Baby's Breath—Sweet and Simple?

Taking that first breath is easy, right? You're born, the doctor holds you upside down by the ankles and slaps you on the backside, and you take your first of many breaths. Of course breathing is more complex than this nostalgic delivery room image, just ask Dr. John Carroll. "Breathing control is deceptively simple—most of us never think about it," says John Carroll, an MD and a Professor in the Department of Pediatrics and Physiology. He continues, "However, breathing control is, in reality, extremely complex and these intricate mechanisms change through late fetal and perinatal development." Our bodies only store enough oxygen to survive for several minutes. Lack of oxygen, just for 2 to 3 minutes, can result in cell damage or even death. Therefore, blood oxygen levels in the blood must be precisely controlled. Too much or too little oxygen is toxic; therefore, regulation of blood oxygen level is critically important to normal functioning.

Dr. Carroll's research may lead to better treatment or prevention of a number of potentially life threatening disorders such as asthma, chronic lung disease of infancy, apnea, and sudden infant death syndrome (SIDS).

The ultimate goal of work in Dr. Carroll's laboratory is to determine how the body senses and controls oxygen levels in the blood. "Despite almost 6,000 articles on the subject, oxygen sensing is poorly understood," says Dr. Carroll. He investigates how the sensing and controlling of oxygen levels change in the developing infant. His research, funded by a five-year National Institutes of Health grant, focuses on the carotid body oxygen chemoreceptors, which control blood oxygen levels very precisely by adjusting breathing to meet the oxygen needs of the body across the full range of activities, from strenuous exercise to restful sleep.

Considering their important role, carotid body chemoreceptors are "turned off" at birth and become more sensitive to oxygen early in life. At this developmental state in infants, particularly premature babies who have underdeveloped breathing capability, increased oxygen levels can keep these chemoreceptors shut off affecting the development of the carotid bodies. For premature babies, abnormal oxygen sensing development can lead to problems High levels of oxygen can lead to oxygen toxicity causing lung damage. Chronically low levels of oxygen can be undetected by the infant possibly leading to pulmonary hypertension (which can result in death), growth failure, impaired cognitive development, and abnormalities in cardiovascular function, breathing control maturation, and lung function.

Dr. Carroll adds, "The long-term impact of oxygen sensing development is not yet understood." Children with severe asthma may not sense low levels of oxygen normally. He asks what the role of oxygen sensing is in fatal asthmatic episodes. "Abnormal development of the carotid body chemoreceptors during infancy can result in life-long abnormalities. "The seed of adult cardiac or respiratory diseases may be sown in childhood," says Dr. Carroll, "which is another reason why the study of oxygen sensing is important." Carotid bodies drive critically important respiratory reflexes such as arousal from sleep when oxygen levels drop and cardiovascular responses to oxygen that control heart rate and blood pressure. People with obstructive sleep apnea have swings in oxygen saturation that stimulate the carotid bodies. This intermittent

stimulation leads to high blood pressure in adults, which increases the risk of stroke; it raises the question about this beginning in childhood.

A more complete understanding of the developmental process behind oxygen sensing will help discover the influences leading to abnormal development. "In our research we are going back to understand the most basic mechanisms of disease to improve on care," says Dr. Carroll. He and other researchers will build on his basic research to develop new treatments and drugs and to modify the administration of oxygen and the way oxygen levels are monitored in neonates. This work may lead to better treatment or prevention of a number of potentially life threatening disorders such as asthma, chronic lung disease of infancy, apnea, and sudden infant death syndrome (SIDS).

Established in 1989, Arkansas Children's Hospital Research Institute provides an on-site research environment for faculty of the University of Arkansas for Medical Sciences working on the Arkansas Children's Hospital campus. Over 120 pediatric researchers with expertise and experience that span the breadth of medical disciplines comprise ACHRI's roster of investigators who work to fulfill its mission to improve children's health, development, and well-being through high quality research. For more information, visit http://achri.archildrens.org.