Title: Application of quantitative imaging to assess hemodialysis-associated lung disease

Trainee Name: Fabio R. Salerno

Supervisor(s): Dr. Christopher McIntyre, Dr. Grace Parraga

Structured Abstract:

Introduction. Lung disease is an under-investigated field in patients on chronic hemodialysis. Its clinical relevance is hinted at by the high reported prevalence of shortness of breath in this patient population, although its causes largely remain unclear. We hypothesized that quantitative imaging would allow a detailed, noninvasive assessment of pulmonary anatomy and function in chronic hemodialysis patients. The objective of this study was to describe and quantify lung disease with multiple imaging modalities and explore their clinical implications.

Methods. To avoid potential confounders, chronic hemodialysis patients with previously diagnosed chronic lung disease, cancer and infections were excluded, and smoking history was limited to 20 packs/year. Study participants underwent pulmonary function tests, hyperpolarized 129Xe MRI, thoracic CT and doppler echocardiography. Ventilation abnormalities were measured with 129Xe MRI as ventilation defect percent (VDP) and values >2% were considered abnormal. Total lung volumes (TLV) and pulmonary vessel volume (PVV) was segmented using a commercial software (VIDA Diagnostics Inc., Coralville, USA), and the latter was indexed by body surface area (PVV/BSA). Lung calcification volume % (LCV%) was measured using a thresholding method (≥ 130 Hounsfield units) and indexed by TLV. Left atrial volume (LAV) and pulmonary artery systolic pressure (PASP) were measured from doppler echocardiography as markers of chronic volume overload and pulmonary hypertension, respectively. PASP ≥ 35 mmHg was considered abnormal. Shortness of breath was assessed with two validated questionnaires (modified Medical Research Council – mMRC, and University of California, San Diego Shortness of Breath Questionnaire – UCSD SOBQ). Associations between quantitative imaging biomarkers, demographics, shortness of breath scores and clinical biomarkers were assessed with Pearson correlation, as appropriate.

Results. Five patients on chronic hemodialysis were recruited so far. Three patients exhibited clinically significant ventilation abnormalities on 129Xe MRI; two patients had PASP ≥ 35 mmHg, and all showed evidence of airway, pulmonary vascular and parenchymal calcifications of varying severity. PVV/BSA was correlated with LAV (r=0.94, p=0.02) and PASP (r=0.92, p=0.03). mMRC and UCSD SOBQ scores did not show any correlation with the aforementioned imaging biomarkers.

Discussion. Quantitative imaging allows a detailed description of pulmonary changes in hemodialysis patients. Based on current findings, we can define hemodialysis-associated lung disease as a syndrome that encompasses ventilation abnormalities, pulmonary hypertension and calcifications. Shortness of breath scores did not correlate with any imaging biomarker, suggesting a multifactorial pathophysiology. More study participants are necessary to increase our observations and better describe the burden of pulmonary changes in this patient population.