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AI MULTIPLY

The NIHR AI-MULTIPLY consortium 2021–2026: Our Impacts and Outputs

Our mission statement: Using the collective expertise of patients, clinicians, researchers and artificial intelligence to improve the care of people who live with many health conditions and medicines

Newcastle University

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NHS Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust

NHS The Newcastle upon Tyne Hospitals NHS Foundation Trust

Social Action for Health

The University of Edinburgh

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Introduction:
The Story Begins

Nick Reynolds **Mike Barnes**

Co-lead investigators of AI-MULTIPLY

Our AI-MULTIPLY research journey began in 2021 with a 12-month Development Award, funded through the National Institute for Health and Care Research (NIHR) Artificial Intelligence for Multiple Long-Term Conditions (AIM) AIM Programme. Building on this early work, our consortium went on to secure a full NIHR Collaboration Award running from September 2022 until March 2026.

Our overall aim is to better understand the complex interactions between multiple long-term conditions (MLTCs) and the multiple medicines often used to treat them (polypharmacy). In particular, we want to explore how these conditions and medications interrelate and influence people's health over the course of their lives. This aim is captured in our mission statement co-developed with our Patient and Public Involvement and Engagement groups (PPIE), whose members have direct and lived experience of MLTCs and polypharmacy:

Using the collective expertise of patients, clinicians, researchers and artificial intelligence to improve the care of people who live with many health conditions and medicines.

Living with two or more long-term conditions is associated with poorer health outcomes, including lower quality of life, higher use of healthcare services, and increased risk of early death. Polypharmacy is common in people with MLTCs, but its benefits and harms are not yet well understood. While taking multiple medicines may be necessary, it can also increase the risk of adverse effects and drug interactions.

Our research examines how patterns of polypharmacy interact with clusters of long-term conditions, and how these combinations influence health outcomes across diverse populations. We use artificial intelligence (AI) to generate new insights that can support safer, more effective care, in line with the NHS Fit for the Future: 10 Year Health Plan for England, particularly its focus on digital innovation and prevention.

AI-MULTIPLY is jointly led by Newcastle University and Queen Mary University of London, in partnership with NHS trusts, universities and community organisations across the UK. The programme is delivered through coordinated workstreams, with patient and public involvement embedded throughout. PPIE contributors have shaped research questions, supported delivery and dissemination, and worked closely with early career researchers, creating a two-way learning environment.

The consortium has also provided strong interdisciplinary training opportunities, helping build future capacity in AI, health inequalities and public involvement. We are grateful to our Independent Advisory Board, chaired by Professor Frances Mair, for its expert guidance.

Our MLTC Journey

What Sparked the Research

Our overarching question is:

How do multiple long-term conditions and polypharmacy interact and how is this interaction modified by inequalities?

Why it Matters

Many people live with two or more ‘long-term health conditions’ which include lots of different illnesses, such as cancer, heart, and mental health problems. People living with multiple long-term conditions (MLTCs) may progress to poor health and have a shorter life expectancy. Treating multiple health conditions is a balancing act. People with MLTCs are often prescribed many different medicines together (known as ‘polypharmacy’). Sometimes these medicines (and their side effects) can interact in unexpected ways, causing further problems. Patients have described living with MLTCs as a “full-time job”, others have highlighted it as a health journey.

Our aim was to better understand the relationships between MLTCs, polypharmacy, personal and social factors to optimise treatment for individual patients.

Who’s Involved

The AI-MULTIPLY consortium brings together multidisciplinary investigators with a variety of expertise (including health, data science, and social research) across universities, the project PPIE groups, the NHS and Social Action for Health.

We are a Research Collaborative which has been awarded funding from the National Institute for Health and Care Research (NIHR) to investigate the use of artificial intelligence for multimorbidity and polypharmacy (NIHR203982).

Figure 1: The experience of living with MLTCs was explored through Social Action for Health’s art workshops

Our Research Process

Methodology Explained

We analysed anonymised health records from GP practices and hospitals across the UK to examine how MLTCs and polypharmacy develop over time. By linking patterns of conditions and prescribing with personal and social factors, we aimed to identify opportunities to intervene earlier, reduce health inequalities and improve care.

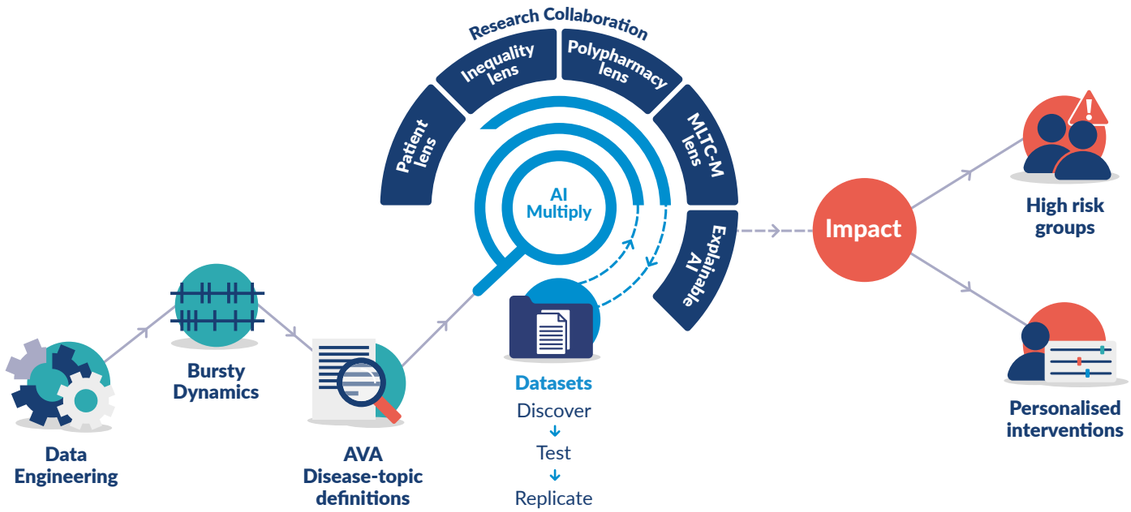


Figure 2: AI-MULTIPLY Overview

Our approach uses a range of artificial intelligence (AI) and machine learning methods, including large language models, supervised learning and clustering techniques. These tools can identify patterns in large, complex datasets that are not visible through traditional analysis, such as common combinations of conditions, prescribing patterns and differences in outcomes linked to deprivation.

Together, these methods provide new insights into how MLTCs and polypharmacy affect people's lives. This evidence can support more informed decision-making in the NHS, including safer prescribing, improved medication reviews and more personalised care.

Key Challenges and Turning Points

Working with large and complex health datasets has been a significant challenge. We had to ensure the data was high quality, deal with missing or inconsistent information, protect patient privacy at every stage, and translate AI findings into solutions that are both practical and ethical. Overcoming these hurdles allowed us to make major progress: we developed new ways to predict hospital readmission for people with MLTCs, created polypharmacy analysis tools to support safer prescribing, and built an inequalities scorecard that helps researchers assess the fairness of their AI work. We even identified a completely novel concept of burstiness in patient health events, that predict patient outcomes across a range of conditions.

Building Future Leaders and Integrating Research

Supporting early career researchers (ECRs) has been central to AI-MULTIPLY. Throughout the project, ECRs have worked closely with patients and public contributors, learning directly from people with lived experience of MLTCs and polypharmacy, including those who do not speak English or have little formal education. These relationships have helped ECRs develop not only technical expertise, but also a deeper understanding of the real-world challenges behind the data – an essential skill for future leaders in health modelling and inequalities research.

One of our major achievements is a PPIE-designed approach for embedding PPIE across all work packages. This framework, now adopted by the University of Oxford's CoMPuTE project, has helped create genuine two-way learning: patients gain insight into how AI and data science work, while ECRs learn how to make their research more relevant, ethical, and impactful.

By bringing researchers and patients together from the beginning, we have strengthened our methods, improved the quality of our models, and created lasting capacity for tackling complex health challenges.

Scan for more details on the methodology

Putting People at the Heart of AI Research

Patient and Public Involvement and Engagement (PPIE) has been central to AI-MULTIPLY, ensuring that lived experience informs research questions, methods, delivery and dissemination. Contributors from diverse communities across the UK have shaped the project at every stage and introduced creative approaches to involvement.

Key PPIE achievements include:

- **Building capacity in underserved communities:** Meaningful involvement throughout the research lifecycle has delivered benefits beyond the project itself. For example, 82% of Social Action for Health PPIE contributors were new to research, 73% do not speak day-to-day functional English, and 86% are from minoritised ethnic backgrounds.
- **International recognition:** PPIE-led abstracts were accepted at major conferences, including the Creative Methodologies Conference (Manchester), MLTC UKRI Conference (Birmingham), and the Participatory AI Conference (Paris), where AI-MULTIPLY was the only team to include PPIE contributors alongside researchers.
- **Innovative and creative methods:**
  - **Theatre:** A Forum Theatre production, co-created with Lawnmowers Theatre Company, explored barriers and opportunities for PPIE in AI research and is informing plans for a future Legislative Theatre project.
  - **Art:** Arts-based workshops captured lived experiences of MLTCs and polypharmacy.
  - **Animation:** Co-produced animated videos explain AI and large language models in healthcare, with versions in English and Bengali.
- **Community engagement:** Workshops on AI explainability have connected with communities affected by kidney disease, diabetes and severe mental illness, helping ensure research reflects lived experience.
- **Skills and leadership development:** Early career researchers gained practical PPIE experience, while contributors were supported to co-author academic papers, extending impact beyond the project.

Together, PPIE contributors have driven innovation, accessibility and collaboration across AI-MULTIPLY. Ongoing PPIE valuation will inform best practice for future AI and data-driven health research (Thompson et al., 2025).

Scan to view our animations explaining AI in healthcare

Working Across Disciplines to Drive Innovation

AI-MULTIPLY brings together health, data science and social research expertise to address complex challenges through interdisciplinary collaboration. Drawing on 230 hours of observation and 19 interviews, we examined how interdisciplinary teams work in practice, identifying both enablers and barriers. These findings informed practical guidance and a paper outlining five recommendations to strengthen patient and public involvement in everyday research decisions, supporting more inclusive and effective collaboration across large research programmes.

Five key recommendations:

1. Identify who makes day-to-day research decisions.
2. Put clear structures in place, with senior support.
3. Foster a culture that supports sharing work-in-progress and open PPIE input.
4. Allocate sufficient time and resources.
5. Remain flexible and responsive to feedback.

