Medical Xpress

High-altitude research advances low-altitude medicine

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High altitude medicine is a "natural research laboratory" for the study of cardiovascular physiology and pathophysiology. As such, it can shed light on conditions and diseases that mimic the low oxygen content of the atmosphere at the top of mountains. Yves Allemann, MD, FESC, Swiss Cardiovascular Center, University Hospital, Bern, and Urs Scherrer, MD, Centre Hospitalier Universitaire Vaudois, Lausanne, have assembled an international group of leading authorities to contribute to a special issue of *Progress in Cardiovascular Diseases* dedicated to high-altitude medicine and novel insights into disease mechanisms provided by high-altitude research.

"We have demonstrated that in recent years, the scope of high-altitude research has broadened considerably, because it has become clear that high-altitude offers a unique opportunity to study fundamental mechanisms of disease," according to Guest Editors Allemann and Scherrer. "During the past decade, high-altitude studies have elucidated fundamental novel mechanisms involved in the pathogenesis of lung edema and hypoxic pulmonary hypertension. The new knowledge generated by these high-altitude studies has already been transferred to the bedside of patients having these problems at low altitude. Second and equally important, we have shown that high-altitude exposure facilitates the detection of vascular dysfunction in humans. Capitalizing on this observation, high-altitude exposure of young apparently healthy children has allowed demonstrating fetal programming of vascular dysfunction at a very early stage. We predict that high-altitude exposure, real or simulated, will become an important tool for the detection of early

vascular dysfunction in humans."

At high altitude, lack of oxygen principally affects the respiratory, cardiovascular, neuroendocrine, and renal systems. At low altitude, the same effects may occur, not due to ambient lack of oxygen, but as the result of hypoxemia, deficient oxygenation of the blood, which is the consequence of an organ insufficiency, usually the heart or the lung.

Allemann and Scherrer observe that "the ultimate goal of most high-altitude researchers is not only to understand physiologic (mal)adaptation to hypoxia for the benefit of the millions exposing themselves to high altitude, but to think beyond that, imagining how the knowledge gained from field research at high altitude may be applied to the much larger number of patients with hypoxia/hypoxemia-associated diseases."

The issue provides cutting-edge insight into the current state of research in the field, as well as up-to-date information on the treatment and prevention of the three major high-altitude related diseases: acute mountain sickness, high-altitude cerebral edema, and high-altitude pulmonary edema. Articles provide unique information useful to clinician-scientists interested in high-altitude medicine and advice for practicing cardiologists and family doctors who have patients suffering from cardiovascular disease planning to travel to high altitude.

For the clinician, the article by Scherrer et al demonstrates how studies at high altitude have provided important insights into fundamental mechanisms underpinning pulmonary hypertension and pulmonary edema in humans. They show how these insights have been translated into novel approaches for the treatment of patients suffering from these problems at low altitude. Finally, it provides some hints on how the natural research laboratory of high altitude may provide novel insight into cardiovascular disease mechanisms in the future.

For the practicing physician, the article by Rimoldi et al provides concise information and practical advice on how to counsel cardiovascular patients planning to travel to high altitude. There is tremendous variability in individual responses to low oxygen that may be further amplified by external factors such as exercise and stress. These responses may induce major problems in patients with cardiovascular diseases, particularly those with already limited functional reserves at low altitude.

High-altitude pulmonary edema is a life-threatening problem, and physicians need to know how to advise individuals planning high-altitude activities. The article by Maggiorini et al provides up-to-date information on how to treat and prevent this important disease.

Sometimes, a hypoxic environment is deliberately sought by endurance athletes who try to naturally augment their oxygen transport capacity. Should the athlete live high and train low or live low and train high? Vogt and Hoppeler bring together the latest concepts on that topic of debate.

Of course, for high altitude populations in the Andes, the Himalayas, or other mountainous regions around the globe, hypoxia is a natural condition of life. In an article by Stuber et al, they describe the cardiovascular adaptation mechanisms of the Bolivian Aymaras and how these differ from chronic adaptation mechanisms of Caucasians living at the same altitude. These differences and their possible positive or negative long-term consequences on cardiopulmonary health are also discussed.

Adaptation mechanisms to hypoxia can sometimes go beyond their primary goal of maintaining adequate tissue oxygenation. In chronic mountain sickness, affected patients develop, usually insidiously over time, excessive erythrocytosis, hypoxemia, and pulmonary hypertension

that can have a major negative impact on quality of life. These cardiovascular consequences of chronic mountain sickness are explained by León-Velarde et al.

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