

Project Details	
Project Code	MRC21PHCa Daniel
Title	Which patient on the kidney transplant list should receive this donated organ? Developing and investigating the consequences of a machine learning approach.
Research Theme	Population Health
Summary	How best to allocate available kidneys to potential recipients on a waiting list is a complex and open problem, to which modern machine learning methods are increasingly being applied. Using data from the UK Renal Registry, this project will focus on improving patient survival, as well as investigating (from a statistical perspective) the ethical implications of possible organ allocation algorithms.
Description	<p>An important open research question in transplantation medicine is how best to use available data on donors and potential recipients to improve the organ allocation process. An ideal algorithm would involve:</p> <ul style="list-style-type: none"> A. the predicted length of time the transplanted organ will function well in the patient (graft survival) B. the expected benefit to the recipient in length (patient survival) and quality of life C. how long the patient has been on the waiting list D. the likely length of time before a better-suited organ for that patient becomes available. <p>Ideally, the algorithm would balance the comparisons of the aspects above between patients in a way that extends and improves the quality of life for all patients, with minimal 'waste' (e.g. an organ expected to function well for 20 years allocated to an elderly patient) and without inadvertently introducing bias, e.g. patients from a particular ethnic group being disadvantaged. A number of research groups (including one at Cardiff University, involving the supervisory team) are tackling the above for kidney transplants, with most of the the work to date focusing on the use of traditional (Cox proportional hazard) models and machine learning alternatives to predicting graft survival (A). This project will focus on patient survival (B) as well as on the ethical considerations alluded to above, using data from the UK Renal Registry. This dataset includes clinical and demographic information on donor and recipient for all kidney transplant surgeries performed with an organ from a deceased donor in the UK during 2006-15; data on over 14,000 transplants are included. The relative emphasis on the different objectives envisaged for the PhD can be adapted to suit the candidate's experience and interest, but these components are:</p> <ul style="list-style-type: none"> i) To predict patient survival using donor and recipient characteristics available at the time of decision to transplant. ii) To compare different methods for achieving i), including traditional (Cox PH regression) and ensemble machine learning methods (including algorithms such as random survival forests, survival support vector machines), along with simpler methods (based on histological compatibility) currently in use. iii) To adapt the above to make hypothetical predictions for patient survival with and without receiving the organ under consideration; this is necessary in predicting the benefit to the potential recipient. iv) To investigate a candidate allocation algorithm that combines iii) with existing work on predicting graft survival and assess (by retrospectively mimicking the use of such an algorithm on the UK Renal Registry data) the extent to which such an algorithm inadvertently introduces gender, racial and other biases,

	<p>comparing with what exists under the current allocation system. v) To explore potential statistical approaches to mitigating biases identified in iv), e.g. using constrained optimisation. The student will develop skills in data science (details below), specifically at the intersection between statistics (including missing data, casual inference) and data science, highlighted as a priority area in UK research. Objectives iv and v on the ethics of AI in medical decision making represents added value relative to a typical statistics PhD. This is a topical debate, currently of interest to a diverse interdisciplinary group at Cardiff comprising philosophers, lawyers, social scientists, etc, and coordinated by the Data Innovation Research Institute. Being able to contribute to this group will represent significant added value to the student. The project has the potential to lead to highly impactful results within a relatively short time frame, by feeding into the current research on developing better algorithms for organ allocation. Having a Consultant Transplant Surgeon from UHW on the supervisory team will ensure that focus is maintained on finding actionable solutions to the problem.</p>
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