By sharing these lessons, we aim to support other consortia to build stronger, more inclusive collaborations and translate research into real-world impact. Further details are available in Reynolds et al. (2025).

Scan for more details on the methodology

Real Stories, Real Impact: PPIE in Practice

Our Patient and Public Involvement and Engagement (PPIE) group brings together people from across the UK with lived experience of MLTCs and polypharmacy, including carers. Members reflect a wide range of ages, ethnicities, socioeconomic backgrounds and intersecting experiences of inequality. Many have substantial prior experience of involvement in health research and share a commitment to ensuring that PPIE within this project is inclusive, creative and meaningful.

From the start, contributors raised important concerns about the use of health data, including privacy, data sharing and commercial use. These discussions reflected wider public unease about artificial intelligence (AI) and the use of routinely collected health data. In response, the project adopted a collaborative approach to data governance and research design, aimed at building trust in both the AI tools developed and the methods used to analyse healthcare data.

PPIE has been embedded throughout the project rather than confined to advisory roles. A PPIE management group sits as equal partners on the study management team, with regular input to project and steering group meetings. Contributors take responsibility for their own reporting and dissemination, including the development and delivery of conference abstracts and publications.

Involvement has extended beyond formal meetings into areas where PPIE is rarely included. Contributors have participated in technical discussions, such as data engineering and whiteboard sessions, helping to shape analytical decisions. Our PPIE group co-created a Forum Theatre production, that explored with the audience barriers and opportunities for public involvement in AI and big data research. PPIE contributors are co-authors on all project publications and have been directly involved in qualitative and quantitative analysis across all work packages. Together these novel methods are shaping ideas and promoting the systematic inclusion of public voices in AI and data-intensive research.

Looking ahead, we aim to build on this work to influence PPIE practice more broadly. We also see a clear need to strengthen PPIE skills among early career researchers and to support contributors to influence day-to-day research decisions. Our overarching goal is to move beyond tokenistic involvement, positioning public contributors as equal partners in research that is relevant, ethical and capable of improving lives.

"Social Action for Health brings long-standing expertise in recruiting and retaining people for PPIE who are often excluded from research. Within AI-MULTIPLY, this has included members of the east London Bangladeshi community and others who face barriers such as language, culture, trust and a history of exclusion from research. By working through trusted community relationships, we have supported people to engage confidently and meaningfully with complex topics such as polypharmacy and artificial intelligence. Our contribution has included delivering creative art workshops, facilitating polypharmacy discussions grounded in lived experience, and co-producing accessible AI explainer videos in both English and Bengali. This work ensures that the voices shaping AI-MULTIPLY genuinely reflect the diversity of communities most affected by multiple long-term conditions and health inequalities."

Ceri Durham,
PPIE Co-Lead and CEO of Social Action for Health

Figure 3: AI-MULTIPLY PPIE session in action

Figure 4: "Body Exhibition" – A patient uses art to depict their multiple health conditions across their body at one of the SAfH Art Workshops

Our Discoveries:
Research Outputs

Our Data

Our findings are based on anonymised health records from millions of people in the UK. We used GP records from two key sources to discover our main findings, including 2.4M patients from the Clinical Practice Research Datalink (CPRD) Gold and Aurum and 500,000 volunteers in the UK Biobank, a large national research study. Both data sources include information on long-term conditions, medicines, and basic background details, including deprivation measures over time. Using these very large, trusted data sources allowed us to discover how health conditions and medicines interact across different groups of people and stages of life. In the final stages of the project, we are seeing how our findings are supported at a local level in the North East, East London, Bradford and Scotland.

Building a Polypharmacy Workbench

Rafael Henkin, QMUL

Our team at Queen Mary University London have developed an interactive **Polypharmacy Workbench** using GP prescribing data from CPRD. The tool helps clinicians and researchers explore how repeat prescribing and polypharmacy relate to MLTCs and adverse health outcomes. Users can compare groups of patients who do and do not experience a specific outcome, examining patterns of conditions and medicines that occur beforehand. This supports investigation of whether particular drugs or prescribing patterns are associated with higher or lower risk. For example, the tool can be used to explore whether vitamin D prescribing is linked to reduced risk of hospitalisation following a fall in older adults.

A key strength of the Workbench is its focus on inequalities. Users can examine outcomes across groups defined by sex, ethnicity and deprivation, helping to identify populations that may be more vulnerable due to specific combinations of conditions and medicines. Although developed using CPRD data, the tool can be adapted for use with other health record systems, including hospital data. It can support a range of future applications, including trial emulation for deprescribing, targeted data collection in local settings and the development of predictive tools for adverse events.

	National 'discovery' datasets		Regional 'health intelligence' datasets			Replication datasets	
	4m	230k	101k	40k	3m	1.2m	1m
	CRPD GOLD	biobank	North East and North Cumbria Anonymised Dataset	North East London Health and Care Partnership	CRPD AURUM	Connected Bradford	DataLoch
	National	**National**	**North-East England**	**East London**	**London**	**Bradford**	**Lothian**
	Representative	Under representative, not diverse	Socially deprived	Socially deprived, ethnically diverse	Socially deprived, ethnically diverse	Socially deprived, ethnically diverse	Representative, small town deprivations
	1* & 2* care, mortality HES	1* & 2* care, mortality HES	1* & 2* care, mortality	1* & 2* care, mortality HES, NHS Digital	1* & 2* care, mortality HES	1* & 2* care, community, social	1* & 2* care, social care, mortality
	1* care	1* care	1* & 2* care	1* care	1* care	1* care	1* & 2* care; community dispensed prescribing

Beyond Labels: Using Self-Supervised Learning to Predict Hospital Readmission

Rebeen Hamad, Newcastle University

Unplanned hospital readmissions, prolonged hospital stays and premature mortality remain major challenges for healthcare systems. Predictive models could help identify people at higher risk, but traditional approaches rely on well-labelled outcomes, which are often incomplete or inconsistently recorded in electronic health records.

