



# Feasibility of the finger photoplethysmography to give feedback on chest compression rate

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## INTRODUCTION

Chest compression (CC) rate during cardiopulmonary resuscitation (CPR) is associated with patient survival in out-of-hospital cardiac arrest (OHCA) and current ERC guidelines [Ref. 1] recommend CCs at 100-120 min<sup>-1</sup>. The photoplethysmogram (PPG) obtained using finger pulse oximeter estimates the oxygen saturation, and the PPG waveform shows amplitude changes with CCs.

The aim of this study was to analyze the feasibility of using the finger PPG to provide feedback on CC rate during OHCA.

## MATERIALS AND METHODS

### Data collection

Records of 46 patients acquired with Zoll E-Series defibrillator by the DFW Center for Resuscitation Research (UTSW, Dallas) and the Clackamas County FireDistrict # 1 (Clackamas, Oregon). Each record included the PPG and the CC-wave/CC-depth signals acquired by the CPR-assist padZ (Fig. 2). The instants and depth of every CC was available from the CC-depth (ground truth).



Figure 1. Zoll AED with padZ

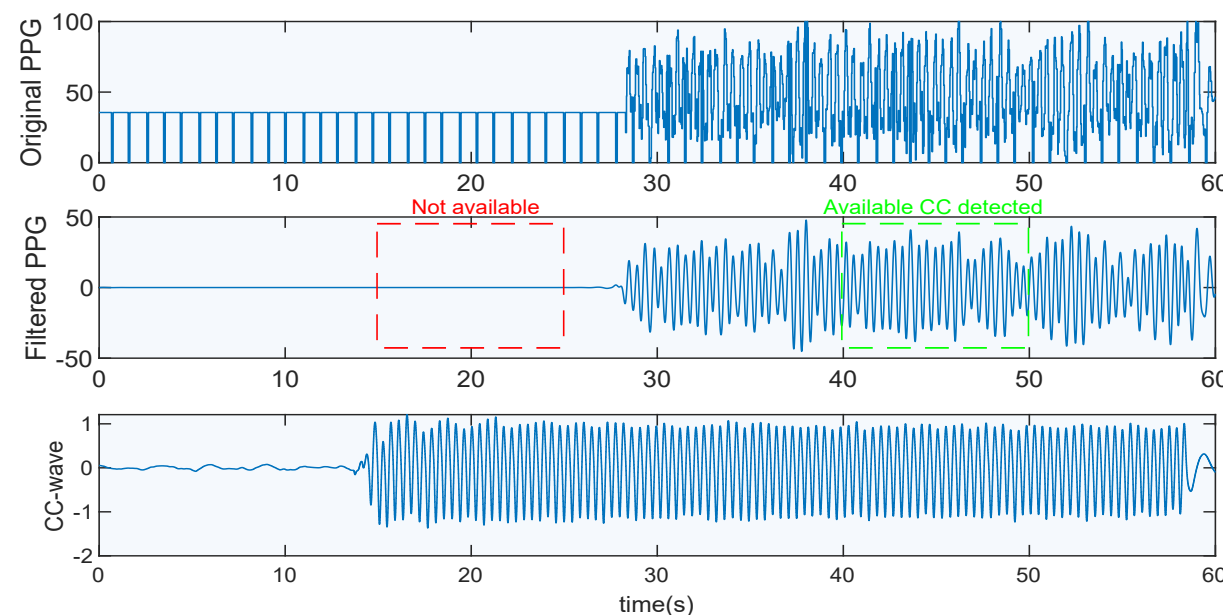


Figure 2. The PPG signal as provided by the device (upper) and after processing (middle); the CC-wave signal from the CPR-assist padZ used as reference (bottom). Two analysis windows are shown where the PPG was not available (red) and where CC are detected (green)

### Automatic algorithm

An automatic algorithm analyzed the PPG every 5s and detected available PPG, presence of CCs and CC-rate (Detailed in Ref. 2)

- 1: Amplitude analysis to check PPG availability
- 2: Preprocessing and Kaiser ( $\beta=3$ ) windowing of 10 s (5 s overlap)
- 3: CC presence detection by power concentration criteria in the power spectrum density (PSD)
- 4: CC-rate computing based on the steepest peak of the PSD

