

# CHANGING THE PARADIGM OF OLD BALNEOLOGY

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“Omnia mutantur, nihil interit” (Everything changes, nothing dies) –  
Publius Ovidius - Metamorphosis, XV, 165

**Authors:** SURDU Olga<sup>1</sup>; ȚUCMEANU Roxana- Elena<sup>1</sup>; SURDU Traian Virgiliu<sup>1,2</sup> MUJDABA Sibel<sup>1</sup> SURDU Monica<sup>2,3</sup>; MARIN Viorica<sup>1</sup> STANCIU Liliana-Elena<sup>1,2</sup>

**Affiliation:** <sup>1</sup> Techirghiol Balneal and Rehabilitation Sanatorium; <sup>2</sup>. Constanta Ovidius University, Faculty of Medicine; <sup>3</sup>Constanta Emergency Clinical Hospital.

**Corresponding authors** – SURDU Olga, [olga@surdu.ro](mailto:olga@surdu.ro) ORCID ID 0000-0002-1288-2720;

SURDU Traian Virgiliu [traian@surdu.ro](mailto:traian@surdu.ro) ORCID ID 0000-0002-7370-9489

# Aim - to explore new topics in order to try to bring the old balneology in third millennium

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- It is not a critical review but an **attempt/a plea for a modern, multi- and trans disciplinary** approach of balneology. It is an investigation of different data basis using key words: entropy, energy, information, genetics, epigenetics, hormesis, ageing, etc AND, OR balneology, balneotherapy, mud therapy, etc;

## **balneology is multi- and transdisciplinary science**

- **Connected with**– geology, hydrology, climatology, chemistry and biochemistry, physics and biophysics (thermodynamics, entropy, energy, radiations, nanoparticles), mathematics (risk analysis, mathematical modelling), information and IT (virtual reality, artificial intelligence, machine learning);
- **TIDE Connected** with biology: cell and molecular biology, genetics, epigenetics, genomics, immunology, neurosciences, hormesis;


## **practice of classic balneology = balneotherapy**

**is connected with all medical specialties:** rheumatology, neurology, dermatology, endocrinology, gynecology, pneumology, cardiology, phlebology, etc.

- \*Non specific prevention of infectious diseases - the neglected field.

# 1.a. energy, entropy and balneology

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- **Energy** = **can do mechanical work, can heat, can be transferred** from one body (physical or biological system) to another as the result of a difference in their temperature\*\*  **balneo-thermo-therapy;**  
\*<https://www.britannica.com/science/energy>; \*\*<https://www.britannica.com/science/heat>;
- **Entropy** = **an attribute of energy** = a measure of **disorder of a system**; **Order** = uniformisation = **0 probability of any action** (in biology = death);
- **Living beings can act both antientropic (to keep internal parameters between the pre-set limits of functioning = homeostasis) and entropic to diversify internal processes that oppose to uniformization;**
- **Balneotherapy – immediately – acts entropic on human body (increases disorder) and “a la longue” – acts antientropic (re-establish homeostasis for better functioning);** \*\*\* <https://www.britannica.com/science/entropy-physics>

Zukow W, Popadynets' OO, Gozhenko AI, Popovych IL. Interindividual differences in parameters of the EEG and HRV in the humans with various levels of the entropy of EEG, HRV, immunocytogram and leukocytogram. Journal of Education, Health and Sport. 2019;9(7):448-466. eISSN 2391-8306. DOI <http://dx.doi.org/10.5281/zenodo.3361498>  
<http://ojs.ukw.edu.pl/index.php/johs/article/view/7233>

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Popadynets' Oleksandr O.1 , Gozhenko Anatoliy I.1 , Badiuk Nataliya S.1 , Zukow Walery 2 , Kovbasnyuk Marta M.3 , Korolyshyn Tetyana A.3 , Popovych Igor L.1,3. Relationships between changes in entropy of the EEG and parameters of the immunity. Pedagogy and Psychology of Sport. 2020;6(1):24-40. eISSN 2450-6605. DOI <http://dx.doi.org/10.12775/PPS.2020.06.01.003> <https://apcz.umk.pl/czasopisma/index.php/PPS/article/view/PPS.2020.06.01.003>  
<https://zenodo.org/record/366119>

Struk Zoryana D.1, Mel'nyk Oksana I.2, Zukow Walery3, Popovych Igor L.1,4. The diversity of immune reactions to balneotherapy and their accompaniments. Journal of Education, Health and Sport. 2019;9(11):349-373. eISSN 2391-8306. DOI <http://dx.doi.org/10.12775/JEHS.2019.09.11.033>;  
<https://apcz.umk.pl/czasopisma/index.php/JEHS/article/view/JEHS.2019.09.11.033>; <https://zenodo.org/record/3666932>

□ Balneotherapy causes multivariate entropy changes of individual EEG loci, conditioned by a number of predictors. This is accompanied by characteristic changes in certain parameters of immunity in line with the concept of immune homunculus. (Tracey KJ. Physiology and immunology of the cholinergic antiinflammatory pathway. J Clin Invest. 2007; 117(2): 289-296). (Tracey KJ. Understanding immunity requires more than immunology. Nature Immunology. 2010; 11(7): 561-564)

□ Authors have shown that the entropy of the parameters of the heart rate variability (HRV= the variation in the time interval between consecutive heartbeats in milliseconds) and spectral power density (SPD =the power present in the signal as a function of frequency, per unit frequency) of loci of EEG significantly correlate with the entropy and parameters of immunity determined in immunogram and leucogram;

□ The authors hypothesize that during balneal course the immunomodulatory action of entropy of nervous structures is realized due to their effect on the tonus of the vagus nerve, whose immunotropic effects are well documented.

