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Physical approach to assessment of interplay between rheology, elastic properties, and measurable parameters of cardiovascular system with the aim to optimize invasive and non-invasive treatment strategies

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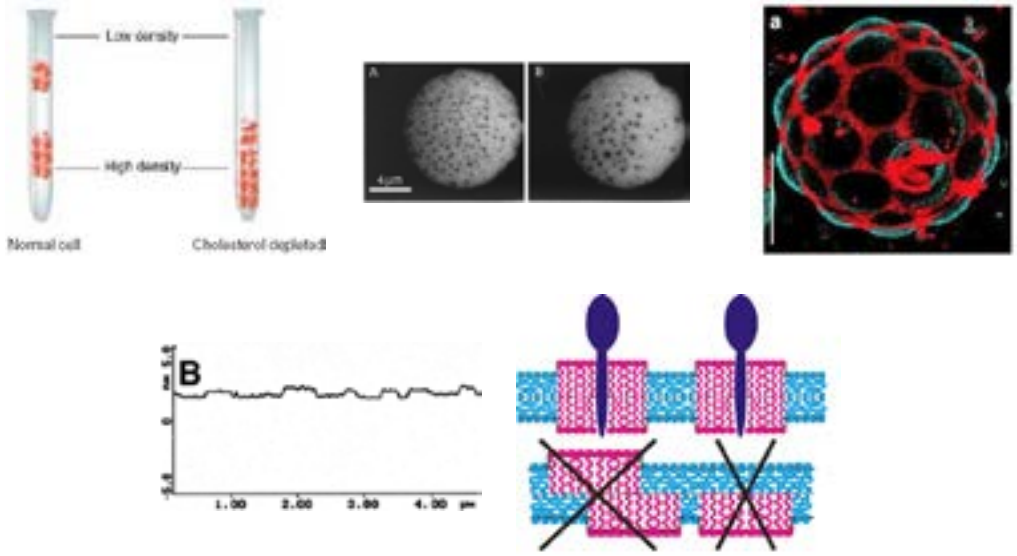
Statement of the Problem: Cardiovascular system connects every organ of living organism through complex network of arteries, veins and capillaries. Tissues with no capillarization (cartilage, bone, and dentine) can exchange with blood through diffusion, and the substances capable of penetrating blood-brain barrier can travel with body fluids to any tissue (on different time scales). This makes pharmaceutic and surgical treatment of cardiovascular diseases closely interdependent with the state and activity of virtually every organ or tissue of organism. Same issues, for similar reasons, complicate diagnostics in cardiology.

Methodology & Theoretical Orientation: Statistical methods and digital simulations applied to non-linear dynamic systems have strong limitations. A hard and costly solution is binning data pools together for similar classes of objects, subsequently using Ishikawa diagrams to discriminate between the essential and non-consequential factors. Use of first physical principles (mechanics, hydrodynamics, thermodynamics, electrodynamics) in analyzing causes of the disease (blood biochemistry, blood flow obstruction, malnutrition, low oxygen or high CO in ambient air, oxidative stress etc.), as well as instruments and methods suitable for diagnostics (number of electrocardiogram leads; electrode and patient preparation, ambient conditions) appears to be another viable solution.

Findings: Theoretical analysis suggests that correlations between blood flow dynamics, elasticity of blood vessels/cell membranes, temperature, and functions of cell signaling receptors (insulin, barocepters, thermosensors etc) can be used to optimize treatment and diagnostics of patients. Experimental evidence supports this hypothesis.

Conclusion & Significance: Prophylactics, diagnostics, invasive surgery, anti-inflammatory treatment, pain medication, nutritional and psychologic support have to be coordinated to achieve the desirable result. Simultaneous use of several alternative methods aimed to protect patient and regulate his functions can be worse than complete absence of medical assistance. Multiple feedbacks, e.g. on physical (hydrodynamics, see above) and subconscious (proper nutrition prevents anxiety, thus ruling out false cardiologic symptoms) levels must be (and are) used by clinicists, as illustrated by examples in the presentation.



Recent Publications

1. S A Akimov, V V Aleksandrova, T R Galimzyanov, Pavel Bashkirov and Oleg V Batishchev (2017). Interaction of amphipathic peptides mediated by elastic membrane deformations. Biochemistry (Moscow) Supplement Series A, Membrane and Cell Biology 11(3):206-216.
2. Rudenko M, Voronova O, Zernov V Kolmakov S, Makedonsky D, Mamberger K, Rudenko S, Volkov A. Volossatykh O, Khlestunov S and Prikhozhan Y (2009). Theoretical Principles of Heart Cycle Phase Analysis. Fouqué Literaturverlag. Frankfurt a/M. München - London - New York. – 336 p. ISBN 978-3-937909-57-8
3. T Lang (2006). How to report Statistics in Medicine M.Secic. American College of physicians. Philadelphia. - - 480 p.
4. Eduard V Bocharov, George V Sharonov, Olga V Bocharova and Konstantin Pavlov (2017). Conformational transitions and interactions underlying the function of membrane embedded receptor protein kinases. Biochimica et Biophysica Acta 1859(9 Pt A)
5. Galya Staneva, Denis S Osipenko, Timur R Galimzyanov, Konstantin V Pavlov and Sergey A Akimov (2016). Metabolic Precursor of Cholesterol Causes Formation of Chained Aggregates of Liquid-Ordered Domains. Langmuir, 2016, 32 (6), pp 1591–1600 DOI: 10.1021/acs.langmuir.5b03990

Biography

Konstantin V Pavlov has experience of being Laboratory Assistant, Engineer, Research Engineer, Junior Research Fellow, Regulatory Reviewer, Data Collector, Simultaneous Translator, Research Fellow and Senior Research Fellow at Frumkin Institute of Electrochemistry, Moscow Institute of Physics and Technology, Moscow Institute of Open Education, FMBI Institute of Physical-Chemical Medicine (in-house); Rosatom, Rosenergoatom, US NIHCD, US DOE, UK DTI, WANO, Ministries of Interior, Trade and Industry, Atomic Energy etc. His areas of research with hands-on experience and proven academic record include "Mathematical methods in physics, wet chemistry, electrophysiology, probabilistic risk assessment, metrology, fluorescent microscopy, and two-phase fluid dynamics in systems with non-stationary boundary conditions (flexible pipelines vulnerable to pipe whip, peristaltic systems etc.)". The general approach assumed for this presentation is simplifying the complex interrelated systems by segmentation or statistical binning, and then discarding the outliers using alternative criteria.

Notes: