Improving Medication Adherence through Machine Learning

HealthNet Homecare, in collaboration with reputable Machine Learning experts, are building an AI-driven Predictive Analytics Platform that could transform the way chronic diseases are managed in the community and support a more efficient use of NHS resources.

HealthNet Homecare

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Medication non-adherence: A serious and complex challenge

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Medication non-adherence is a major challenge globally, with up to 50% of patients with chronic conditions reported to be non-adherent, in some form, to their prescribed medication[1]. Such non-adherence can have serious consequences including faster disease progression, reduced functional abilities, a lower quality of life, medication wastage, greater pressure on health resources, and increased hospital admissions[2].

The decision-making process for addressing non-adherence is complex, as there are many contributing factors: patient-related, therapy-related, and system-related. Importantly however, feedback from leading NHS consultants, with expertise across multiple therapy areas, highlight where some of the greatest challenges lie, with respect to tackling non-adherence. We expand on three of these challenges here:

Measuring non-adherence: Whilst adherence questionnaires have been commonly used to monitor non-adherence, in some therapy areas e.g., respiratory and gastroenterology, there remains a feeling that there are challenges in measuring it objectively.

Monitoring non-adherence: In order to be able to manage non-adherence to therapy, a clear and acceptable method of systematically and consistently monitoring such non-adherence is critical. This is a significant challenge for healthcare professionals (HCPs). Routinely asking patients how many times they have missed their medication has its limitations, for example.

- HCPs may struggle to accurately assess whether a patient is indeed adhering to their treatment.
- Patients may be unaware of their own non-adherence.
- Patients may be intentionally misleading the clinician to avoid clinical or social repercussions.

Well-integrated reporting system: Another considerable gap in the efforts to tackle non-adherence, particularly for patients being treated with long-term conditions, is the lack of integrated reporting systems. Data from the integrated reporting systems supports all HCPs involved in the patient's care in accessing and interpreting adherence data in these complex chronic conditions.

> **Whilst prescription pick-up ratios, subjective questionnaires and self-reports have been used to measure adherence, HCPs have highlighted the challenges in monitoring adherence in complex chronic conditions and the need for proactive and individualized approaches to address non-adherence.**

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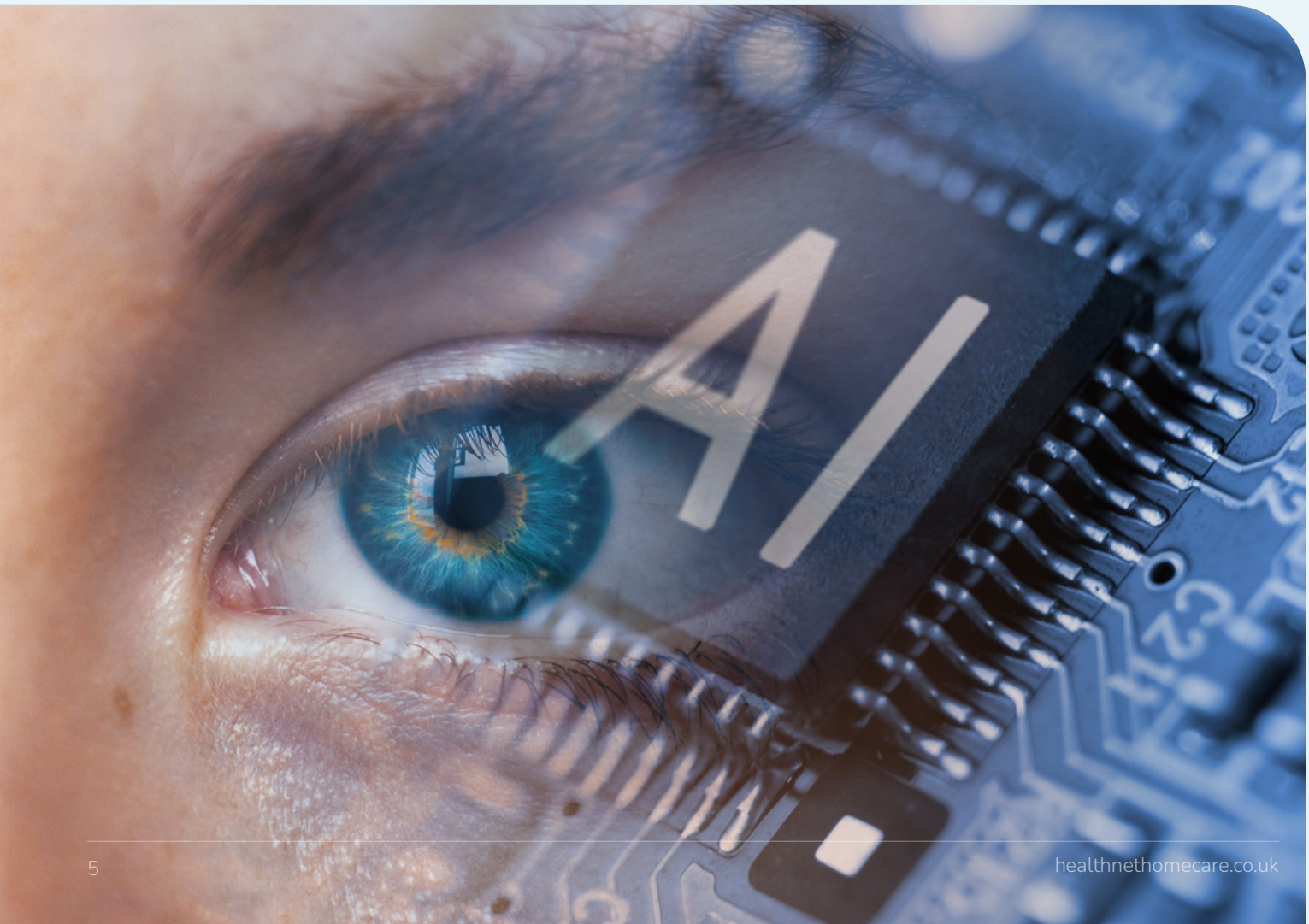
HealthNet Homecare: Tackling Poor Adherence through Machine Learning

