrest model in dogs, simulating the failure of CPR-ALS to restore spontaneous circulation, CPB resulted in better coronary perfusion pressures and cardiovascular resuscitability. CPR-ALS for restoration of spontaneous circulation adds an uncontrollable variable low flow insult which makes such models less suitable for evaluation of cerebral resuscitation potentials. CPB after a 20 min total insult gave the same neurologic outcome as CPR after 17 min total insult.

References.

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