To address this, we developed a self-supervised learning (SSL) approach that learns directly from routine health records without relying on predefined outcome labels. Using patients' diagnoses, long-term conditions, prescriptions and demographic information, the model learns compact representations that summarise overall health profiles.

These representations were then used to predict outcomes such as 30-day readmission, mortality risk and length of hospital stay. In people with multiple long-term conditions, the SSL approach outperformed standard supervised models in both UK Biobank and CPRD data, particularly where labelled data were limited. This method offers a more robust and scalable way to support risk prediction using routinely collected health data.

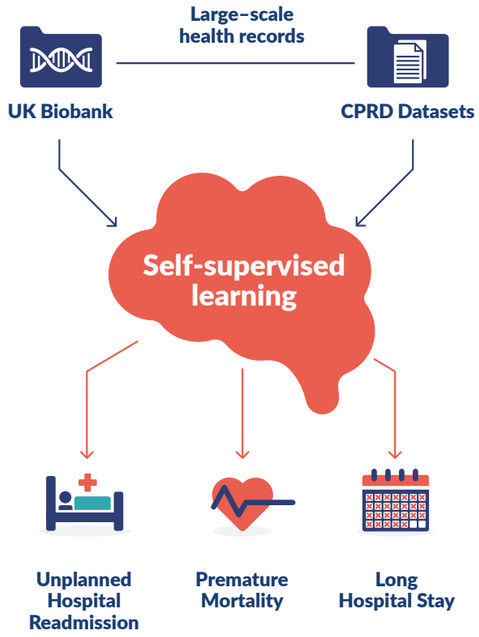


Figure 5: Beyond labels – Using Self-Supervised Learning to Predict Hospital Readmission

Bursty Dynamics in Health: Can the Timing of Our Health Events Tell Us Something Important?

Alisha Angdembe, QMUL

Health events often occur unevenly over time, with long stable periods followed by clusters of new diagnoses or care episodes. We examined whether these "bursty" patterns in healthcare records provide useful signals about health risk.

Using a method known as Bursty Dynamics, which has been used to study many different types of event sequences, including earthquakes and cyber-attacks, in our case we studied how the pattern of LTC health events over time influenced health in over 2m CPRD patients. This approach measures how regularly or closely events occur over time. We found that, for many LTCs, tightly clustered events were associated with increasing health instability. In older adults, these bursty patterns were strongly linked to poorer outcomes, including higher mortality.

Patterns varied by condition. Coronary heart disease, some cancers and alcohol-related conditions, for example, were more likely to emerge during bursty periods. These findings suggest that when health events occur may be as important as how many occur. Identifying bursty patterns early could help target timely support and intervention to vulnerable patients.

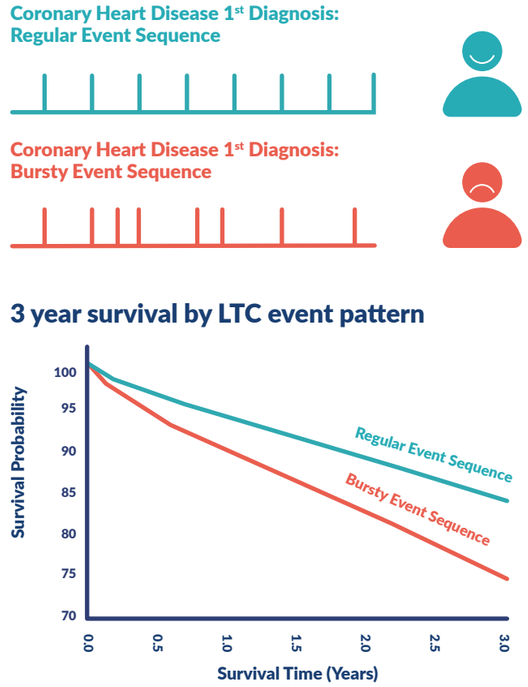


Figure 6: Bursty Dynamics matters for health

Our Discoveries:
Research Outputs

Finding Hidden Health Pathways: Using Probabilistic Models to Understand Lifelong Care Patterns

Kieran Richards, University of Edinburgh

This work explored how probabilistic methods can be used to identify common patterns in people's health and treatment histories over time. Real-world health data are often uncertain, with incomplete information early and later in life. Our approach explicitly accounts for this uncertainty, rather than treating records as complete.

We developed two probabilistic models. The first, **Probabilistic Modelling of Onset Times (ProMOTe)**, groups individuals by how long-term conditions accumulate across the life course. Applied to over 150,000 UK Biobank participants, ProMOTe identified 50 distinct clusters, including groups characterised by multiple mental health conditions and others dominated by cardiovascular disease.

