Realtime Detection of Spontaneous Circulation in Humans During Cardiopulmonary Resuscitation Using a Continuous Hands-Free Carotid Doppler: A Cardiac Arrest Pilot Study

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INTRODUCTION

During cardiopulmonary resuscitation (CPR), accurately identifying the return of spontaneous circulation (ROSC) and ensuring the quality of chest compressions is challenging.

Methods like manual palpation, end-tidal carbon dioxide (EtCO2) measurement, and point-of-care ultrasound can be inaccurate, time-consuming and intermittent.

There is currently a need for a non-invasive, continous, real-time personalised tool to guide CPR.

AIM

To evaluate whether a novel continuous hands-free carotid Doppler ultrasound system, RescueDoppler (RD), can detect velocities generated by chest compressions and spontaneous circulation during CPR in humans.

METHODS

In this pilot study, we included both pre- and in-hospital adult cardiac arrests patients to assess the feasibility and clinical utility of RD. The RD probe was positioned over the left common carotid artery using a hydrogel patch by the cardiac arrest team after defibrillator pads were applied. The team was blinded to the real-time ultrasound data for ethical reasons. CPR followed ERC guidelines. Data collected included ECG (Corpuls, Zoll), RD pulse-wave Doppler blood flow velocity curves from the carotid artery, chest compression accelerometer readings, and end-tidal CO2, all synchronized in Matlab.

Informed consent was obtained post- cardiac arrest from relatives or the patient.

Figure 1

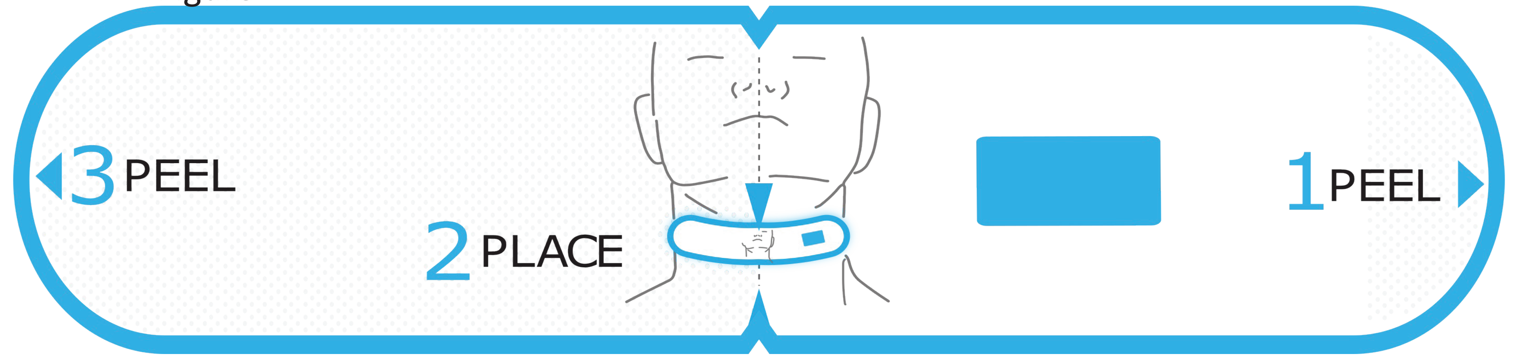


Figure 2

Figure 1. RescueDoppler application guide.

Figure 2.. RescueDoppler probe and selfadhesive patch.