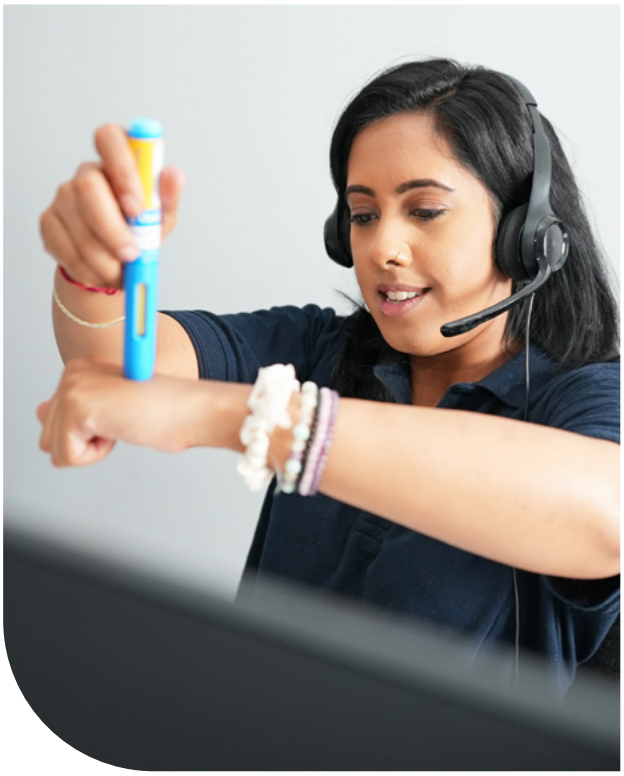


HealthNet Homecare: Tackling Poor Adherence through Machine Learning

Addressing the individual patient's reasons for non-adherence and avoiding a one-size-fits-all approach should be at the core of interventions designed to address non-adherence. This is because the reasons at play may vary from patient to patient and be determined by their individual circumstance. For instance, patients may forget to take their medication or intentionally skip their prescribed doses, for a myriad of reasons including occurrence of side effects, medication/healthcare cost, a lack of perceived benefit, inconvenience of accessing relevant support, a lack of motivation, mental health challenges, socioeconomic factors etc.

HealthNet has had considerable success in improving medication adherence for patients through tailored and enhanced homecare support. For instance, an analysis carried out in 2023 found that, for patients enrolled onto the HealthNet Enhanced Nurse Support Program for four services found the trend for adherence increased with length of service. This same observation was not found with patients not enrolled onto this program.

