Alterations in breathing pattern and cardiorespiratory coupling as a novel mechanism leading to autonomic imbalance in cardiovascular diseases

DESCRIPTION FOR THE GENERAL PUBLIC

Cardiovascular disease (CVD) remains a major killer of the world. Each year CVD causes 3.9 million deaths in Europe and over 1.8 million deaths in the European Union. Majority of the studies assessing mechanisms underlying CVD focused on its advanced stages. Much less is known about factors determining early development and progression of CVD. Respiration, although being a basic vital process, is especially neglected as a potential cause or a key element in the pathophysiology of CVD.

It is well known that alterations of breathing frequency and/or depth are common in various pathologies like pulmonary cardiovascular or brain diseases. All medical students have to learn special respiratory patterns such as so-called Cheyne-Stokes', Biot's or Kussmauls' and know that they might occur in patients with stroke, congestive heart failure or stroke, diabetic coma or renal failure. However, the mechanisms linking altered respiratory patterns to autonomic imbalance and cardiovascular diseases are largely unknown. What is more, there is a limited understanding of the role of respiratory variability in healthy individuals.

Therefore, we propose a series of pioneering studies performed by a multidisciplinary team including clinicians, physiologist and specialist in metabolomics.
We will test the hypothesis that changes in breathing pattern (rate and/or depth) occur early in cardiovascular diseases causing so-called autonomic imbalance mediated by the alterations in cardiorespiratory interdependencies (coupling). We have a unique opportunity to study the source of respiratory pattern change and its impact on cardiorespiratory coupling in the cooperation with the outstanding physiologist Professor Julian Paton (the University of Auckland, The University of Bristol) and excellent group specialists in metabolomics headed by Professor Michał Markuszewski (Department of Biopharmacy and Pharmacodynamics Medical University of Gdansk).

100 healthy subjects and 100 hypertensive patients will be included in the study. Detailed assessment of cardiovascular system will be performed as well as continuous recordings of respiration, ECG and beat-to-beat blood pressure on spontaneous respiration and during paced breathing. Moreover, metabolomic analysis of exhaled air and plasma serum will be done in all subjects.

We intend:

- To perform the analysis of cardiorespiratory interactions and cardiorespiratory coupling for better understanding of mechanisms linking respiratory plasticity (alterations) and cardiovascular diseases. We are especially interested in the qualitative and quantitative assessment of respiratory pattern (changes in rate or depth) in humans.
- To detect possible metabolic pathways responsible for the development of cardiovascular diseases in patients with altered respiratory pattern.
- To perform quantitative analysis of catecholamines for verification of a role of autonomic system in periodic breathing occurrence.
- To explore of a number of animal models of cardiovascular disease that reflect the human condition studied herein. We will look at measuring respiration and sympathetic activity to the heart and vasculature during disease progression to determine the temporal sequence and then attempt to rescue the pathology using exercise training to demonstrate causality and reversible plasticity.

The project should significantly contribute to a better understanding of the pathogenesis of cardiovascular diseases. The results of our study may help to identify new mechanisms for the development of cardiovascular diseases at their early stages, and may also provide an opportunity to learn what metabolic mechanisms are associated with the change of breathing pattern during the day. We will also try to discover cause-and-effect relationships that combine plasticity of breath and cardiovascular disorders. We will check if changes in the respiratory tract can be referred to as first signs of organ damage.