

**Title:** Texture Analysis of Thoracic CT to Predict Hyperpolarized Gas MRI Lung Function

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### **Structured Abstract:**

**Introduction:** Hyperpolarized noble gas magnetic resonance imaging (MRI) provides valuable insights on lung function, and yet this method is not widely available, whereas thoracic x-ray computed tomography (CT) protocols are nearly universally available. Unfortunately, structural information inherent to thoracic CT does not directly inform on regional lung perfusion or ventilation. Advanced image registration and processing techniques have been developed to glean functional information from contrast enhanced dual-energy and multi-volume CT. Despite recent success, these techniques require specialized complex analyses and additional scans (1,2). Advances in machine learning allow for accurate, large scale classification of images.

**Hypothesis:** We hypothesize there is sufficient structural information contained in single volume, non-contrast enhanced CT to inform machine learning systems of functional information that is not significantly different than ground truth derived from hyperpolarized gas MRI.

**Methods:** Thoracic CT volumes were co-registered with MRI ventilation maps, generated as previously described (3). Isotropic (15x15x15mm) three-dimensional regions of interest (ROIs) were generated and labeled as well- or abnormally-ventilated based on co-registered hyperpolarized gas MRI. A set of features based on first and second order statistics were generated to describe each ROI. For this preliminary analysis, datasets for patients with CT evidence of emphysema ( $\leq 950$  HU,  $>9\%$  of relative area) and high ventilation defect percent (VDP $>12\%$ ) were randomly assigned to a training set (n=7) and a test set (n=3). From each subject in the training set, an even number of ventilated and non-ventilated ROIs was employed to train a logistic regression classification model, resulting in  $>20,000$  ROIs for training. The trained logistic regression model was applied to the thoracic CT of the test set, yielding  $>17,000$  ROIs. The predicted classification was compared with ground truth (MRI ventilation map).

**Results:** In three test cases there was qualitative spatial agreement for the experimental MRI ventilation maps and the CT-predicted functional maps. The training set was classified with a 65.7% accuracy, while the test set was classified with a 63.4% accuracy with area under the curve (AUC) of the model equaling 0.68.

**Discussion:** In this proof-of-concept study, we developed a pipeline to co-register hyperpolarized gas MRI and thoracic CT and extract features from each three-dimensional CT ROI to predict functional information. The results presented here in 10 datasets is limited to patients with both ventilation abnormalities and emphysema, and as such future work will involve development of this pipeline with iterative improvements based on a larger and more heterogeneous patient cohort.

**References:** [1] McCollough et al. (2015); [2] Guerrero et al. (2006); [3] Kirby et al. (2012)