> **With adherence defined as a patient having access to medication for >80% of the time, a study conducted by HealthNet in 2023 found that patients enrolled into the Enhanced Nurse Support program improve their adherence over time — whilst typically, for people with no access to such enhanced support, adherence deteriorates over time.[3]**



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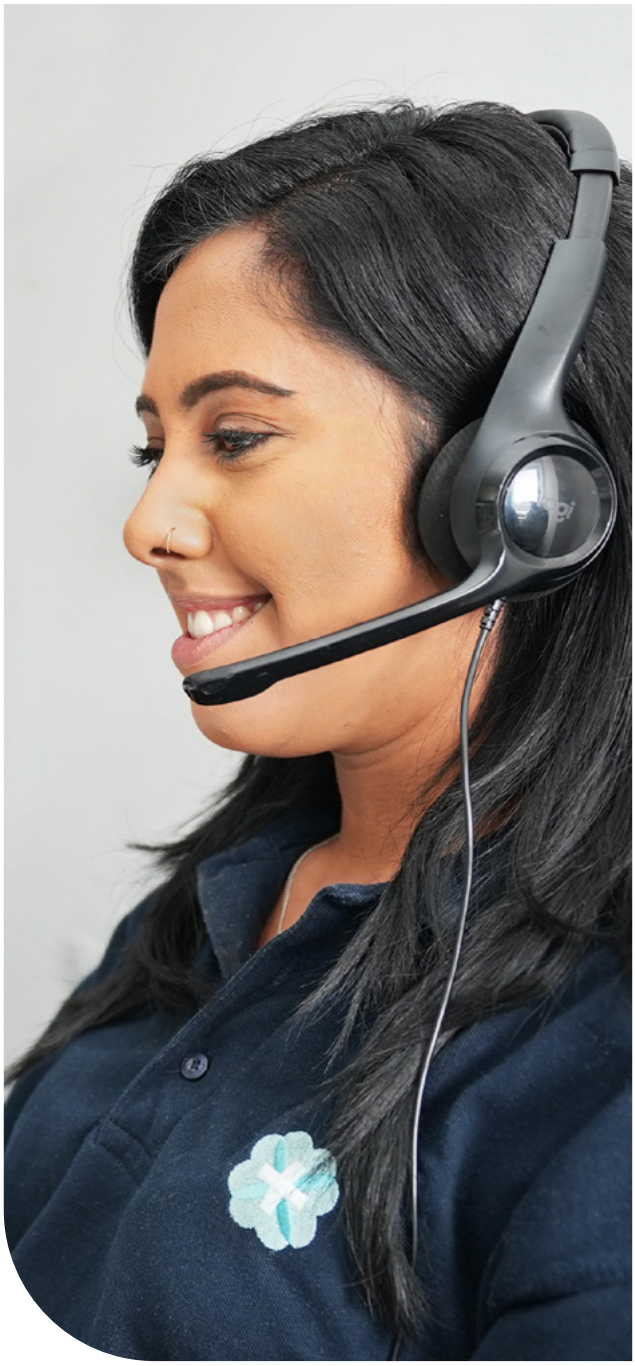
HealthNet Homecare: Tackling Poor Adherence through Machine Learning

Through experience, HealthNet recognises that adherence can be improved by an integrated analysis of relevant clinical and non-clinical factors that influence adherence behaviours. Therefore, designing tailored interventions to support patients accordingly is key.

In view of this, HealthNet commissioned a Machine Learning initiative, whereby the interventions and patient support programs are not only tailored to individual patient persona/ risk but are also based on predictive analytics around learned patient behaviour and deeper population health understanding.

> **The HealthNet Predictive Analytics Platform captures anonymised patient-level data and simulates how patient behaviour and risk of non-adherence changes over time. The value-add of such simulation is unquestionable as the predicted insight informs the tailoring of the support that is offered to the patient, and by doing so, facilitates better engagement and outcome for the patient.**



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The HealthNet Homecare Prediction Model: A Significant Milestone Achieved

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To design patient support programs that can be tailored to individual patient risk and persona, a critical initial step is the development of a robust analytics model that is able to accurately predict the individual patient risk of non-adherence.

