Use of the Impedance Cardiogram in Public Access Defibrillators as an indicator of Cardiopulmonary Resuscitation effectiveness

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The ERC guidelines place a greater emphasis on the importance of external cardiac massage and advocate the prompt initiation of effective bystander cardiopulmonary resuscitation (CPR) to significantly reduce mortality due to out-of-hospital cardiac arrest. An algorithm has been developed for a Public Access Defibrillator (PAD) which utilizes distinctive features from the impedance cardiogram (ICG) signal recorded from defibrillator pads to ensure effective chest compressions are administered by the operator.

A retrospective analysis of simultaneously recorded ECG and ICG signals which included episodes of CPR was carried out. Data were collected following ethical approval, marked and documented by physicians at the Royal Victoria Hospital in Belfast, UK. CPR was administered by trained personnel. A total of 211 patients were recruited and the random training set included 106 cases. The rate of compression (speed) can be calculated by counting the outstanding waves in the ICG signal during CPR: every time an absolute maximum in a window is reached a wave is counted. Local maxima can interfere in this process. Additionally the base-to-peak amplitude of the ICG signal was analyzed. If it is greater than a minimum threshold, it was classified as adequate CPR. Furthermore additional cut-offs were employed to further sub-categorize the amplitudes into levels of CPR force.

Sensitivities and specificities for detecting adequate speed for CPR at every second recorded were 95.38% and 93.11% in the training set (82377s analyzed) and 91.45% and 96.27% in the validation set (79826s). Sensitivities and specificities for detecting adequate force for CPR at every second were 99.96% and 98.47% in the training set (108728s) and 99.94% and 97.91% for the validation set (91973s).

Both CPR speed and CPR force can be continuously monitored and consequently the PAD can advise (using audio and visual messages) both lay users and minimally trained bystanders to ensure CPR effectiveness.