

Validation of a smartphone-camera based software for the identification of electrodes location on human chest

Niccolò Maurizi, MD^(1,2), Carlo Fumagalli, MD^(1,2), Mattia Targetti, MD⁽¹⁾, Silvia Passantino, MD⁽¹⁾, Anna Arretini, MD⁽¹⁾, Alessia Tomberli⁽¹⁾, Katia Baldini⁽¹⁾, Niccolò Marchionni, MD⁽²⁾, Iacopo Olivotto, MD⁽¹⁾, Franco Cecchi, MD⁽³⁾

⁽¹⁾ Cardiomyopathy Unit, Careggi University Hospital, Florence, Italy ⁽²⁾Department of Experimental and Clinical Medicine, University of Florence, Italy, ⁽³⁾ARCARD Foundation, Florence, Italy.

Background.

- Smartphone are producing profound changes in diagnostics.
- Clinically **actionable** data could now be generated locally by the patient.
- Multiple-lead **ECG** is a cost-effective, valuable and non-invasive test, but its use requires trained healthcare workers to correctly record the exam (due to specific position that electrodes).

Purpose.

To validate **'Mobile ECG on other'**, a smartphone App AI algorithm that guides electrode self-placement via imaging processing technology by identifying electrode theoretical location on the patient's own chest, via the smartphone camera. The app is coupled with D-Heart®, a **multiple lead mobile ECG** designed for users with no medical background.

Methods. Methods are summarized in Figure 1 and 2.

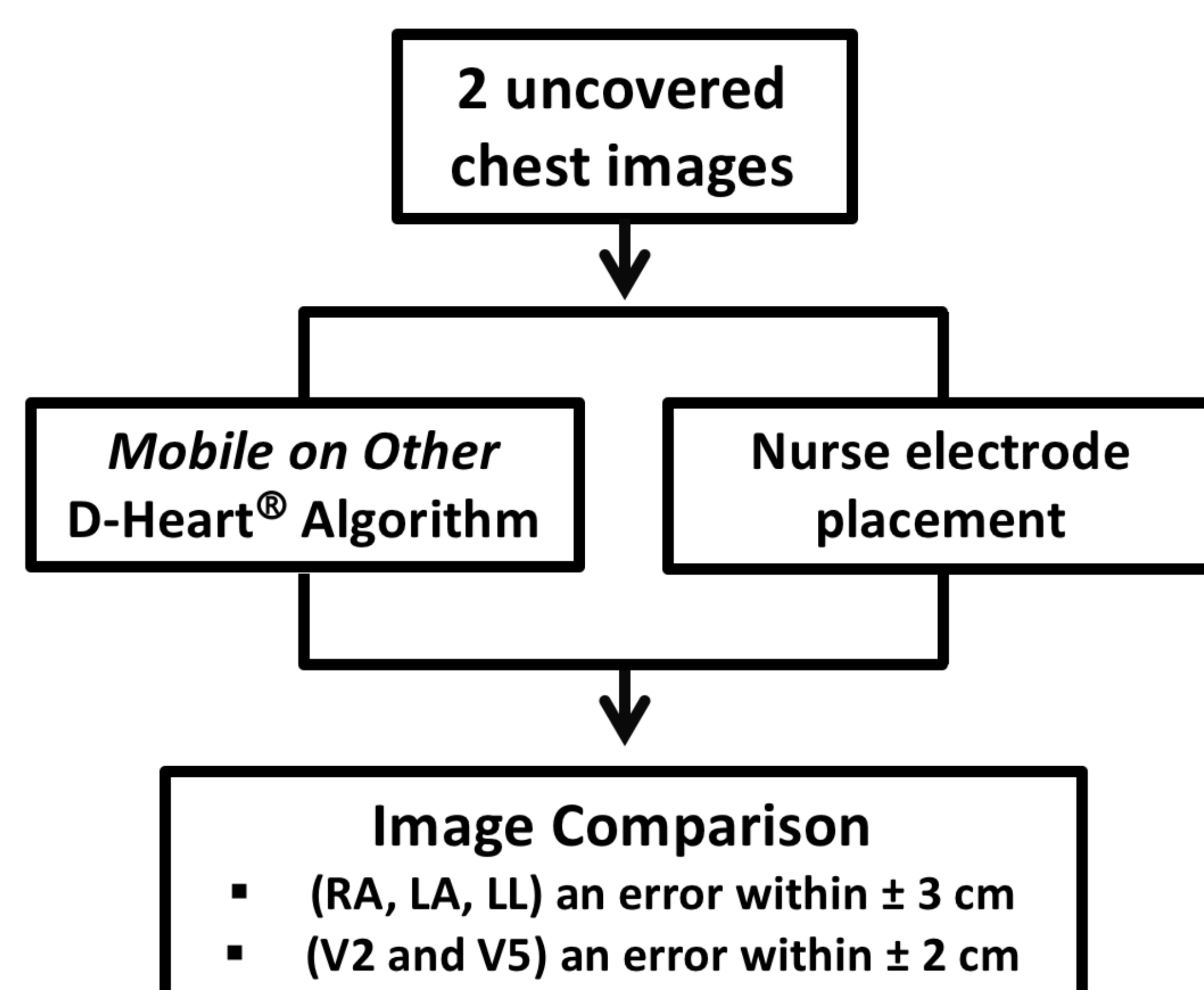


Figure 1. Validation study Enrollment and analysis



Figure 2. A. Mobile on other AI electrode placement algorithm with D-Heart. B. D-Heart mobile ECG final placement

Results. Consecutive healthy volunteers (n=40, men=30) were enrolled from June to July 2017. Results are presented in Table 1, Table 2 and Figure 3.