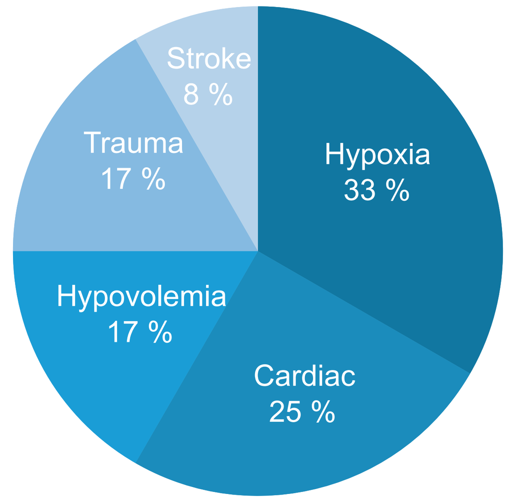
RESULTS

We included 12 CA patients (9 men, mean age 60.6±18.4 years), treated out-of-hospital (n=6) and in-hospital (n=6).

The RD patch was applied for an average of 35 minutes. Mechanical compression was used in one patient, a chest compression accelerometer in 5 patients and end-tidal CO2 monitoring in 8 patients.

Eight patients achieved ROSC, with 3 later dying; 7 patients died overall.

Causes of CA



Initial Rhythms

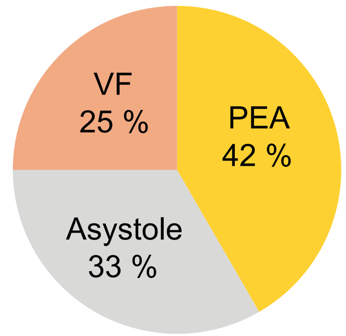
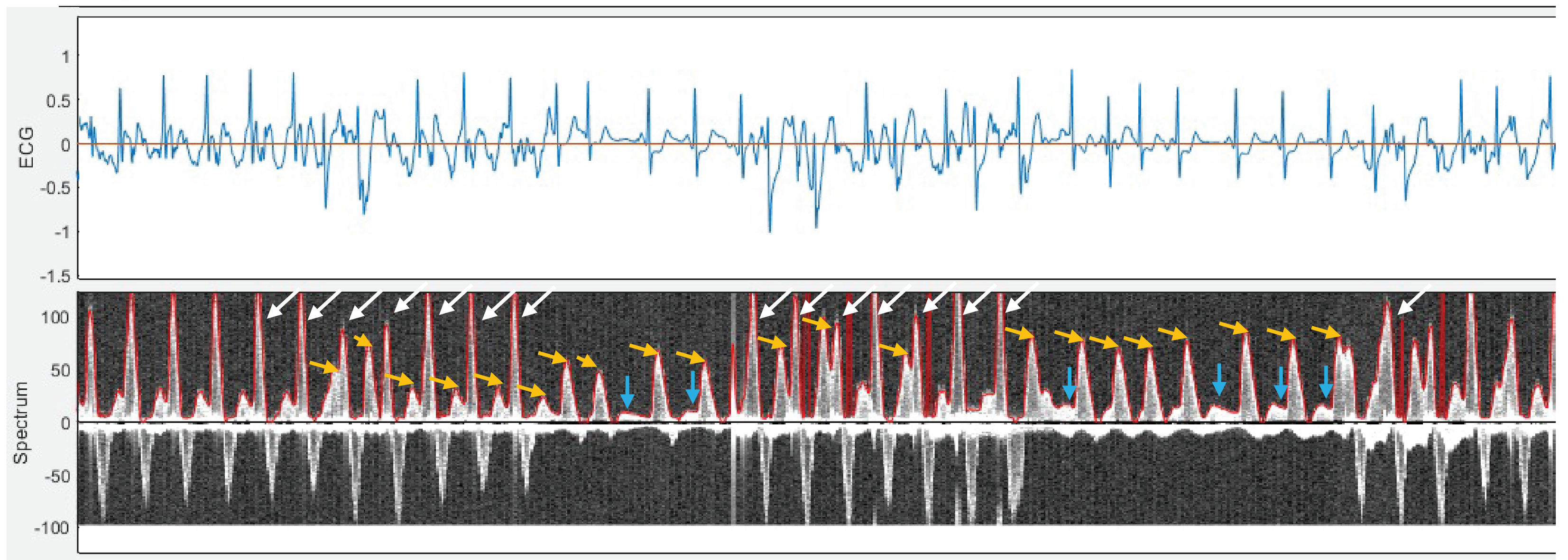
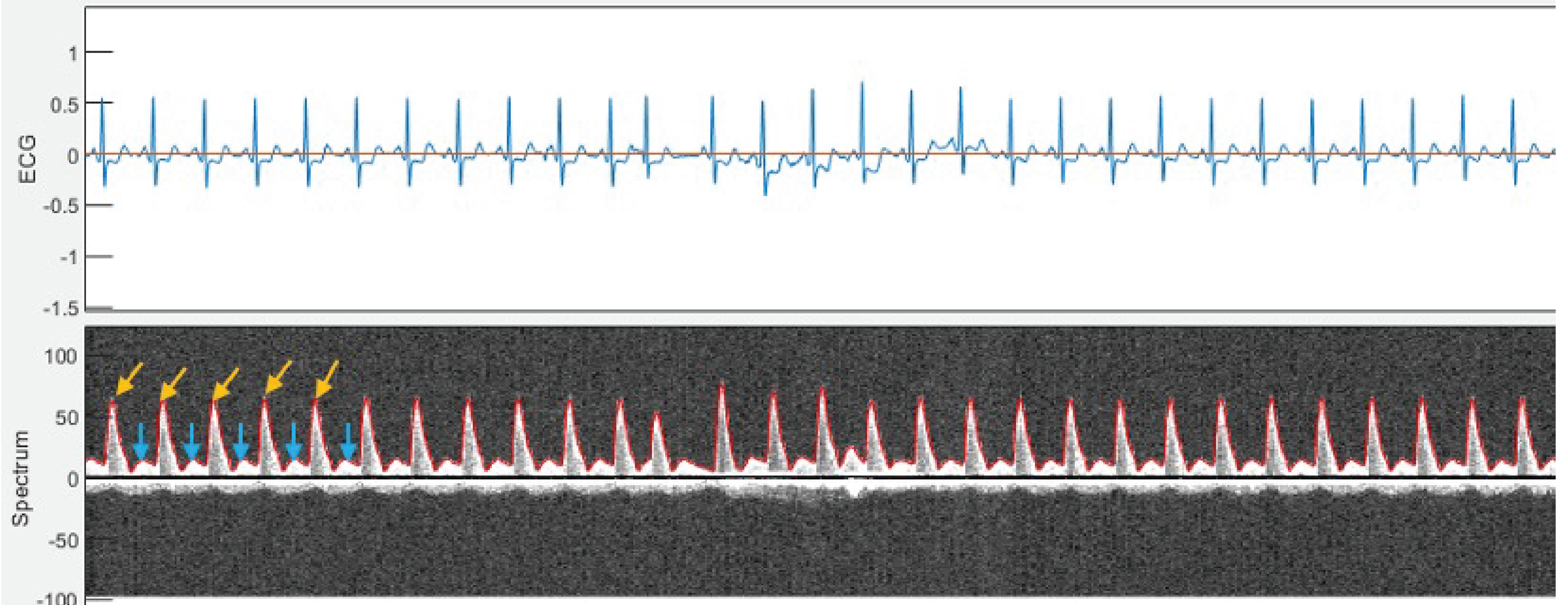