The second model, **Probabilistic Modelling of Prescribed Medications (ProMPT)**, focuses on patterns of medication use over time. Applied to CPRD data from 10,000 people with stage 3 chronic kidney disease, it identified 10 prescribing clusters, highlighting patterns that may increase the risk of drug interactions or adverse effects.

Mental Health Matters: Antidepressants, Multimorbidity, and Long-Term Health

Soraia Sousa, Newcastle University

Around one-third of people with MLTCs experience both physical and mental health problems. From the outset, PPIE contributors emphasised the importance of addressing mental health within research on multimorbidity and polypharmacy.

Our work has examined antidepressant prescribing for depression and its association with long-term health outcomes. Using UK Biobank data, we conducted a **trial emulation** to compare cardiovascular outcomes across different antidepressants. This initial analysis was limited by small sample sizes, and the study is now being repeated using the larger and more detailed CPRD.

In parallel, we explored associations between antidepressant use and mortality, with a focus on mirtazapine. Early findings are consistent with previous evidence suggesting higher mortality risk, and further analyses are underway to confirm these results and investigate potential mechanisms.

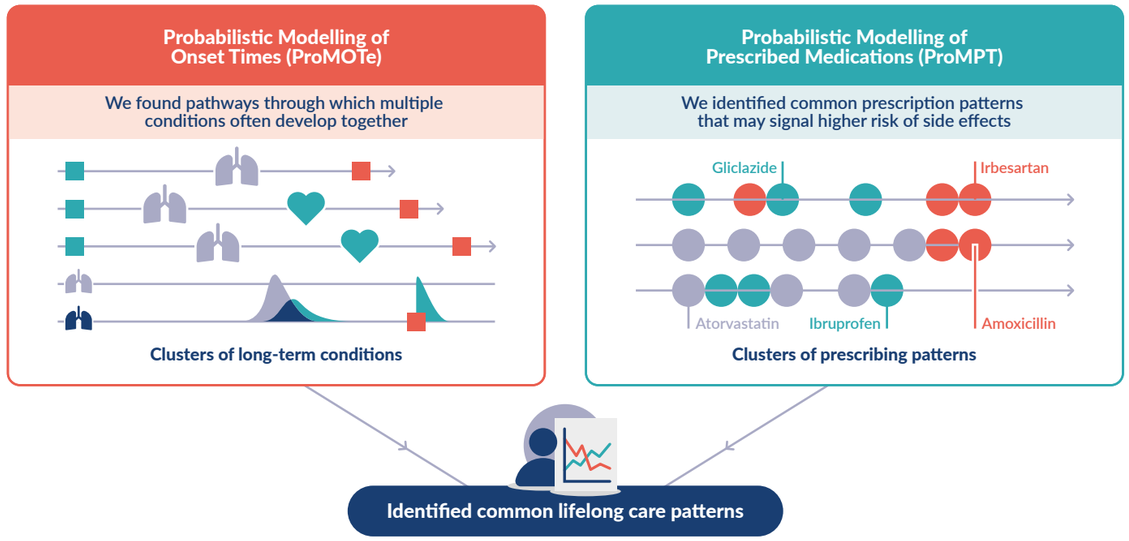
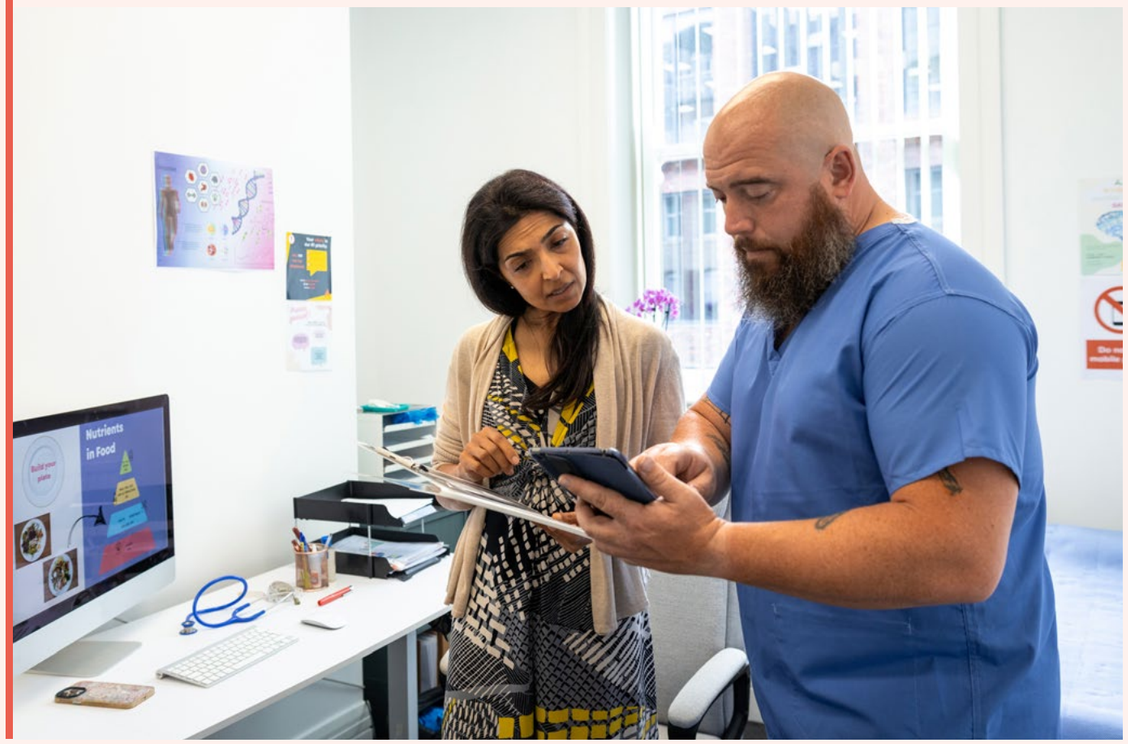


