**Title**: Predicting outcomes for individual patients receiving antibiotics using a recurrent neural network

**Background**: As electronic health record (EHR) data becomes more prevalent numerous clinical decision support systems (CDSS) utilising machine learning have been developed to assist with infection management. CDSS uptake has been limited in part due to acceptance and behavioral issues. By predicting ‘hard’ outcome measures such as mortality and length of Intensive Care Unit (ICU) stay, we hope to provide information to healthcare professionals that they are familiar with and can understand to positively influence clinical decision making.

**Methods**: Patient data were extracted from MIMIC-IV and filtered to those who received antibiotics in the ICU for between 1 and 21 days. Input features including lab test results and clinical parameters were selected based on prevalence and critical care consultant advice. Features were normalised, aggregated by day and missing values highlighted or forward filled. Data was split into training, validation and testing sets for model development and evaluation. PyTorch was used to develop a many-to-many long short-term memory (LSTM) recurrent neural network (RNN) with a custom dataset class to address class imbalance and extract labels and features as appropriate. The Adam optimiser was used with binary cross entropy loss for the classification task and mean squared error loss for regression. Ray Tune was used for hyperparameter optimization.

**Results**: In total 18,988 patients, associated with 22,845 unique ICU stays, were included within the final dataset. A RNN architecture was chosen as it considers the temporal nature of EHR data. The model achieved an area under the receiver operating characteristic of 0.78 for the mortality classification task (accuracy of 0.75, precision of 0.47, recall of 0.57 and F1 score of 0.51), and a root mean square error of 3.67 for length of stay regression prediction on the unseen test set.

**Conclusions**: Results present a promising step towards predicting the ‘hard’ outcome measures mortality and length of ICU stay for patients receiving antibiotics through routinely collected EHR data. However, they also highlight difficulties associated with mortality class imbalance and the inherent regression challenge of estimating patient length of stay. Future research will discern the ability of such a tool to influence decision making and optimise antimicrobial management.

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