PREMILK - Preeclampsia-Related Metabolomic Insights into Lactation and Nutrition in Premature Infants

Popular science summary

Hypertension during pregnancy is one of the most common complications, affecting about eight to ten percent of women. In some cases, it can lead to the development of preeclampsia — a serious, life-threatening condition for both mother and neonate, in which, apart from high blood pressure, symptoms of multi-organ failure appear. The increasing incidence of this disease is associated with a trend of late motherhood and the growing prevalence of so-called lifestyle diseases such as obesity and metabolic syndrome.

Despite advances in perinatal medicine, our understanding of how preeclampsia affects the fetus and influences health outcomes in the neonatal and infant period remains limited. The early-onset preeclampsia (before the thirty fourth week of pregnancy) significantly increases the risk of preterm birth, growth restriction, neurological disorders, and perinatal death. These newborns often require intensive medical care. Even in milder cases (late-onset preeclampsia), children are at higher risk of metabolic diseases and cognitive problems that may appear in the future.

To date, research on preeclampsia has primarily focused on studying the mother's organism, for example, in the search for biomarkers for early diagnosis. However, little is known about how this condition affects the composition of breast milk, the most important source of nutrition and immune protection for a newborn, particularly for premature infants. Increasing evidence suggests that the course of pregnancy and maternal illnesses can significantly modify the composition of breast milk, thereby affecting the child’s development and health. It is already known that the milk of women from pregnancies complicated by preeclampsia differs from that of healthy women. For example, it contains more DHA (an omega-3 fatty acid), different proportions of oligosaccharides, and may have an altered energy value. All of these components play an important role in the development of the newborn’s brain, immune system, and metabolism.

The **PREMILK project** aims to assess the impact of preeclampsia on the composition of human milk, with particular emphasis on the **metabolomic profile** — a set of small-molecule compounds present in milk. Analyses will be conducted at three stages of lactation (colostrum, transitional milk, and mature milk) to account for its natural variability. The study will use advanced analytical techniques such as liquid chromatography mass spectrometry (**LC-MS)** and gas chromatography mass spectrometry (**GC-MS)**, enabling highly precise detection and comparison of hundreds of metabolites. Additionally, the project includes research on **exosomes** — microscopic vesicles present in milk that can carry molecules regulating a child’s development, including the nervous system. Although research on exosomes is still emerging, it is already believed that they may play an important role in the so-called "communication" between mother and child.

The results of the **PREMILK project** may help to better understand how pregnancy complications affect newborns and their nutritional needs. In the future, this could enable the development of **personalized nutritional strategies** — for example, fortifying donor milk for preterm infants born from pregnancies complicated by preeclampsia. The study aligns with current trends in neonatology and personalized medicine, addresses an existing knowledge gap in neonatal nutrition, and may contribute to improving care for the youngest patients from their very first days of life.