Figure 7: The ProMOTe and ProMPT methods



Social Science Investigation of Interdisciplinary AI-in-Healthcare Work

Duncan Reynolds & Megan Clinch, QMUL

Work Package 4 (WP4) is a social science–led ethnographic study examining how interdisciplinary teams work together to design AI for healthcare. The NIHR programme assumes that combining clinical, data science and social science expertise leads to better understanding of MLTCs and polypharmacy. WP4 explored how this collaboration operates in practice and what supports effective teamwork.

Using observations, interviews with researchers and public contributors, and reflexive workshops, we examined AI development as a socio-technical process shaped by both technical and social factors. Analysis focused on three themes. First, **explainability**: making AI outputs meaningful requires ongoing dialogue, particularly when results challenge established clinical assumptions. Second, **ethics**: decisions about data, model design and acceptable error are value-laden and affect who benefits from AI. Third, **exnovation**: teams adapt and refine practices from within existing academic and organisational constraints.

Our findings show that effective AI in healthcare depends on managing diverse expertise, addressing ethical tensions and embedding reflexivity throughout the research process. By documenting these dynamics, WP4 offers practical guidance for future interdisciplinary AI collaborations, highlighting the importance of social processes alongside technical performance.

Trial Emulation Using Real-World Data to Bridge the Evidence Gap

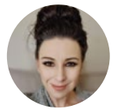
James Wason, Newcastle University

Improving care for people with MLTCs requires evidence to guide treatment decisions, particularly around polypharmacy. While randomised clinical trials (RCTs) provide high-quality evidence, they are often costly, slow and exclude people with complex health needs, limiting their relevance to routine care.

Routinely collected health data, such as CPRD, provide an opportunity to address these gaps. We used **target-trial emulation**, a framework that applies the design principles of an RCT to observational data, allowing clinically relevant questions to be studied where trials are impractical. This approach specifies a hypothetical trial and uses real-world data to estimate treatment effects while accounting for confounding.

Within AI-MULTIPLY, we applied this method to questions such as the safety of stopping statins after long-term use. Patient and public contributors helped prioritise research questions, ensuring patient relevance. Despite methodological challenges, target-trial emulation offers a scalable way to generate timely, inclusive evidence that can complement traditional trials and support better decision-making for people with MLTCs and polypharmacy.

Our Impacts: Developing People and Partnerships in PPIE and Early Career Research



Fiona Cammack, PPIE Contributor

"I began my PPIE journey as a student on the Northumbria University Public Involvement and Co-Production course in 2022. As part of the course, we were encouraged to look for PPIE opportunities. One of the research projects looking for public contributors was AI-MULTIPLY, so I contacted Olivia Grant the PPIE Co-lead and over a coffee, had a lengthy conversation where I was welcomed on to the PPIE Management team.

Over time my confidence grew, working closely with the other members of the PPIE Management team helped me develop new skills and apply my learnings from the University course. I was tasked with organising both in person PPIE meeting held in September 2024 and October 2025. I was responsible for the accessibility needs of all attendee's ensuring inclusion was a priority and worked closely with the project manager to ensure the smooth running of the meetings.

I became interested in using creative methods in research working with the Lawnmowers Theatre Company, who were created by and for people with learning disabilities. We co-created a forum theatre piece about the challenges people with MTLCs face taking part in big data research. As part of my professional development, I was also able to devise and deliver two workshops with our PPIE contributors to create "I poems" as part of the qualitative analysis using the data from patient interviews.

Being part of the AI-MULTIPLY PPIE management team has been exciting, educational and a little bit daunting at times. Through my involvement I have gained a deep understanding of what it means to be involved in research in a meaningful way. My confidence has grown immeasurably, and I have since sought out other opportunities for PPIE, becoming involved in two further research projects."

Liyuan Zhu, PhD student

"As a PhD student and researcher on the related NIHR Newcastle Patient Safety Research Collaboration project, I have cultivated and refined a diverse skill set. Firstly, I have had the invaluable opportunity to engage with a highly talented community of researchers, discussing both technical and academic questions. Together, we explore clinical challenges and develop AI-driven solutions. What I found most inspiring was gaining firsthand clinical insight and learning to think critically about how to apply state-of-the-art technology to create tangible impact.

Secondly, this environment has significantly enhanced my teamwork and communication abilities. Through daily collaboration, regular meetings, and informal exchanges of ideas, I have built meaningful professional connections, which are an essential foundation for any early-career researcher.

Thirdly, AI-MULTIPLY fosters an encouraging culture that allows room for trial, error, and even failure. With considerable freedom to explore new ideas and methods, as well as to collaborate with external organisations, I have been consistently motivated to push the boundaries of my knowledge in a supportive and collaborative setting.

