Improving Efficiency and Equity of Ambulance Services through Advanced Demand Modelling

Background

Demand for Ambulance Services in England has risen dramatically over recent years. (Peacock and Peacock 2006, Lowthian, Jolley et al. 2011). The disparity between the increasing demand and limited ambulance resources makes the major challenge for maintaining a high-quality service. In 2017, NHS England undertook a significant national reform called the Ambulance Response Programme (ARP), designed to address efficiency and performance issues (Turner, Jacques et al. 2017). It noted the over-use of immediate dispatch decisions and the insufficient allocation of resources to incidents. The underlined principle is the emergency medical resource should be optimally allocated rather than exhaustively use, which has to be supported by good decision making. Moreover, key issues concerned: the quality of care; its cost-effectiveness; and the equality of provision across areas and population groups.

Research Aim

Given the urgent needs, the proposed PhD project aims to develop an advanced demand prediction model for ambulance services taking LAS as a case study. The model will highlight two features. The first is prediction at the disaggregated level, which considers the varied probability of incidences in contexts. The second is the spatial heterogeneity, which allows an optimised distribution and planning of resources (e.g. vehicles). The ultimate goal is to support high-quality dispatch and clinical decision-making considering **equity alongside efficiency**. Research questions are defined as:
•   What are the most correlated socioeconomic, environmental, and spatiotemporal factors and how to model these factors as predictors of ambulance demand generally and in LAS priority segments?
•   What demand management innovations can LAS develop based on this research to improve efficiency and equity of ambulance service?

Research Methodology

In general, the proposed project will follow an interdisciplinary approach. Spatial analysis and modelling methods will build the core of the demand prediction. Policy analysis will be applied to get an overall understanding of healthcare service in the UK such that the demand innovations developed will be rooted in a good understanding of context.

A case study of London will be implemented using LAS data. The LAS handles more than 2 million calls and sends a physical response to more than 1 million incidents per year (DASH 2018). Since the new operating model of ambulance service launched in early 2017, LAS has accumulated a good volume of data including call and response data, ambulance incident data and vehicle data. These are well-structured data in fine granularity (e.g. incidents are geocoded; response time are in minutes), providing a good overview of the hotspots of emergency incidences. LAS data will be linked with other thematic data sets, e.g. weather and demographic data for a comprehensive modelling of demand.

The state-of-the-art research progress on demand modelling is mostly developed toward prediction at disaggregated level, for instance, differences between urban and rural areas (Wong, Lin et al. 2018), weather and age-gender effects (Lai and Wong 2015), spatial variations (Chen, Chen et al. 2015), age group and the impact of available facilities (Cantwell, Morgans et al. 2017). The proposed research is in the same trend with interest in how the probability of emergency incidents, especially the LAS priority segments, varies across space, time and population and how to use the modelled results for spatial planning of healthcare facilities.

Normalisation Process Theory (NPT) (Murray, Treweek et al. 2010) is suggested for developing demand management innovations. The PhD candidate will be working closely with LAS Forecasting & Planning team and Business Intelligence team, and potential outreaching a broader range of interested parties. They will undertake a series of stakeholder interviews with ambulance drivers, call handlers, service planners, and other key partners to better understand the context within which demand management innovations could be developed.

Timescales

In general, we expect the student to conduct methods training and extensive literature review in the first year. As part of the practical training, preliminary data processing and analysis will be conducted. The student is expected to pass the upgrading by year one. In year two, the main part of the demand prediction model will be developed and applied to the case study of LAS. In year three, work will be a focus on completing the pathway analysis and open policy development, including interviews. The PhD project needs to be wrapped up from the end of year three, allowing the student to submit the final dissertation within four years.

Dissemination and knowledge exchange

The research will contribute to public health by providing a better understanding of the demand for health & care services. Various means of dissemination and knowledge exchange are planned:

[Between LAS and KCL] The student will strengthen the collaboration between KCL and LAS. Ideally, the student will have a seat at KCL and LAS. The supervisors will meet to check the research progress monthly.

[Wider research communities] The student will immediately become a member of research hubs at KCL (e.g. CUSP, SUPHI), allowing outreaching wider communities via the professional network. Moreover, the student is expected to travel to core conferences or training annually.

[Public sector – Healthcare service] The research tackles problems of digital change in health & care services. We will encourage the student to engage with wider partners in healthcare sectors with LAS's support.

[General public] Both KCL and LAS have social media channels. Besides publications, we will also regularly post short reports that can be read by the general public.

References

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