External Cardiac Defibrillation During Wet Surface Cooling in Pigs

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BACKGROUND
Prior studies have shown that resuscitative mild hypothermia (approximately 3-5°C below normal body temperature) can reduce the level of damage to vital organs, including the brain, following cardiac arrest.

Life Recovery Systems (Life Recovery Systems HD, LLC, Kinnelon, NJ) has developed an advanced surface cooling system, the ThermoSuit System™ (TSS) (fig. 1), for rapid cooling of the patient. Our objective was to prove the safety of performing transthoracic defibrillation in a wet condition during the use of the TSS, in case a converted patient requires defibrillation again while being cooled. Therefore, we compared the defibrillation success in dry and wet conditions after one minute of ventricular fibrillation cardiac arrest.

METHODS
Six pigs (28-35 kg) were anesthetized and mechanically ventilated. Ventricular fibrillation (VF) was electrically induced with a catheter advanced into the right ventricle. After one minute of VF, pigs were transthoracically defibrillated with AED pads. After restoration of spontaneous circulation (ROSC) and a recovery period of 20 minutes, the procedure was repeated. In group A (n=3), pigs were put into VF and defibrillated first in the dry condition, and then in the wet condition. In group B (n=3), the setting was first wet and then dry. Success of defibrillation was defined as ROSC, and current and voltage of the defibrillation signal were measured (fig. 2). Leakage current was estimated by calculation of the area under the curve (AUC) of the current-time curves during the first shock in both dry and wet conditions.

RESULTS
All animals achieved ROSC. In the dry condition, 2 pigs achieved ROSC after 1 shock and 4 pigs after 2 shocks. In the wet condition, 5 pigs achieved ROSC after 1 shock, and 1 pig after 2 shocks (p=0.083) (fig.3). The current-AUC in both dry and wet conditions were 144±3 mAs (p=0.96). This concordance indicates that no appreciable leakage current exists in the wet condition. No skin lesions (e.g. burns) were observed on the areas under the defibrillation pads.

CONCLUSIONS
Trans-thoracic defibrillation with AED pads is safe and effective in a wet condition after cooling with ice-cold water in a pigVF cardiac arrest model. Thus this new cooling device needs further exploration in cases of cardiac arrest in humans.

Figure 1: Test pig in LRS-ThermoSuit™ System

Figure 2: example of voltage and current curves of the defibrillation signal in dry and wet conditions.

Figure 3: Comparison of defibrillation success in dry and wet conditions (a point represents one pig). P=0.083. ROSC: restoration of spontaneous circulation