Finally, I am grateful that AI-MULTIPLY enabled me to take my first step in PPIE. This experience brought me directly in contact with real patient perspectives, helping me move beyond preconceived notions and connect more deeply with real-world needs. This will undoubtedly strengthen my future career trajectory, whether in applying for research grants or pursuing a postdoctoral fellowship".

Lisa McFie, PPIE Contributor
"I Never Thought I'd Be Talking About AI"

"I first got involved with Social Action for Health through their gardening for bereavement programme. Sometime later, I was invited to take part in a new research project, and I thought I would give it a go. At the time, I'd never heard of AI. I mean, I'm still not that brushed up on it, but I understand so much more.

I've got a lot wrong with me medically – asthma, diabetes, rheumatoid arthritis, depression – so when this group came along to talk about my conditions and medications, it made sense.

At first, a lot of it went over my head. I attended a training session which did not make a lot of sense. That's when the art workshops came in and they really helped. We didn't just sit there talking – we were cutting things out, sticking things down, relaxing first, shaking it out. I put my cats into my artwork because my life is around my cats. It activated your brain instead of just sitting indoors. I'd never done art before that, never. But after the workshops, I found a low-cost art class and now I go every Tuesday. That came straight from those workshops. I always say, "There's not a lot I look forward to, but I look forward to my Tuesdays."

From the art workshops, I also got involved in making a film (animation) about "Large Language Models". The AI side was scary at first, but also amazing. I didn't know nothing about that. Now I can talk about ChatGPT, voice assistants, all that. I've got the [Chat GPT] app on my phone – you just click it and speak. I think it would've helped me at school. I've learned more since I left school than when I was at school.

I can see how AI could help healthcare too, like summarising records, as long as you don't just believe everything it says. It's guidance – you can't go by it completely. And you've got to watch the bias – like we did a test and it assumed doctors are men and nurses are women.

What I didn't expect was the new confidence I got. I've been to Birmingham, Glasgow, Queen Mary conferences – academic places I never thought I'd be in. I didn't stand up and speak at first because I was shy, but I still went. And later, I put my hand up in a big lecture theatre. I wouldn't have done that before. I'm not educated. I don't have any qualifications at all, but I've learned I can still understand and join in.

Being named on a research paper meant a lot to me. I said my name should be at the back because "she's [the researcher's] done all the hard work," but just being included showed that my experience mattered. Now I share what I've learned with other people – at bingo, with my brother, with friends. They even look forward to seeing my art.

This hasn't just been about research. It's been about community. They're not just people – they're friends now. People from all different backgrounds. I never thought coming along to a gardening session would lead to all this, but it has. And if there's more research, I'll do it. Definitely".

Figure 8: Lisa and some of the SAfH PPIE group prepare for an art workshop

Our Impacts: Dissemination, Stakeholder Engagement and Research Outputs

Conference Abstracts

- Flowers C, Naveed S, Reynolds N, Barnes MR. (2025). Setting up for Success: Insights from a Project Manager in AI-Driven Healthcare Research.
- Mountain S, Thompson A, Reynolds N, Reynolds DJ, Barnes MR. (2025). Democratising research through PPIE and ECR collaboration in an AI-in-Healthcare research project. Participatory AI Research & Practice Symposium in Paris.
- Reynolds N, Bartle V, Barnes MR. (2025). Summary of NIHR AIM funded AI-MULIPLTY consortium.
- Richards K, Henkin R, Barnes MR, Reynolds NJ, Guthrie B, Seth S(2025). Understanding the pattern of prescribed medication.
- Thompson A, Bartle V, Hanratty B, Remfry E, Reynolds N, Barnes MR. (2025). Evaluating public and patient involvement and engagement in AI-driven healthcare research project.
- Swinglehurst, D, Reynolds, DJ, and Clinch, M (2025). Ethnography for exnovation: interdisciplinary practices in the creation of 'AI-in-health' technologies. STS Hub: Diffracting the Critical. Berlin, 2025.
- Remfry E, Morgado De Queiroz S, Mathur R, Barnes MR, Thomson A, Reynolds DJ. (2025). Using arts-based methods to include the perspectives of underrepresented groups in the development of artificial intelligence tools in healthcare research.
- Remfry E, Angdembe A. (2024). Studying the longitudinal dynamics of multimorbidity in electronic healthcare records: a rapid review of machine learning methods.
- Reynolds, D (2024). Negotiating Explainability in the Development of Sociotechnical Intelligence: An ethnographic study of the creation of AI for healthcare. European Association for the Study of Science and Technology.
- Reynolds, D, Clinch, M and Swinglehurst, D (2024). Awaking from the "moral anaesthetic" of quantification: An ethnographic study of the creation of Artificial Intelligence for general practice. Oxford Global Health & Bioethics International Conference, Oxford.

Workshops and Engagement Activities

- Lawnmowers theatre piece.

- Duncan Reynolds and Elizabeth Remfry organised and ran the engagement event "Humanising AI in Healthcare: Incorporating social sciences in algorithms". This was attended by people nationally with around 40 attendees.
- Deborah Swinglehurst spoke at the AIM RSF Open Invitation Seminar – "Translating 'Practice into Evidence'" (January 2024).
- Our recently published critical review on the emergence of multimorbidity as a 'matter of concern' (written with D. Swinglehurst's PhD candidate Esca van Blarikom) was selected for discussion at a Social Theory Group at the University of Oxford in January 2023 where Deborah and Esca were invited as guest authors.