Figure 3



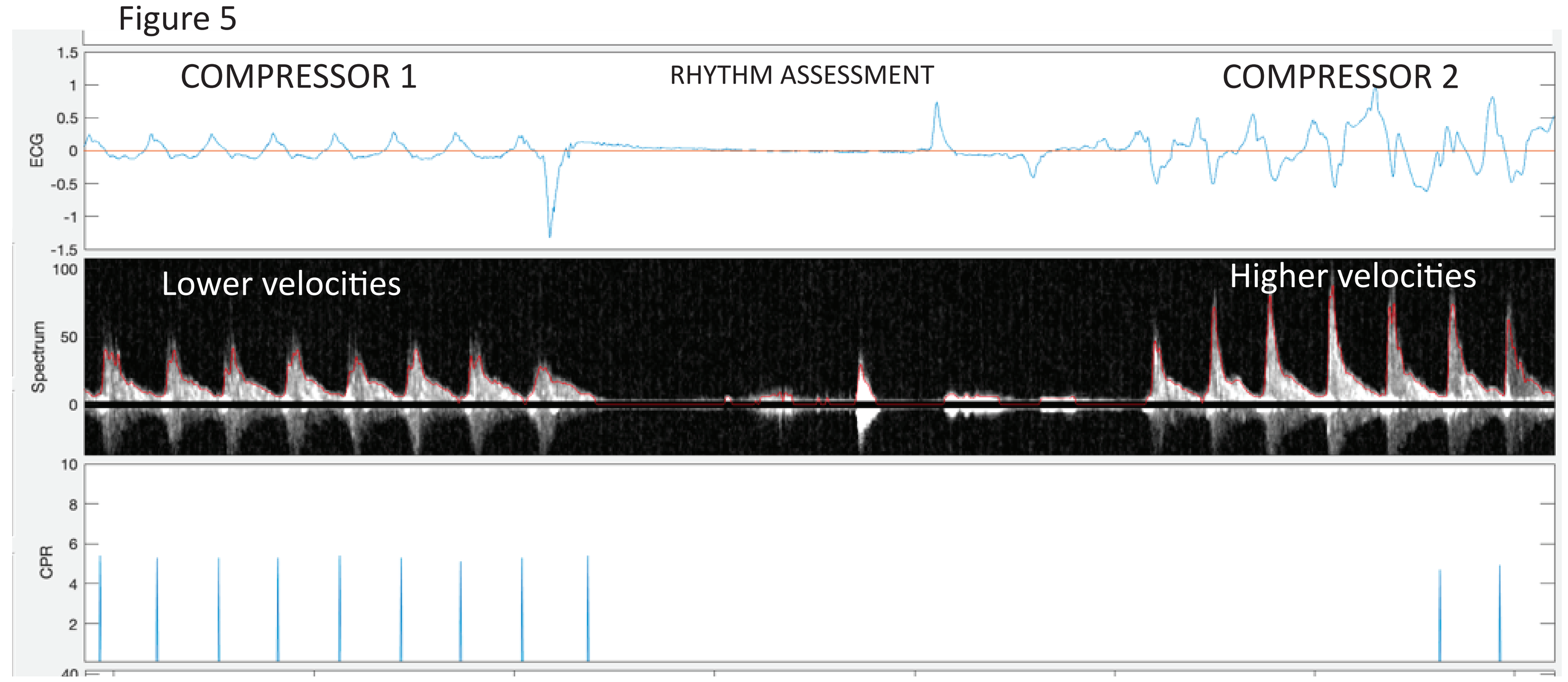
Spontaneous circulation observed during rhythm assessments and between chest compressions during CPR. Upper panel ECG, lower panel carotid blood flow velocity.

