HealthNet Homecare

Medication Adherence Prediction for Homecare Patients, Using Medication Delivery Data

AUTHORS:

Ben Malin, Brunel University London

London, United Kingdom, ben.malin@brunel.ac.uk

Ejike Nwokoro, HealthNet Homecare

London, United Kingdom, ejike.nwokoro@healthnethomecare.co.uk

Tatiana Kalganova, Brunel University London

London, United Kingdom, tatiana.kalganova@brunel.ac.uk

Joshua Hinton, HealthNet Homecare

London, United Kingdom, joshua.hinton@healthnethomecare.co.uk

Declarations

- This research was funded by HealthNet Homecare, one of the UK's largest Patient Support Program (PSP) providers
- The company utilizes market-leading technological solutions to streamline Clinical Homecare & Direct-to-Patient Delivery services
- Patients are referred to the services from NHS Secondary Care Hospitals and generally are diagnosed with long-term conditions

Medication Adherence

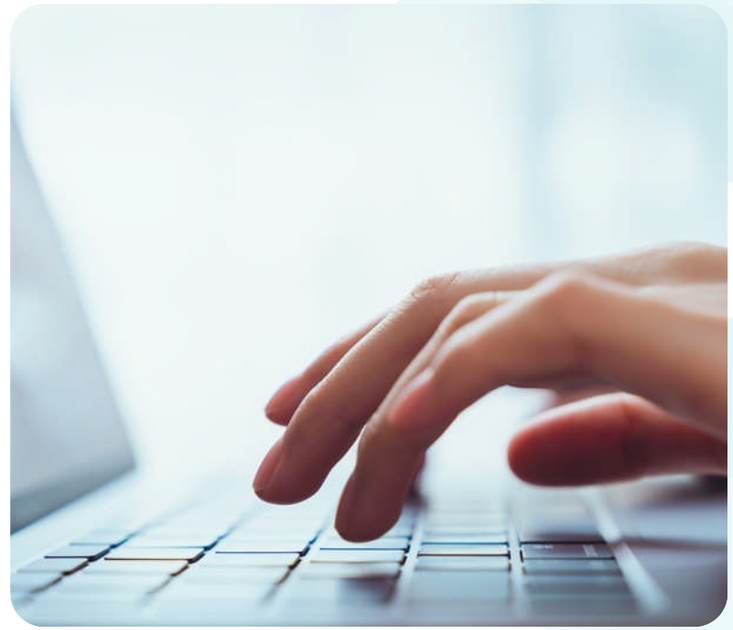
- Adherence is a measure of how reliably a patient takes their medication
- Challenges associated with tackling adherence are both enormous and well-documented
- Common approaches for measuring adherence
  - Proportion of Days Covered by medication (PDC)
    - Medication stock-based measure – how many days does the patient have stock for?
    - 80% of days covered by the stock is typically used
  - Adherence questionnaires
    - Less objective, but still common
    - Patient reported adherence scores

Adherence Prediction

- Using Machine Learning to predict whether a patient will adhere to their medication in the future has been demonstrated successfully in many studies
- Our study objective is to identify the patients who are likely to become nonadherent, so that tailored interventions can be implemented accordingly.
- To accommodate the variation in the therapy areas and in the repercussions for nonadherent patients included in our study, we opted for a stricter PDC (100%) than is used in many studies (80%)
    - A patient is deemed nonadherent if their medication stock is fully depleted at any point(calculated using frequency of the prescription from their physician and their confirmed medication delivery dates)

Dataset

- Our study's dataset contains, but is not limited to:
  - Chronic disease patients across diverse therapy areas
  - Demographic data of the patients, with service-level information
  - Confirmed medication deliveries – with prescription duration
  - Communications to the patient regarding medication deliveries
- These patient data points have been used to generate timelines showing each patient's stock level for each day, across their treatment duration

