# Voxelwise Comparison of Hyperpolarized He-3 and Xe-129 Lung Ventilation MR Imaging in Cystic Fibrosis

Nicholas James Tustison[1], Alicia Muratore[1], Benjamin Contrella[1], John P. Mugler III[1], Eduard E de Lange[1], and Talissa A. Altes[1]
[1]*Department of Radiology and Medical Imaging, University of Virginia, Charlottesville, VA, United States*

## Introduction

Both hyperpolarized He-3 and Xe-129 are gaseous contrast agents that can be used in ventilation imaging allowing for functional visualization of obstructive airflow. Computational methods [1] have allowed for the extraction of quantitative relationships between ventilation and gas uptake to provide insight into pulmonary pathologies. The purpose of this study was to determine whether the different physical properties of He-3 and Xe-129 lead to differences in the appearance of ventilation abnormalites with these two inhaled MRI contrast agents in cystic fibrosis (CF) patients.

## Methods

8 subjects (3 male, 5 female, mean age = 27 years, mean FEV1 67% predicted) performed spirometry and were imaged with both He-3 and Xe-129 on the same day. Only 7 were analyzed due to technical difficulties during processing. *Image acquisition*. The order of He-3 and Xe-129 acquisitions was alternated between subjects. All imaging was performed on a 1.5T scanner (Avanto, Siemens). He-3 specifics: Dosing of ~300 ml hyperpolarized He-3 with sufficient nitrogen to total ~1/3 the subject's FVC with either a flexible (Clinical MR Solutions) or rigid (Rapid Biomedical) chest RF coil. Xe-129 specifics: Dual air bag apparatus with dosing of 500-700 mL Xe-129 in on bag and medical grade oxygen and room air in the other bag with total volume ~1/3 of subject's FVC and O2 concentration ~21%. A custom-build rigid chest RF coil was used. *Image Processing*. As described in [1] and [2], each ventilation image was normalized using N4 to correct for B1 inhomogeneity. Following inhomogeneity correction, each image was segmented into 4 regions (representing varying degrees of ventilation) using a Bayesian-based segmentation algorithm with a Markov Random Field prior (cf Fig. 1). The resulting posterior probability images were combined to create a universally normalized "expected ventilation" (EV) image with intensities in the range [0,4]. Each subject's Xe-129 EV image was registered to its corresponding He-3 EV image using ANTs [3]. Average difference values ($EV_{He\text{-}3} - EV_{Xe\text{-}129}$) were calculated within the He-3 lung mask.

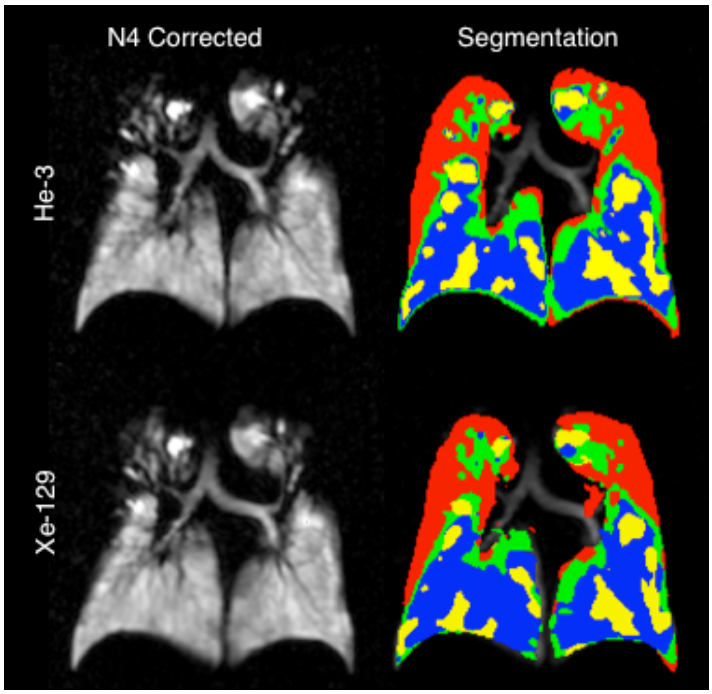


**Figure 1.** N4 corrected and segmentation regions for the He-3 (top row) and Xe-129 (bottom row) images. Labels 1=red, 2=green, 3=blue, 4=yellow.

## Results

Average expectation ventilation differences over all 7 subjects were greater than 0 ($p < 0.05$) consistent with relative increase in ventilation signal in the He-3 images versus Xe-129 over the region of interest.

**Discussion:** A possible explanation for the results is that the higher diffusivity of helium-3 allows more helium than xenon to enter regions of partial airflow obstruction, while areas with complete airflow obstruction appear the same.

## References

[1] Tustison, et al., JMRI 2011, 34(4):831-41.
[2] Tustison, et al, 8672-33, SPIE 2013.
[3] http://www.picsl.upenn.edu/ANTs