Using a term to model the impact of COVID-19 between January 2020 - December 2021 plus a 6-month tune period produced more accurate predictions when forecasting the use of antibiotics with ARIMA models

Forecasting the prescription rates of antibiotics in the UK between 2013 to 2023 incorporating the impact of COVID-19

Methods

- Study design: Retrospective analysis including all individuals in

  CPRD GOLD (UK) mapped to OMOP-CDM

- Exposure: monthly use of 6 antibiotics

- Outcome: incidence rates of antibiotic use

- Study period: Jul 2013 to May 2023

- Statistical methods: ARIMA and ARIMA with Exogenous Variable (ARIMAX) models. (**Figure 1**)

This study was run under the scenario that the available data ended in Nov 2022, and we forecasted the usage of antibiotics for the next 6-months. We have used the remaining data up to May 2023 to test the accuracy of the models pretending we received these subsequent data later.
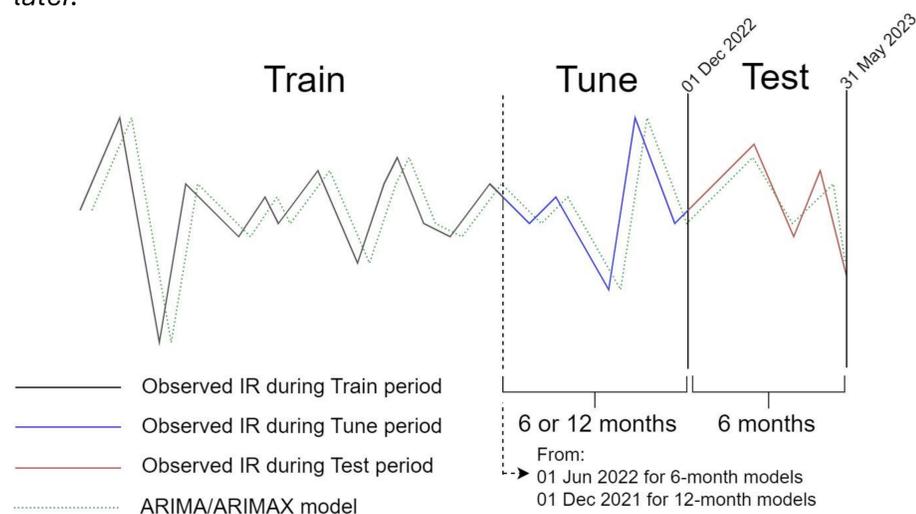

Figure 1. Graphical representation of the time periods where the ARIMA/ARIMAX models were trained, tuned and tested. ARIMAX includes a model term from Jan 2020 to Dec 2021 to account for the effect of the COVID-19 pandemic. Tune period: used to evaluate the model's predictive performance with accuracy metrics MAE (mean absolute error) and MAPE (mean absolute percentage error). Test period: used to evaluate the 6-month forecasted through the train and tune periods

After fitting the ARIMA models, the average ratio between the 6- and 12-month showed that using a tune period of 6-month were more accurate than using 12-month (average ratio was 0.66 for MAE and, 0.64 for MAPE). The test period metrics also favoured the 6-month models (average ratio was 0.96 for MAE and, 0.95 for MAPE).
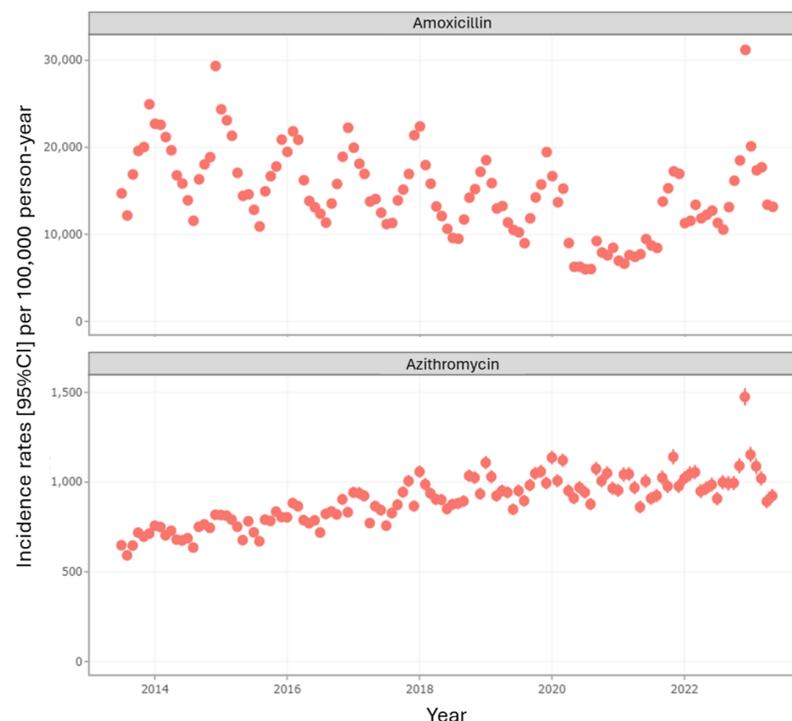

Figure 2. Incident use of amoxicillin and azithromycin in CPRD Gold between 2013 and 2023. We observed a seasonality pattern with peaks around Nov-March months in antibiotics with an indication for bacterial infections frequent in winter, such as the two presented in this figure.
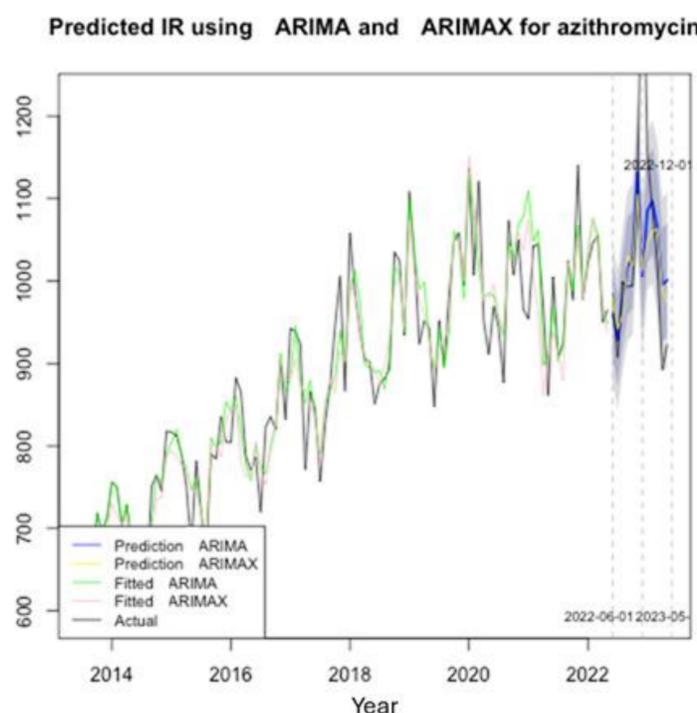

Figure 3. ARIMA and ARIMAX models for the use of azithromycin. When comparing ARIMA vs ARIMAX models, the tune period indicates that ARIMA may be more reliable (average ratio was 0.96 for MAE and, 0.95 for MAPE). However, when the test period was evaluated, the ratios favoured the ARIMAX (average of 1.08 for both, MAE and MAPE).

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