**Project title:** Assessing personalised brain tumour evolution dynamics with synthetic DTI, MR radiomics and near-patient sensing.

**Project Summary:** The brain exhibits a unique structure-function relationship, with certain areas having a predictable link between lesion location and functional impairment (e.g. lesions in the motor cortex causing weakness). However, tumour cells often exert pressure on or invade adjacent normal brain tissue along white matter tracts (WMT) which relate to more than one functional region. Standard structural imaging captures tumour location, but does not measure tract anatomy, which requires much more resource-consuming MRI tractography such as Diffusion Tensor Imaging (DTI). Treatment is therefore indiscriminate to WMT involvement and functionality and its evolution over time.

In patients with high-grade gliomas, functional ability as assessed by performance status is a prognostic measure and we have previously shown that wearable devices are acceptable to brain tumour patients, and that changes in activity levels correlate with disease progression. However, activity only measures motor function, and many patients have lesions in areas of the brain that cause other functional problems. Our BrainApp trial addresses this by gathering multi-modal data (e.g. steps, speech, balance and cognition) to better understand patients' functional performance. Although we possess the technical capability to measure a growing array of functional parameters through near-patient sensing, each measurement incurs both cost and time, and adds noise. Therefore, it is not practical to incorporate all measurements for every patient, and some measurements may be more sensitive than others in allowing us to track disease progression.

Previous work by the Brain and Signal Research and Analysis Lab at ICL (Rekik) has utilised generative deep learning techniques to enhance the resolution of medical imaging. Previous work in our group has shown that we can measure sarcopenia from routine imaging in brain tumour patients, and work conducted at Kings (with us as collaborators) has produced a novel prognostic model based on MR radiomics.

Our hypothesis is that by using synthetic-DTI imaging, alongside tumour radiomics, we will be better able to predict the type, and time course of disease progression and its functional impact, and that sarcopenia may help either predict or explain some of these changes.. We will then use this information to predict which modality is likely to be most affected by disease progression, and when. To integrate the different aspects, we will use an explainable AI approach based on argumentation. By doing this, we will significantly improve our ability to use multi-modal, near-patient sensing to detect disease progression in brain tumour patients, and thus intervene earlier, potentially improving Quality of life and survival.

This work draws on significant work conducted across multiple groups over the last 5 years, and integrates and applies that to a novel. The candidate will be supported by input from the eXplainable AI group at Imperial (Toni) and based in the Computational Oncology Group (Williams) with input from KCL (Booth) and the IX centre at Imperial (Rekik). It will use data from the BrainApp trial (already recruiting) and the Brain Tumour Data Accelerator (Williams).

**Supervisory Team:** Dr Matt Williams, Prof Francesca Toni

**Clinical Specialities:** Oncology (Clinical or Medical)