Impact Statement

This thesis investigated the use of diffusion weighted imaging in Wilms' tumours. A range of advanced non-Gaussian models of diffusion were compared. Each model provides various biomarkers of diffusion and have the potential to provide clinically useful information.

This thesis demonstrated that in Wilms' tumour tissue and normal renal tissue, diffusion does not exhibit mono-exponential behaviour, but is better described by non-Gaussian models. In Wilms' tumour the stretched exponential model provided the best description of the data and in normal renal tissue the IVIM model (intravoxel incoherent motion) provided the best description. This finding could be beneficial in many areas of research as many studies utilise ADC (a diffusion parameter derived from a mono-exponential model) and thus assume the tissue has a mono-exponential signal decay as the diffusion weighting is increased. Being aware that tissue may be better described by other models may lead to more accurate representations of the underlying tissue structure.

Another finding was that many parameters produced from diffusion models are reproducible, including ADC, D (IVIM), f (IVIM), D_k (kurtosis), and α (stretched exponential), when generated based on acquisitions using different b values and at different magnetic field strengths. This finding will help with generalising the results from this thesis and interpreting research from different centres who do not have identical imaging protocols. Furthermore, some parameters were less reproducible [D^* (IVIM), K (kurtosis) and DDC (stretched exponential)], thus aiding the interpretation of future research using these parameters, as some findings may not be able to be replicated across different centres.

A key result from this thesis was the ability to identify necrotic tissue within Wilms' tumour using a non-invasive method. It was shown that necrotic tissue could be visualised and quantified using a combination of ADC and T_1weighted imaging, whereas currently an injection of gadolinium contrast is required. This finding has the potential to be clinically useful as the volume of necrotic tissue post-chemotherapy is informative of treatment response, and gadolinium is not always appropriate in some patients.

Furthermore, this thesis highlighted that subtypes of Wilms' tumour may be able to be identified *in vivo* using diffusion measurements, whereas currently this can only be determined via histological analysis after surgery. This thesis suggested that non-Gaussian diffusion parameters may be superior to ADC in distinguishing different Wilms' tumour subtypes.

Therefore, overall this thesis has suggested that non-Gaussian models of diffusion should be investigated in future research in Wilms' tumour, and potentially other forms of abdominal cancer. These models provided an improved fit to the raw DWI signal and provided novel biomarkers to describe the microstructure and physiology of the tumour tissue.