- In the fields of brain function entropy has yielded highly promising results: **the (altered) state of consciousness**, **the ageing brain**, and the quantification of **the brain networks' information processing**;
- the use of entropy measures for the study of the ageing brain resulted in significant insights on various ways that the process of ageing may affect the dynamics and information processing capacity of the brain

## 1.c. information and balneology

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- **Information** = **energy or substance**, processed, organised and structured data that **has meaning** for a **receiver** = immune, endocrine and nervous systems; the difference is given by the information they are able to take over, process and integrate in their own pattern:
- for immune system – antigen or antigen-like structure
- for nervous system – energy (amount of) or substance (molecules);
- for endocrine system – variations of inner parameters such as glycemic, calcemic level, etc
- **Balneotherapy is bathing in energy (water/mud – cold, warm, hot), receiving information (energy and substance), changing entropy;**

## 2. Hormesis and balneology

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- **Hormesis** = biphasic dose-response phenomenon in which exposure (systematic, repeated and well dosed of NTF) of a cell or organism to a low dose of a chemical agent or condition induces **stimulation or adaptive beneficial effects** (as balneal course does), while higher doses cause inhibition or toxic effects\*;
- **Hormetin** = any condition that **can activate or upregulate one or more cellular and molecular pathways of stress response** that protect against a similar but more severe stress such as chemicals and toxins; ex. biological hormetins: infections, hypoxia/ischemia, endogenous metabolic products, dietary caloric restriction, intermittent fasting, and micronutrients; psychological hormetins: mental challenge and meditation; physical hormetins: **exercise, heat, radiation**.
- **repeated mild heat stress-induced hormesis (bathing cure) affects various cell functional characteristics such as differentiation, ageing, wound healing and angiogenesis.**

\* Mattson MP. Hormesis defined. Ageing Res Rev. 2008 Jan;7(1):1-7. doi: 10.1016/j.arr.2007.08.007. Epub 2007 Dec 5. PMID: 18162444; PMCID: PMC2248601 ■

1. Mark P. Mattson, **Hormesis Defined**, *Ageing Res Rev.* 2008 January ; 7(1): 1–7;

2. Edward J. Calabrese<sup>1</sup> and Mark P. Mattson, **How does hormesis impact biology, toxicology, and medicine?** [www.nature.com/npjamd](http://www.nature.com/npjamd) *Aging and Mechanisms of Disease* (2017) 3:13 ; doi:10.1038/s41514-017-0013-z;

3. Gyorgy Csaba, **Hormesis and immunity: a review** *Acta Microbiologica et Immunologica Hungarica* 66 (2), pp. 155–168 (2019)

DOI: 10.1556/030.65.2018.036

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4. Isabel Gálvez<sup>1</sup> ID , Silvia Torres-Piles<sup>2</sup> and Eduardo Ortega-Rincón, **Balneotherapy, Immune System, and Stress Response: A Hormetic Strategy?** [www.mdpi.com/journal/ijms](http://www.mdpi.com/journal/ijms), *Int. J. Mol. Sci.* 2018, 19, 1687; doi:10.3390

- ❑ several hormetic pathways can be described in **neuro-endocrine, metabolic and immune effects of balneotherapy**;
- ❑ the common factor to all types of warm or hot balneotherapy - **heat** and **heat shock proteins** (HSP) = **Heat stress hormetic effect in balneotherapy**;
- ❑ other factors: specific biochemical components of therapeutic factors that can penetrate skin, such as: **hydrogen sulphide** (H<sub>2</sub>S), **carbon dioxide** (CO<sub>2</sub>) and **radon**;
- ❑ The combination of bathing in and drinking sulphurous water is a common practice (increase plasma thiol levels and decrease circulating levels of MDA, carbonyls, MMP-2, COMP and TNF) and offers protection against age- and disease-related, oxidative damages.
- ❑ synergistic effect of heat and radon and beneficial long-term clinical effects of radon balneotherapy—consistent with the concept of hormesis



### 3. Epigenetics and balneology

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- **epigenetic inner mechanisms can be modulated by balneal therapeutic factors, by natural, clean, non – polluted environment in thermal stations;**
- Ultraviolet radiation has been shown to reduce methylation levels through the inhibition of DNA methyltransferase activity pathways.
- MBT can modify the expression of some miRNAs that are up-regulated in OA. It could be due to the heat stress and the hydrostatic pressure, since some miRNAs were found to be temperature and mechano-responsive.

1. Antwi DA, Gabbara KM, Lancaster WD, Ruden DM, Zielske SP, Radiation-induced epigenetic DNA methylation modification of radiation-response Epigenetics. 2013 Aug; 8(8):839-48 ; 2. Cheleschi S, De Palma A, Tenti S, Giordano N, Fioravanti A, Mud-bath therapy regulates the expression levels of microRNA in osteoarthritis. Epigenetic contribution to explain the mechanism of action of Balneotherapy Bol Soc Esp Hidrol Méd ISSN: 0214-2813 2018, Vol. 33, Supl. 1, 75-76 DOI: 10.23853/bsehm.2018.0592

# Many questions remain to be ask

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- **Is cure duration long enough** that human body receives health information to reset the disturbed parameters, and is this aspect suitable for consideration of balneology in **information theory**?
- **Can neuroendocrine and immunological responses** (humoral and cell-mediated, activated during balneotherapy) **be systematically applied in prevention of non-communicable diseases**?

Many answers can occur from trans- and multidisciplinary approach of balneology

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Thank you for listening this plea for a  
modern, multi- and trans disciplinary  
approach of balneology