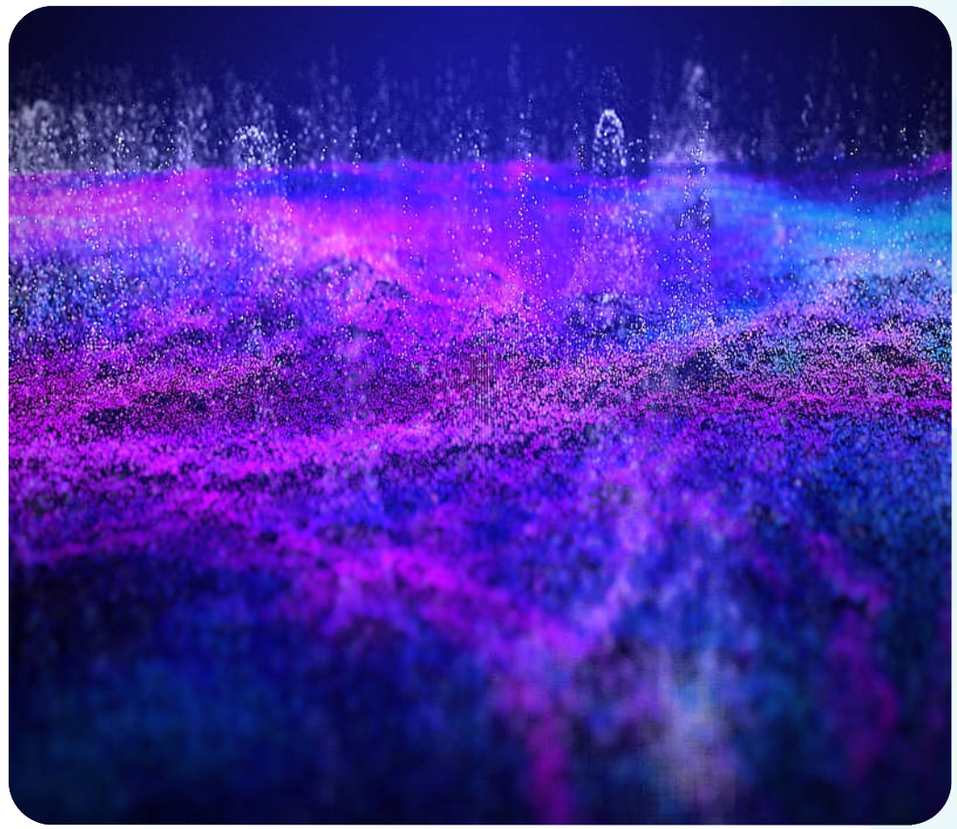


Data Processing

- Many chronic disease patients often request more medication than required. Commonly done to cover for holiday periods, as well as stress alleviation. This is referred to as stockpiling
- We made the design decision to allow for patients to stockpile medication due to this ubiquity
- Confirmed delivery dates are used in conjunction with prescription frequency information to calculate medication stock for every date a patient is on the service