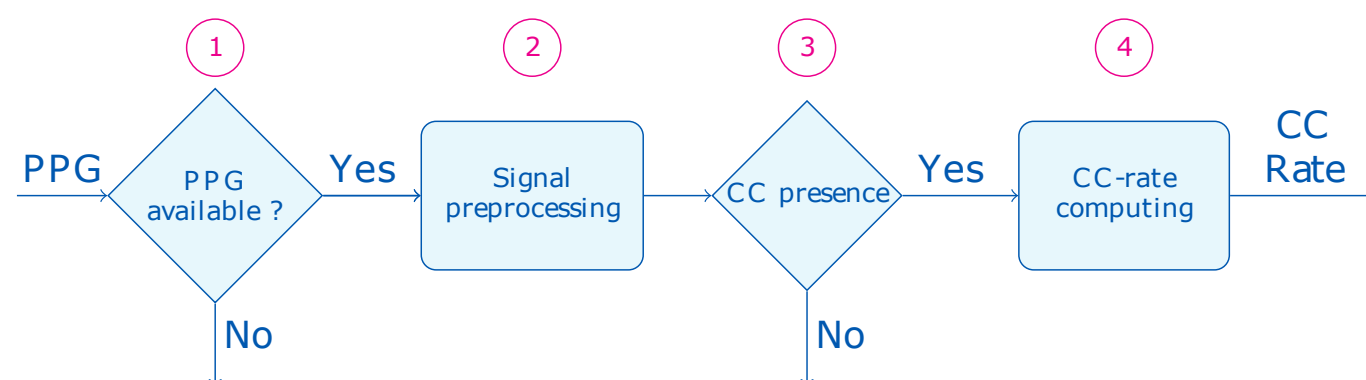


Figure 3. Algorithm scheme for processing the PPG.

## ANALYSES

The CC-depth signal (CPR-padZ) was used as the reference signal to evaluate the algorithm proposed on the PPG. Analyses were performed to compute the following:

- Percentage of available PPG signal
- Sensitivity (SE)/positive predictive value (PPV) for detecting the presence of CCs
- CC-rate absolute error
- Accuracy to trigger alarms for CC-rates out of 90-120 min<sup>-1</sup>.

## RESULTS

A total of 420 min (9.1±7.6 min per patient) were processed. 4971 segments were analyzed, 4319 including CCs with mean(SD) rate of 116(15) min<sup>-1</sup>.

### PPG signal available

17% of the time

### CC presence detection

SE= 86.2% PPV= 95.4%

### CC-rate absolute error

Mean(SD)= 2.4 (6.3) min<sup>-1</sup>

### CC-rate alarm

SE= 80% SP= 98.03% PPV= 87.2%

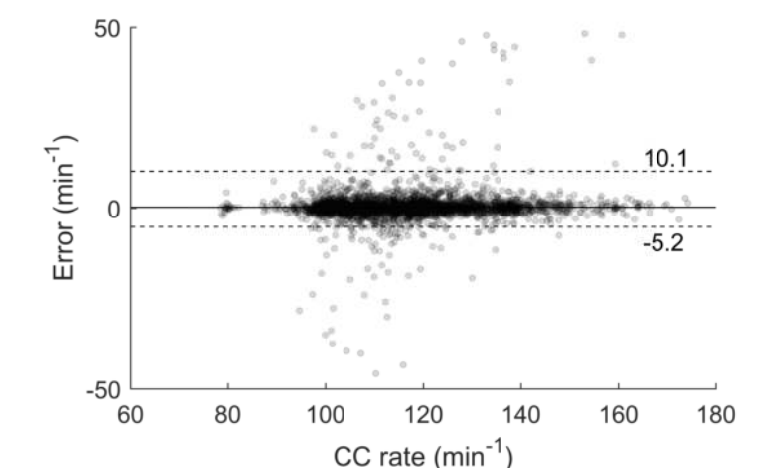


Figure 4. Bland-Altman plot for the CC rate error. The continuous line shows the mean error, and the dashed lines depict the 95% level of agreement.

## CONCLUSIONS

① When available, the finger PPG signal reliably gives feedback on CC rate

Ref. 1 Nolan, Jerry P., et al., "European resuscitation council guidelines for resuscitation 2010 section 1. Executive summary." Resuscitation 81.10 (2010): 1219-1276.

Ref. 2 A. Elola, et al., "Finger Photoplethysmography to Monitor Chest Compression Rate during Out-of-Hospital Cardiac Arrest." Computing in Cardiology Conference (CinC), 2018.