Effects of Interindividual Differences in Human Nasal Anatomy on Upper Respiratory Tract Airflow and Inhaled Gas Uptake

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Differences in nasal anatomy and respiratory airflow patterns among different humans may lead to significant differences in the regional dose of inhaled gases within the nasal passages and subsequently in the lung. These differences are not accounted for in the calculation of human equivalent concentrations (HECs) from animal-based No Observed Adverse Effect Levels using U.S. EPA’s default Inhalation Reference Concentration (RfC) methodology. Therefore, the default methodology requires division of HECs by an uncertainty factor of 10 to account for potentially sensitive subpopulations. Information on the range of effects that anatomical variation has on nasal uptake and identification of sensitive subpopulations is needed to assess the reasonableness of this uncertainty factor and improve the efficacy of the RfC methodology. Sensitivity is a function of both site-specific uptake and tissue susceptibility. Site-specific uptake is determined in part by airflow-driven mass transport patterns that are integrally related to nasal airway shape. Since there is a high degree of variability in human nasal airway shape, there may be a corresponding variability in nasal uptake. Computer models of nasal airflow are well suited to determine the degree to which anatomical variation affects nasal uptake among individuals. Efforts in this project will focus on estimating the variability of nasal uptake through simulation of a number of individuals. Creation of computer models for several individuals is not feasible in a reasonable time frame without automation of the current time consuming grid generation process. Therefore, initial efforts focused on automation of this process. Correlation of uptake with anatomical features is being used to identify anatomical determinants of sensitivity and will aid in the identification of potentially at-risk subpopulations. Together with an understanding of regional tissue susceptibility, this opportunity to quantitatively evaluate the effects of interindividual differences in nasal anatomy on airflow and uptake is expected to provide a sound scientific basis for reducing the use of the 10-fold sensitive human subpopulation uncertainty factor. This project is currently in its last year of research.

Start and end date: July 1999 – May 2003

Presentation(s):


Kimbell, J.S. (2002). ABC-TV Channel 11 interview by anchor/reporter Scott Light on nasal airflow modeling of several human individuals to determine the role of anatomical variation on the ability of the nose to act as a filter, March 14.

This abstract was prepared by the principal investigator for the project. Please see www.USLRI.org for more information about the LRI.


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