'Everest in Utero' - Lessons for critical Care?

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The human fetus develops in a profoundly hypoxic environment. Thus, the foundations of our physiology are built in the most hypoxic conditions that we are ever likely to experience: the womb. This magnitude of exposure to hypoxia in utero is rarely experienced in adult life, with few exceptions, including severe pathophysiology in critical illness and environmental hypobaric hypoxia at high altitude. Indeed, the lowest recorded levels of arterial oxygen in adult humans are similar to those of a fetus and were recorded just below the highest attainable elevation on the Earth's surface: the summit of Mount Everest. We propose that the hypoxic intrauterine environment exerts a profound effect on human tolerance to hypoxia.

This idea is not new. In the early 20th century, after extensive studies of the ovine fetal circulation, Sir Joseph Barcroft (1872-1947) postulated that the environment in which the human fetus develops would be comparable to that likely endured by an adult on the summit of Mount Everest. He termed this intriguing hypothesis 'Everest in utero' and proposed that to survive the hypoxic uterine environment the fetus must develop elaborate physiological strategies comparable to those seen in climbers ascending the great Himalayan peaks. In 2007, four climbers descending from the summit of Mount Everest (8,848 meters) took arterial blood gases from one another at 8,400 meters above sea level. Their mean arterial partial pressure of oxygen (PaO_2) was 3.28 kPa (24.6 mm Hg) with a mean calculated arterial oxygen saturation (SaO_2) of 54% while they rested without supplemental oxygen. Among this group, one individual had a PaO_2 of 2.55 kPa (19.1 mm Hg), the lowest PaO_2 ever reported in an adult human. So how far removed from intrauterine life were these measurements, and do climbers exhibit, as does the fetus, physiological strategies that may benefit the similarly hypoxemic critically ill patient?

Cellular mechanisms that facilitate fetal well-being may be amenable to manipulation in adults to promote survival advantage in severe hypoxemic stress. Many of these mechanisms act to modify the process of oxygen consumption rather than oxygen delivery in order to maintain adequate tissue oxygenation. The successful activation of such processes may provide a new chapter in the clinical management of hypoxemia. Thus, strategies employed to endure the relative hypoxia in utero may provide insights for the management of severe hypoxemia in adult life and ventures to high altitude may yield clues to the means by which to investigate those strategies.

References

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