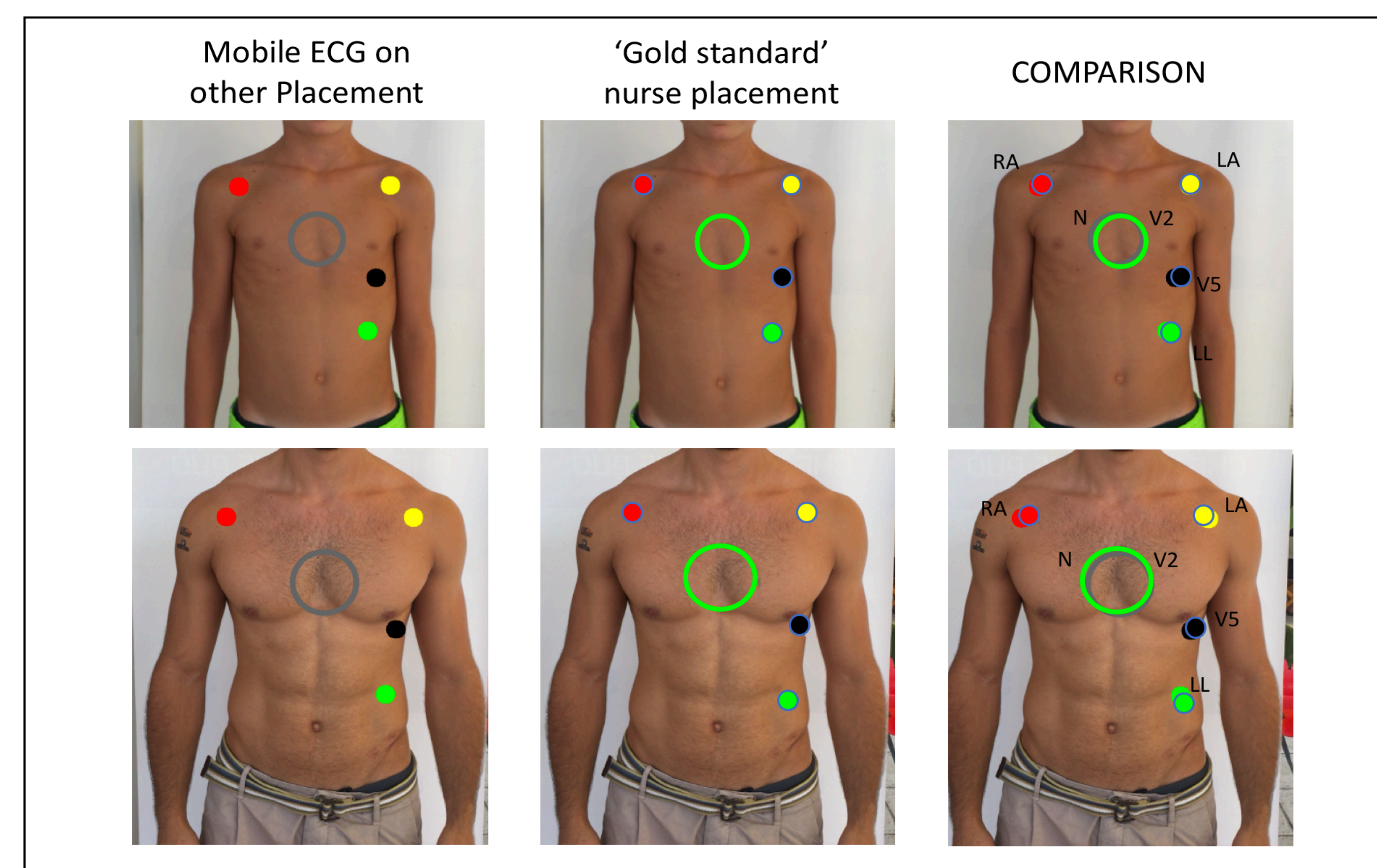


Figure 3. Mobile on Other vs Nurse placement comparison

Table 1. Median displacement in the horizontal and vertical axis for each electrode in the modality D-Heart 'Mobile ECG on other'

	Δ Height	Δ Width
RA (cm)	0.3 [0.1-1] (0-3)	0.5 [0.3-1] (0-2)
LA (cm)	0.5 [0.2-1] (0-3)	0.3 [0.2-1] (0-3)
LL (cm)	1 [0.5-1] (0-2)	0.6 [0.5-1] (0-2)
V2 (cm)	0.5 [0.1-1] (0-3)	0.5 [0.1-0.9] (0-3)
V5 (cm)	0.5 [0.1-1] (0-3)	0.5 [0.2-1] (0-1.5)

Table 2. Number of electrodes misplaced by the algorithm in the modality D-Heart 'Mobile on other ECG'.

	Misplacement (N)	Six (15%) patients had >1 electrode misplaced.
RA	1	
LA	1	
LL	0	
V2	5	
V5	4	

Mean time for ECG placement and recording (defined as the time needed for the user to open the D-Heart soft case until the beginning of the ECG streaming from the D-Heart device to the smartphone) was **58 ± 12 seconds**.

Conclusions. 'Mobile ECG on other' software proved reliable and accurate for correct electrode self-placement, thereby opening new perspectives for accurate patient generated remote diagnostic tests.