Figure 4



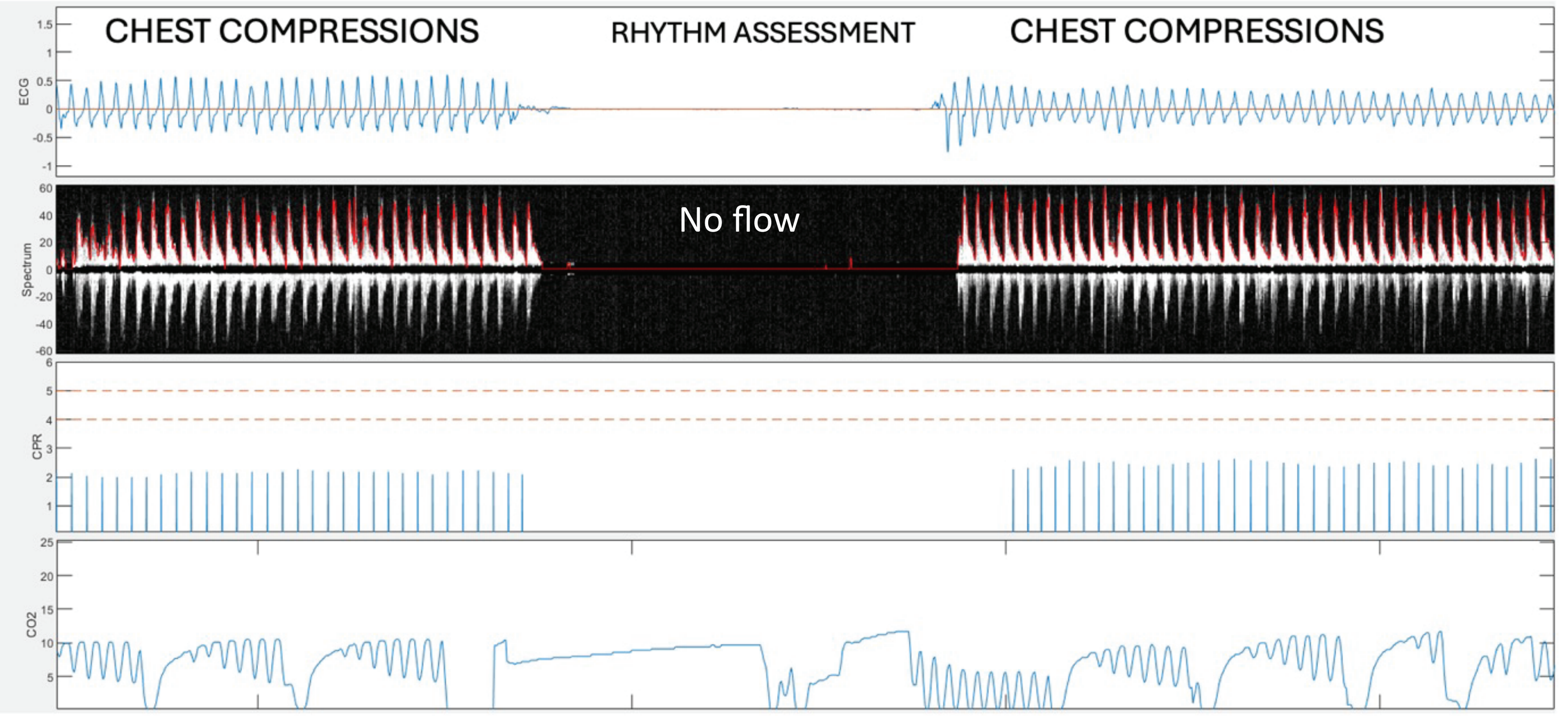
ROSC. Upper panel show ECG with sinus rhythm and lower panel carotid blood flow velocity with both systolic and diastolic velocities.

Figure 5



Chest compression-generated peak carotid blood flow velocity by two different compressors. Upper panel ECG, second panel carotid blood flow velocity, third panel chest compression accelerometer signal.

Figure 6



Absence of blood flow at rhythm assessment during asystole. Upper panel ECG, second panel carotid blood flow velocity, third panel chest compression accelerometer signal, lower panel end-tidal CO2.

CONCLUSION

Hands-free continuous carotid blood flow monitoring is feasible during CPR and cardiac arrest in humans. RescueDoppler successfully detected spontaneous circulation and chest compression-generated blood flow, offering potential for real-time personalized CPR that could improve outcomes and save lives.

DISCLOSURES

The RescueDoppler Project has received funding from the Norwegian Research Council and from the Norwegian Health Association.

Charlotte Björk Ingul serves as a Medical Advisor at Cimon Medical. Hans Torp and Torbjørn Hergum are employed by Cimon Medical.

All other authors have no conflicts of interest.