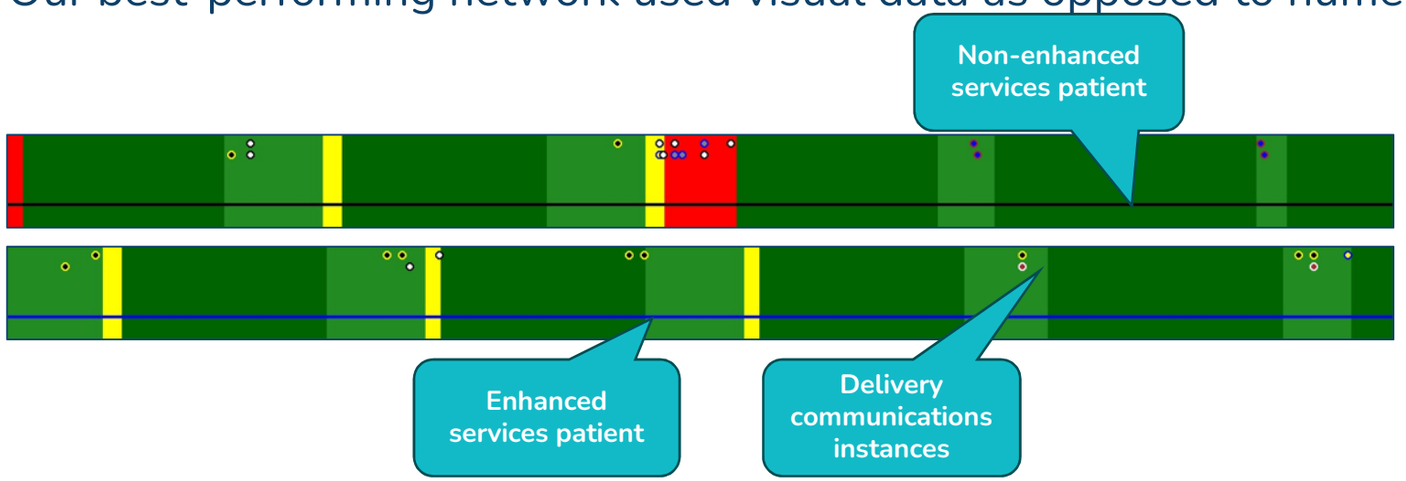
Networks

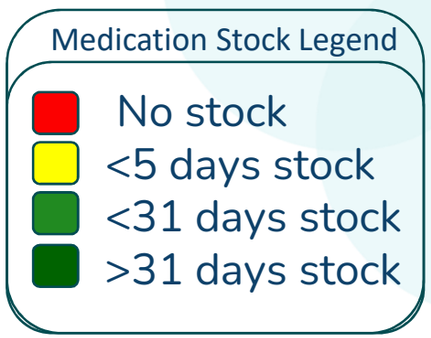
- Two types of network were trialled for adherence prediction of our dataset
  - Random Forest (RF) as it is the most common network in reviewed studies for adherence prediction
  - Convolutional Neural Network (CNN) was also tested due to its capability in time-series forecasting and predictions



Data Visualisation

- Inspired from signal processing where one-dimension time-series inputs are frequently converted into the visual domain and processed by a CNN
- The use of data visualisation and processing via CNN has been shown to improve performance in other studies for similar objectives
- Every patient has their tabular medication stock data converted into visual data. The image represents each patient's medication stock at each day for the past year
- These images are generated deterministically using the available patient data
- Our best-performing network used visual data as opposed to numerical data





Results

- Area Under the Receiver Operating Characteristic Curve (AUC) is the primary metric used to assess performance
- Both RF and CNN were tested using different available inputted data
- CNN with medication stock data, service level information and delivery communication data was our best-performing model for both AUC and nonadherence prediction precision

Medication Stock Data	Enhanced Services	Delivery Communications	Mean AUC		Mean Nonadherent Precision	
			RF	CNN	RF	CNN
✓			95.36%	95.70%	88.64%	80.02%
✓	✓		95.40%	95.14%	88.49%	81.31%
✓		✓	94.90%	96.26%	88.13%	87.69%
✓	✓	✓	94.92%	97.40%	88.53%	90.10%

Results

- New patients are our focus because identifying nonadherence before it occurs allows for targeted interventions to be put in place. Additionally, it is desirable for us to make accurate predictions without the need for the patient to be on the service for a long duration

Medication Supply	Enhanced Services	Delivery Communications	Mean AUC		Mean Nonadherent Precision	
			RF	CNN	RF	CNN
✓			55.44%	82.12%	38.74%	19.13%
✓	✓		53.64%	68.49%	37.81%	80.33%
✓		✓	54.47%	80.05%	37.01%	40.07%
✓	✓	✓	54.81%	82.84%	37.99%	38.54%

Conclusion

- CNN is more suitable for our patient dataset than the RF
  - This is likely due to RF networks utilising independent feature inputs, unlike CNNs which are more appropriate for time-series data
- Adherence can be accurately predicted for patients on a medication delivery service
- Our best-performing network utilised time-series delivery communications, that the RF network was unable to attain benefit from
- Our research adds to the body of knowledge pertaining to the accurate prediction on poor medication adherence
- Healthcare stakeholders can utilise such predicted insight to tailor the support that is offered to the patient, and by doing so, facilitate better engagement and outcome for the patient

HealthNet Homecare

Any questions?

Thank you