Contents

Background

Many people live with multiple long-term health conditions (MLTC), such as diabetes, heart problems and mental health illnesses. People living with MLTC may be more likely to have poor general health and a shortened life expectancy. To treat multiple conditions, people are often prescribed many different medicines together (known as ‘polypharmacy’.) Sometimes these medicines and their side effects can interact in unexpected ways, causing further health problems.

We aim to better understand the relationships between MLTC, polypharmacy, and personal/social factors to optimise treatment for individual patients. The project will focus on five different aspects of research, known as work packages (WPs), which are summarised below.

Work Package 1: Collecting Data

Data Access, Data Wrangling, Data Engineering

AI MULTIPLY researchers will make use of multiple, large patient datasets, both national and regional, to address key research questions.

To achieve this, we will make use of a new generation of algorithms that can identify trends in large collections of patient records. Examples of these records include Electronic Health Records (e.g. diagnoses, clinical test results) and associated Prescription Records (from GP practices and primary care records). We will use data which represents ethnic minorities and migrants.

Artificial Intelligence

The algorithms, known as “Machine Learning” or “Artificial Intelligence”, specialise in recognising patterns in large amount of data, including patients’ medical histories. For the algorithms to be able to function effectively, it is important that the data used is available in large quantities (thousands of patients) and is of good quality.

Whilst in principle these records “tell a patient’s story”, they mostly reflect doctors’ notes, taken either in a GP clinic or in a hospital, and as such they can be incomplete, ambiguous, and possibly vague (for example, the rationale behind a specific drug prescription may not be clear). When similar data are collected across different practices and at different times, they also need to be integrated, as the format and clinical meaning of the data may be different.

Data Engineering

“Fixing” the data that we have access to entails multiple technical challenges. In Work Package 1 we will access the data required and address these challenges, so that they can be meaningfully analysed in Work Package 2. We will use techniques known as ‘data engineering’ to make it easier to use the data in the next part of the project.

We are also planning to share our research with teams working on similar projects throughout the UK. This will help us to understand how our research can be applied across different communities. We will work with local healthcare providers and inequality groups to ensure our findings have impact within local populations.

Work Package 2: Analysing Data

Analysing for Multiple Long-Term Conditions and Medicines

In this part of the project we will use further AI techniques to analyse the data collected in Work Package 1. We will look for relationships between MLTC, polypharmacy and personal/ social factors.

To test these relationships, we will repeat our investigation across different datasets and compare our results to findings in similar studies.

Work Package 3: Clinical Interpretation of Results

Work package 3 will look at how the results from work packages 1 and 2 can be applied to real-world situations, to improve healthcare outcomes for patients with multiple long-term conditions. The research in this work package will be divided into three parts: mental health, inflammation, and how ethnicity and various social factors may affect the best treatment options for patients.

Mental health

Patients who have mental illnesses often suffer from physical illnesses too. This may be due to unhealthy illness-related behaviours, shared underlying causes, or side effects of

medication. For example, antidepressants may lead to weight gain, heart abnormalities and increased bleeding, all of which could make physical health problems worse.

Some physical health medications, such as medicine to control blood pressure, can be associated with increased risks of depression, whereas other medications (such as anti-inflammatory medicines) may improve depression. On the other hand, treatment of mental illnesses may improve physical health.

Mental illnesses are recorded in various ways in electronical health records. Using AI technology to analyse these large sets of information, we will explore the relationship between mental health illnesses and other conditions such as obesity, diabetes, heart disease etc, as well as the impact of combining medications used to treat these conditions on overall health outcomes.

We will also explore the interaction between personal/social factors and depression/anxiety on health outcomes, and how this might be modified by antidepressant usage.

Inflammation

Inflammation is linked to many diseases such as heart disease, stroke, cancer, and depression, and is known to contribute to the development of MLTC. Anti-inflammatory medicines are also linked to the development of health conditions such as diabetes and infections.

We will test whether having an inflammatory disorder and taking specific anti-inflammatory drugs is linked to developing multiple conditions. We will look for evidence to support the use of anti-inflammatory drugs to treat health conditions which may be associated with inflammatory disease.

Population Differences

Differences in the treatment of multiple long-term conditions are well documented. For example, people of different ethnicity can respond differently to medicines, and clinical trials often exclude the older population. We will use data from Electronic Health Records to assess inequalities in the diagnosis and treatment of multiple long-term conditions, looking at characteristics such as age, sex, ethnicity, and social circumstances.

Electronic Health Records may not have enough information on all patient characteristics which we are interested in. We will conduct in-depth interviews with patients to:

- understand patients' experiences, perceptions, and priorities
- explore real-world differences in the treatment of multiple long-term conditions, the meaning of these differences for individuals, and public perceptions of inequality in healthcare
- uncover different methods of recording healthcare data which may be useful in our investigation

We will also conduct follow-up interviews to ensure patients' real-world experiences and perceptions can influence how we interpret the findings from our research.

Work Package 4: Successful Collaboration of Researchers

Here we will explore how all the different people in the AI MULTIPLY collaboration work together in practice and how this informs the design of the Artificial Intelligence technology. This is important as the people in the collaboration bring different kinds of expertise, perspectives and knowledge to the project.

The work will explore:

- how different people in the project understand and value what they are doing
- what assumptions different people in the collaboration bring to the project
- how collaborators contribute to the project team
- how different kinds of knowledge and expertise are 'worked through' within the team.

The key aim is to understand how successful collaborations between people who have different fields of expertise can be achieved in the field of Artificial Intelligence in healthcare.

We will observe and record project team meetings and write detailed notes of our observations. We will conduct 24 – 30 in-depth interviews with selected researchers and PPIE members, and run three interactive workshops to help the research team reflect on their work.

Work Package 5: Health and Social Care Outcomes

Research from other parts of the project will identify which people are more likely to experience harm or side effects from their medicines. This work package is focused on making sure these findings can be used in practice to help improve the treatment of people with different long-term conditions.

The aims of this work package are as follows:

1) To investigate how different patient factors (e.g. age), social factors (e.g. living conditions), medical factors (e.g. different long-term conditions), and different medications contribute to people experiencing side effects or harm from their medication
2) To work towards developing a guide which will assist healthcare professionals in making decisions on whether certain medications are suitable for patients. This method works by comparing health outcomes of patients with MLTC who have received different treatments.
3) If the guide proves to be beneficial for patients, we aim to design a trial which would evaluate the guide and apply for further funding to refine and test it.

To help develop the guide, we will speak to a range of different healthcare professionals involved in the prescribing, supply and monitoring of medications. We will also speak to people who have experience of using medications to treat long-term conditions.