To this end therefore, the first phase in the development of the HealthNet Predictive Analytics platform entails:

(a) the identification of the **most relevant data metrics required to predict** risk of non-adherence in chronically ill patients being managed through Homecare

(b) the development of **a predictive model** that will use the identified metrics to **actually predict** non-adherence.

> **The first phase of the HealthNet Predictive Analytics project aimed to predict medication non-adherence for patients that are newly enrolled into a homecare nurse support service — the resulting insight underpins the design of more impactful patient support programs for patients with long term conditions.**

This first phase of this HealthNet Homecare project has concluded with resounding success, and with results that compare favorably with similar models in published scientific literature.

The HealthNet research team utilised what Machine Learning experts refer to as a Convolutional Neural Network (CNN), taking into consideration delivery data, level of nurse support a patient receives, as well as the range of communication received by patients for the entire time they are on service.

To enable comparison to similar models in the field, two important metrics were used in this project:

- Area Under the Curve (AUC): This indicates the ability of a machine learning model to discriminate between two classes – in this case, between adherent and nonadherent patients. It is the most used metric within comparable studies for adherence and non-adherence prediction.[4]

- Proportion of Days Covered (PDC): This estimates medication adherence via the proportion of days in which a person should have access to the medication.[5]

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Fig 1: End-of-Phase 1 Results of the HealthNet Predictive Analysis Project

Author, Year	Adherence Metric	AUC
Lucas et al., 2017[5]	PDC >80%	73.60%-81.00%
Kumamaru et al., 2018[6]	PDC >80%	Up to 69.60%
Galozy et al., 2020[7]	PDC >80%	80.30%-80.70%
Gao et al., 2020[8]	PDC >80%	81.00%
Wu et al., 2020[9]	PDC >80%	57.70%-86.60%
Hsu et al., 2022[10]	PDC >80%	80.50%
HealthNet Predictive Analytics Project, 2023	**PDC >80%**	**97.89%**
HealthNet Predictive Analytics Project, 2023	**PDC = 100%***	**97.40%**

*We also ran the model with an even stricter PDC measure, to accommodate the variation in therapy area and patient diagnosis in our sample. The results we achieved with this stricter measure is equally impressive.

Using the above two metrics, our end-of-Phase 1 results were very impressive when compared to other similar studies (See Fig 1).

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A sneak peek into the HealthNet Homcare Predictive Analytics Platform

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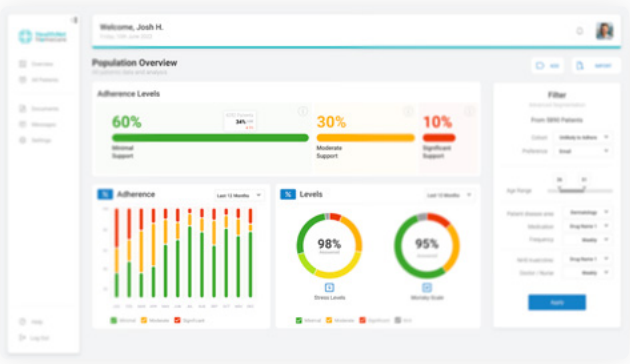
Phase two of the HealthNet Predictive Analytics project entails the UX and GUI design of the front-facing dashboard for the platform. We recognise the importance of such dashboards being visually appealing, with data that is easy to understand and one that encourages engagement by NHS Clinicians.

Fig 2. The HealthNet Predictive Analytics Dashboard



Crucially, the specifications of the dashboard have been influenced by feedback from leading NHS therapy area specialists from across the UK.

Among other things, the platform will provide:

- an alert function that flags, to the HCP, which patients could become/have become non-adherent
- live access to the dashboard provided for the HCP, allowing them to see adherence data relevant for patients that are in front of them in a clinic
- granularity of data that enables the HCP to differentiate between patients who have had breaks from treatment due to external reasons (e.g., hospital admissions) and those who are poorly adherent

HealthNet Homecare's mission is to improve the way healthcare is delivered in communities; by delivering services that empower patients and enable clinicians to take control.

One of the credible channels through which this can be achieved is by facilitating the early understanding, by HCPs, of which patients are more likely to drop off their therapy within a pre-determined period.

With such understanding, HealthNet Homecare would work collaboratively with pharmaceutical companies and the NHS in mitigating pain points through targeted intervention programs.

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