

# Measurement of Depth, Thrust and Thoracic Impedance During Mechanical Cardiopulmonary Resuscitation: Is Thoracic Impedance a Potential Indicator of Effective External Cardiac Massage in a Porcine Model of Cardiac Arrest?

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**Purpose of the Study:** The 2010 AHA guidelines currently recommend a depth of at least 2 inches (5cm) during external cardiac massage. The purpose of this study was to determine if the use of an alternative measure to depth could assist in quantifying the effectiveness of CPR in an out-of-hospital setting and to determine how achievable depths of at least 2 inches are in experimental models of cardiac arrest.

**Materials and Methods:** A total of 12 porcine models were used each weighing  $30.7 \pm 4.2$ kg. Depth (mm), thrust (kg); End-tidal CO<sub>2</sub>, and Cardiac Output (CO) were measured at 2 minute intervals for each model. The Impedance Cardiogram (ICG)/Thoracic Impedance (non-invasive measure of cardiac output) was recorded via 2 standard defibrillation electrodes, as a method of detecting the presence of effective CPR. Ethical approval was granted by the Northern Ireland Home Office. Models were anaesthetised using Isoflurane and connected to a Datex Ohmeda® for anaesthesia monitoring. Depth and rate of CPR were continuously measured using Q-CPR®, Philips. CPR was administered using the HLR-201®, Michigan Instruments. Recordings from each experiment were acquired using the Datex Ohmeda for statistical analysis using Microsoft Access®.

**Results:** During CPR, cardiac output was maintained at an average of 21% of normal CO levels. At thrusts of 60kg and a rate  $112 \pm 2$  compressions per minute, the average depth (using Q-CPR®, Philips) achieved using a stabilised mechanical CPR system was  $37.12 \text{mm} \pm 3$  ( $1.46 \pm 0.12$  inches). Using the HLR-201®, Michigan Instruments the average depth achieved was 50mm (1.97 inches). A strong linear correlation was achieved when comparing depth (mm) using Q-CPR® and the thrust (kg) using the HLR-201®, Michigan Instruments;  $r=0.856$ . In addition a strong linear correlation was attained when the Impedance cardiogram (ICG) (ohms) was compared with depth (mm) using Q-CPR®, Philips of;  $r=0.86$ .

**Conclusions:** A depth of at least 2 inches was almost unattainable in this porcine model, even at thrusts of 60 kg. An algorithm will incorporate the results from this study, providing feedback to the operator on the quality of CPR by measuring the ICG amplitude which has been strongly correlated with standard measures of depth as well as a number of physiological parameters.

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