

Airstream Delivery

Chronic lower respiratory diseases and pneumonia are among the top ten causes of death in the United States according to the Centers for Disease Control and Prevention. To help combat these statistics, Worth Longest, Ph.D., and his cross-campus colleagues are focusing their research efforts on the development of new and improved mechanisms for more efficient and effective therapeutic pulmonary drug delivery.

Longest, associate professor in the department of mechanical and nuclear engineering and specialist in aerosol dynamics, is collaborating with a number of his Virginia Commonwealth University Medical Center partners on three exciting projects. With Federal Drug Administration (FDA) and National Institutes of Health (NIH) funding in excess of \$2.5 million, the teams are studying systems and devices to better deliver and distribute medical therapies for upper and lower respiratory diseases and illnesses.

One of the projects, an FDA funded study, compares two types of handheld inhalers to determine the effectiveness of drug delivery within the respiratory airways. Through his joint appointment with the VCU School of Pharmacy's Department of Pharmaceutics, Longest and research associate professor in the department of pharmaceutics, Michael Hindle, Ph.D., are using modeling and experiments to discover the differences between the inhalers including where the drugs go once delivered inside the airways by the devices.

Another project is designed to develop a new generation of handheld inhalers using nanoparticles to improve



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drug delivery efficiency and to reduce dosage variability between subjects. Only 10 percent of a drug delivered by way of inhalers actually reaches the lungs; the rest goes into the mouth and throat and is swallowed. Experiments have shown a dramatic improvement in drug delivery and efficiency through the use of nanoparticles.

"We can get the 10 percent up to 80 or 90 percent using nanoaerosols," Longest said. "If we can improve the device, we can better target drug delivery in the lungs in cases of cystic fibrosis, for example, or lung cancer and other respiratory diseases." Other applications for nanoaerosol drug delivery include inhaled insulin for diabetes and inhaled chemotherapy.

Longest and Hindle have a rich history of collaboration on similar work and were awarded a four-year investigator-driven Research Project Grant (R01), the oldest funding mechanism used by the NIH, to study the use of nanoaerosols to improve pulmonary drug delivery during mechanical ventilation. It is the first R01 grant in the School of Engineering with faculty in a primary investigator role. Such work, Longest explains, involves three patient groups who often require pulmonary ventilation: critically ill infants, injured people and the elderly in critical care.

"Using nanoparticles to improve delivery of inhaled drugs during ventilation is known, but our nanoaerosol approach improves delivery rates by a large amount," Longest said. "This technology can help minimize or eliminate respiratory infection while patients are receiving ventilation."

The long-term impact of his work is significant. Improved medical therapies through aerosol dynamics stand to benefit those suffering from pulmonary diseases or illnesses, and others for which inhaled drug delivery increases efficacy.

Longest also collaborates with assistant professor Dr. Kelly Dodson in the VCU School of Medicine's Department of Department of Otolaryngology - Head and Neck Surgery; Peter Byron, Ph.D., E. Claiborne Robins Professor and Chair of the VCU School of Pharmacy's Department of Pharmaceutics; and Dr. Bruce Rubin, Jessie Ball duPont Professor and Chair of the VCU School of Medicine's Department of Pediatrics.

Multidisciplinary collaborations such as these lead to groundbreaking discoveries that transform lives.

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