

How fast is ECG signal? Propagation of the endogenous electromagnetic wave of cardiac origin

Teodor Buchner (✉ teodor.buchner@pw.edu.pl)

Warsaw University of Technology

Maryla Zajdel

Warsaw University of Technology

Kazimierz Pęczalski

Warsaw University of Technology

Paweł Nowak

Warsaw University of Technology

Article

Keywords:

Posted Date: August 8th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1916139/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at Scientific Reports on March 22nd, 2023.

See the published version at <https://doi.org/10.1038/s41598-023-29904-2>.

Abstract

A satisfactory model of the biopotentials, propagating through the human body, is essential for medical diagnostics, particularly for cardiovascular diseases. In our study, we develop the theory, that the propagation of biopotential of cardiac origin (ECG signal) may be treated as the propagation of low-frequency endogenous electromagnetic (EM) wave through the human body. We show that within this approach, the velocity of the ECG signal can be theoretically estimated, like for any other wave and physical medium, from the refraction index of the tissue in an appropriate frequency range. We confirm the theoretical predictions by the results of a direct measurement of the ECG signal propagation velocity and obtain mean velocity as low as $v=1500$ m/s. The results shed new light on our understanding of biopotential propagation through living tissue. This finding may improve medical diagnostics based on the impedance spectroscopy and electrocardiographic imaging, not to mention ECG, EEG and virtually all electric measurements. Better understanding of the underlying phenomena may also lead to new therapy solutions in various clinical contexts.

Full Text

This preprint is available for [download as a PDF](#).