This paper raises some debates which are highly relevant to AI-MULTIPLY.

- Duncan Reynolds spoke at the AIM RSF Seminar "Explaining the unexplainable: The Paradox of Explainability in the Development of Artificial intelligence" (February 2025).
- Duncan Reynolds spoke at the Health Science for Health Equity November 2025 Download on "how an AI-in-healthcare project shifted from reactive to proactive PPI by engaging everyday decision makers in research".
- Duncan Reynolds appeared on the "Thinking in Between" podcast talking about AI and Healthcare. Episode available here:

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3. Reynolds DJ, Mountain S, Bartle V, Remfry E, Barnes MR, Reynolds NJ, Thompson A, AI MULTIPLY. 19th August 2025. Targeting everyday decision makers in research: early career researcher and patient and public involvement and engagement collaboration in an AI-in-healthcare project.
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Under Review

- Hamad RA, Angdembe A, Casement J, Iqbal WA, Atallah C, Canoy D, Henkin R, Taylor D, Mountain S, Barnes MR, Missier P, Reynolds NJ, The AI-MULTIPLY Consortium. Multi-Outcome Prediction for People with Multiple Long-Term Conditions: Unplanned Readmission, Mortality Risk, and Emergency Care Duration (under review).

Our Impacts: Awards and Resources

Awards and Recognition

- Duncan Reynolds, Megan Clinch and Deborah Swinglehurst won two awards for their poster at the William Harvey Research Day. The poster was entitled “Interdisciplinary entanglements: emergence of ideas, consensus and technologies in scientific practice.” The awards won were: Best Poster: Digital Health & Data Science category, and The Worshipful Society of Apothecaries Prize.
- Kieran Richards won Poster with Best Scientific Content at the Multiple Long-Term Conditions: From Research to Reality Conference (Birmingham, May 2025) titled “Understanding the Pattern of Prescribed Medication”.
- Nick Reynolds awarded the Arthur Rook Oration, British Association of Dermatologists and reappointed NIHR Senior Investigator in 2023.

Resources

1. We have developed an open-source software package for the evaluation of bursty dynamics in event data, including EHR data. Scan the QR code to access the package in GitHub.

2. Scan the QR code to read our latest publications and outputs.

Next Steps: Advancing our Research and Collaborations

Links Between AI-MULTIPLY, NIHR Infrastructure and NIHR Initiatives

AI-MULTIPLY is closely integrated with NIHR infrastructure, including the NIHR Newcastle Patient Safety Research Collaboration (PSRC) and the NIHR Newcastle Biomedical Research Centre (BRC), ensuring strong alignment with national research priorities. Within the NIHR Newcastle PSRC, Nick Reynolds and Mike Barnes co-lead the **Artificial Intelligence and Data Science in Multiple Long-Term Conditions** theme, while Adam Todd and Barbara Hanratty co-lead the Safer Management of Polypharmacy in Multiple Long-Term Conditions theme. In parallel, Nick Reynolds also co-leads the **Skin Disease, Oral Disease and Immunogenetics** theme within the NIHR Newcastle BRC.

AI-MULTIPLY has also established strong collaborative links with complementary initiatives, including the UKRI and NIHR-funded **ADMISSION** programme and the NIHR **Artificial Intelligence and Multimorbidity: Clustering in Individuals, Space and Clinical Context (AIM-CISC)** consortium. Collectively, these partnerships have strengthened methodological capability, enhanced cross-infrastructure learning, and built sustainable expertise in the application of artificial intelligence and data science to multiple long-term conditions, positioning the programme to deliver ongoing impact and inform future NIHR research investment. Additionally, connectivity across these programs has helped to create a community of knowledge and practice in the field of AI and MLTCs, in line with the original objectives of the NIHR AIM funding initiative.

What’s Next for AI-MULTIPLY and the Research Consortium?

Our work is paving the way for real-world applications of AI in healthcare. While our models are not yet ready for clinical trials, ongoing development will support future tools such as apps for predicting hospital readmissions and clinical decision support systems for structured medication reviews.

Key Areas of Future Research:

- **Scaling AI Models:** Enhancing algorithms like ProMOTe and ProMPT to handle millions of records, enabling deeper insights into multimorbidity and polypharmacy patterns, making the models more accurate.
- **Innovative Approaches:** Combining probabilistic modelling with bursty dynamics to improve prediction of complex health outcomes, including chronic kidney disease.
- **Decision Support Tools:** Developing AI-powered tools for prescribing pharmacists using advanced language models, with pilot testing planned for 2026.
- **Equity in Healthcare:** Building on our landmark study of early onset MLTCs in diverse ethnic groups to ensure future interventions reduce health inequalities.
- **Collaborative Impact:** Continuing partnerships with NIHR consortia, healthcare providers, and Small/Medium-sized Enterprises to translate research into practical solutions, including deprescribing strategies and structured medication reviews.

“What’s Next” discussions with PPIE members and researchers will shape new priorities, feeding into national initiatives like the Patient Safety Research Collaborative (PSRC) and the MLTC National Centre for Coordination (MLTC CNC). Our goal: turn cutting-edge AI research into tools that improve care for everyone.

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Further Information

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Scan to visit our website
www.ai-multiply.co.uk

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