Mathematical Modelling for Cortisol Replacement

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Adrenal insufficiency (Addison's disease) affects over 100 per million people worldwide. It is a condition characterised by low levels of the hormone cortisol, wherein people develop symptoms including extreme fatigue, low blood pressure, and depression. These symptoms become increasingly severe over time. If left untreated, there is a risk of adrenal crisis which can be fatal.

Addison's is treated by glucocorticoid replacement, of which hydrocortisone is the most prescribed. Keeping patients in a therapeutic range is a continuous battle – other stressors and lifestyle changes can impact how much cortisol is needed. The aim is to avoid adrenal crisis whilst maintaining good quality of life for patients. Getting the dose correct takes several visits to the doctor – all the while individuals are not having their condition properly managed.

Instead, we have developed a mathematical model that allows us to create personalised treatments strategies tailored to a specific patient and their individual circumstance. Using intrinsic properties of biological functions, we can simplify our model to reduce the complexity of our equations. My research identifies which features we need to know about patients to pin down unique, physical process rates, whilst allowing us to gain insight into the dominant processes happening within the body. This approach enables us to evaluate how individual patient characteristics and treatment choice affect results.

Ultimately, we would like to give people living with Addison's the autonomy and independence over their condition by anticipating individual treatment plans, whilst saving medical practitioners valuable time and resources.