Project Title: Data-Driven Insights for Improving Patient Journeys in Unscheduled Care: A Comprehensive Analysis of Healthcare Services in Scotland

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Project Description

Abstract

This project addresses the pressing need for enhanced efficiency in managing unscheduled care services within Scotland's healthcare system, particularly in the wake of the COVID-19 pandemic. In collaboration with Public Health Scotland (PHS), we will leverage the Unscheduled Care Data Mart (UCD) to gain insights into patient pathways across various care settings. The project aims to map current care pathways, identify data gaps, and implement feedback mechanisms for continuous service improvement, focusing on equitable access for marginalised populations.

Utilising a combination of descriptive statistics, data visualisation, and advanced machine learning techniques, the project will develop predictive models to analyse factors influencing patient outcomes and employ clustering methods to identify systemic bottlenecks. Active collaboration with PHS will immerse students in the operational challenges of unscheduled care, ensuring practical insights inform our findings.

The project adheres to Responsible AI principles, prioritising transparency, fairness, and ethical data governance. Expected outcomes include actionable policy recommendations to enhance service delivery and optimise urgent care redesign, contributing to a more resilient and responsive healthcare system that can serve as a model for global healthcare practices.

Introduction

The COVID-19 pandemic revealed significant vulnerabilities in global healthcare systems, particularly in managing increased demand while maintaining routine care for non-COVID conditions.[1-2] In Scotland, this crisis led to unprecedented backlogs, prolonged waiting times, and excess deaths, underscoring the urgent need for a resilient healthcare system that can recover from emergencies and prevent future adverse outcomes.[2-4] In response, the Scottish Government launched the Urgent and Unscheduled Care Collaborative as part of its Recovery Plan to modernise NHS services and enhance system responsiveness.[4] This initiative aims to optimise care pathways, improve access to services like Hospital at Home, and ensure timely, appropriate care through better coordination between primary and

secondary care. The goal is to redesign urgent care delivery, enabling healthcare systems to effectively manage both routine and emergency demands in the future.

Research Challenge

The research challenges identified for this project include:

1. **Understanding Current Care Pathways**: Mapping patient care pathways is essential to identify bottlenecks that impact system performance (e.g. patient waiting times, length of stay). The challenge lies in correlating pathway efficiency with patient outcomes and understanding how different pathways contribute to systemic inefficiencies.
2. **Identifying Data Gaps and Leveraging Existing Datasets**: Healthcare data is often fragmented, with significant gaps in patient information as they transition across care settings. Research must determine how existing datasets can fill these gaps and where new data collection capabilities are needed to improve service delivery and patient care.
3. **Leveraging Feedback Loops for Service Improvement**: Integrating feedback mechanisms into care pathways is essential for continuous service improvement. The challenge lies in pinpointing key data collection points that can guide service adjustments, promoting more responsive and efficient care delivery. Addressing health inequalities to ensure equitable care for underserved populations is also a priority.

Data

This project will leverage a comprehensive dataset from Public Health Scotland (PHS) via the Unscheduled Care Data Mart (UCD), a collaboration with NHS 24 and the Scottish Ambulance Service (SAS).(5) The UCD captures patient-level information across various sources, including Primary Care Out of Hours, Emergency Departments, Acute Hospital Admissions, Mental Health Admissions, and Death Records. It enables detailed analysis of the patient journey through unscheduled care, tracking interactions from initial contact with NHS 24 to hospital admission. Covering the entire Scottish population from 1 January 2011 onwards, the dataset records an average of 2.8 million patient pathways annually, is updated in real-time, and links data at both patient and episode levels through the Community Health Index (CHI) number.

Methodology

We will analyse patient pathways using descriptive statistics and data visualization techniques for an overview of unscheduled care flows. The project will employ both supervised and unsupervised machine learning approaches(6-7):

- **Supervised Learning**: We will develop predictive models to identify factors affecting key outcomes, such as length of stay, admission likelihood, and waiting times, evaluating these models using performance metrics and cross-validation for robustness.

- **Unsupervised Learning**: Clustering techniques will identify common patient pathways and system bottlenecks, with stakeholder engagement validating insights to ensure alignment with real-world conditions.

To enhance model robustness and generalizability, we will split the data according to established machine learning procedures, such as k-fold cross-validation, and use regularisation to minimise the risk of overfitting.

Collaboration with Public Health Scotland
The project will involve active collaboration with Public Health Scotland (PHS), where the student will dedicate 20% of their time (one day per week) to being embedded within the relevant PHS team. This arrangement aims to provide the student with live experience and a deep understanding of the data mart and its operational challenges. This immersive involvement will allow direct engagement with the relevant team within PHS and promote hands-on experience and practical learning throughout the PhD journey.

Responsible AI/Ethical Considerations

In this project, we will adhere to Responsible AI principles to ensure our models are transparent, fair, and ethically sound. We will focus on minimising bias, especially regarding health inequalities among different socioeconomic and ethnic groups. The data will be pseudo-anonymised to protect patient privacy, and researchers will receive training in data governance and patient confidentiality. Engaging stakeholders will be essential to ensure our AI systems align with societal values and promote equitable healthcare access for all.

Expected Outcome and Impact

This project aims to generate policy recommendations for meaningful improvements in healthcare service delivery by:

1. Proposing strategies to enhance service efficiency at hospital and specialty levels, addressing bottlenecks and improving patient pathways.
2. Advocating for better data collection practices to support robust monitoring and evaluation of healthcare services.
3. Informing the redesign of urgent and unscheduled care services to optimize patient flows and resource allocation.
4. Identifying priority areas for healthcare resource allocation to maximize impact and improve patient outcomes.

Overall, the project seeks to enhance healthcare system efficiency, reduce strain on services, and improve patient care quality. By promoting data-driven decisions, it will contribute to a more resilient and sustainable healthcare system.

References

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