Development of MRI scan methods to image inhaled fluorocarbon gases as biomarkers of lung structure and function (Ref MOS19-04)

[Newcastle University, Institute of Cellular Medicine]

Supervisory Team

- Dr Pete Thelwall, Newcastle University (Lead)

Overview

Lung diseases are a leading cause of death, and new treatments are emerging. Tests to determine patient response to new treatments are essential for disease management, and for development of new therapeutic approaches. We are developing new MRI-based tools to image lung ventilation properties, and this project will involve optimising MRI scanner hardware and scan protocol setup for visualisation of inhaled perfluoropropane (an inert MR-visible tracer), and development of new measures of lung perfusion, ventilation and microstructural properties. The new scan methods will be tested in studies of healthy volunteers and in patients with a lung disease.

Research Project

Lung diseases cost the UK £11 billion every year, making it the 4th most costly disease area to the UK. £9.9B of these costs fall on the NHS and patients. Methods to assess changes in lung structure and function play vital roles in diagnosis and monitoring, but existing clinical methods lack spatial information and/or incur a radiation dose. New developments in magnetic resonance imaging (MRI) now create the potential for simultaneous quantifiable evaluation of lung ventilation, perfusion and microstructural properties. We are at the cutting edge of these developments through our studies on inhalation of a low cost and inert MR-visible fluorocarbon gas, perfluoropropane. This \(^{19}\text{F}\)-based tracer can be visualised without hyperpolarisation (magnetic preparation of the tracer gas) and is thus simpler to implement than current lung gas tracer MRI methods.

This project will develop \(^{19}\text{F}\)-MRI-based measures of lung microstructure and functional properties towards use in clinical practice. In our pilot studies we have observed that the transverse relaxation rate of inhaled perfluoropropane (T\(_2^*\), a magnetic property detected with MRI) is highly sensitive to alveolar diameter and we hypothesise that this confers ability to detect lung microstructural change arising from disease processes such as fibrosis and emphysema. Also, we have pilot data showing that the T\(_2^*\) of inhaled perfluoropropane can be lengthened by administration of an intravenously administered MRI contrast agent. This forms a novel approach for assessment of alveolar perfusion by exploitation of the effects of intravenous contrast agent on inhaled tracer gas in adjacent airspaces. These technologies enable detailed, serial assessment of pulmonary alveolar perfusion and alveolar diameter without recourse to ionising radiation, opening up the potential for safe, detailed monitoring in a broad range of important clinical conditions including pulmonary embolism (PE), pulmonary arterial hypertension (PAH), idiopathic pulmonary fibrosis (IPF) and chronic obstructive pulmonary disease (COPD). Downstream, these new methods will be developed to provide valuable new imaging tools for clinical research and clinical practice.

Specific aims for the project are to develop new scan methods for dynamic quantitative image of the T\(_2^*\) of inhaled perfluoropropane in patients, and to use these methods to determine the dependence of T\(_2^*\) on lung microstructure and perfusion properties through studies of test objects, healthy volunteers and patients with lung disease. If successful, these studies will provide unique novel quantitative tools for clinical diagnosis and treatment monitoring, and for use in clinical trials of novel lung disease therapeutic approaches.

The project forms part of our broader strategic thrust to develop better imaging tools for lung
disease, tackling the shortcomings of existing methods in current clinical use such as spirometry (which lacks spatial information) and CT / gamma camera scans (which incur a radiation dose and are thus ill-suited to monitoring over time).

Training & Skills

The project will provide a training in magnetic resonance imaging applied to biomedical research. This represents an interdisciplinary training in priority areas and skill priorities identified by the EPSRC and the MRC. The project will be performed within an existing research agreement with Philips Healthcare, providing MRI scanner source code, programming tools and scanner capabilities to enable cutting edge research, an providing training opportunities in both project-specific and transferable skills. The project will operate across studies of test objects, healthy volunteers, and patients with respiratory disease, providing comprehensive training in interdisciplinary medical research (partnered with our local NHS Trust).

Further Information

Dr Pete Thelwall  
Pete.thelwall@ncl.ac.uk  
+44191 208 1156

How to Apply

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• attach degree transcripts and certificates and, if English is not your first language, a copy of your English language qualifications