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A machine learning approach to dengue diagnosis and the impact of seasonality in patients presenting with an acute febrile illness in Ho Chi Minh city, Vietnam

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On behalf of the Vietnam ICU Translational Applications Laboratory (VITAL) investigators

Background

Dengue commonly presents as an acute febrile illness (AFI) and infection can result in a life-threatening shock syndrome. Current diagnostics which detect non-structural protein 1 and IgM are widely used, but performance can be limited. We evaluated the ability of a supervised machine learning model to predict whether patients with AFI had a final diagnosis of dengue or another illness. The impact of seasonality on the model was examined.

Methods

We analysed data from a prospective observational clinical study consisting of paediatric patients (<16 years old) attending healthcare facilities in Ho Chi Minh City, Vietnam. Enrolled patients presented with an acute febrile illness with a duration less than 72 hours. A gradient boosting model was used to predict final diagnosis using age, sex and full blood count results collected on enrolment only. We split the data into a training and hold out set for model evaluation. A rolling window approach over the whole study period was used to examine the temporal and seasonal nature of the data.

Results

We included 8,100 patients recruited between 16th October 2010 and 10th December 2014, and 2,240 (27.7%) patients were diagnosed with dengue. Optimised models using training data had a median area under the receiver operator curve (AUROC) of 0.86 (interquartile

range 0.84-0.86), specificity of 0.92, sensitivity of 0.56, positive predictive value of 0.73, negative predictive value of 0.84 and a Brier score of 0.12 in predicting the final diagnosis. Similar performances were achieved in hold-out set testing (AUROC of 0.86). Model performance varied significantly over time as a function of seasonality and other factors. Incorporation of an adaptive dynamic threshold tuned according to recent cases resulted in a more consistent performance throughout the year.

Conclusions

Supervised machine learning models perform well for dengue diagnosis for patients with AFI. This could be of clinical utility to support healthcare decision-making and passive surveillance across dengue endemic regions. However, effects of seasonality and changing disease prevalence must be taken into account. This is particularly crucial given the growing effects of human-induced climate change with its diverse impact on disease incidence and health outcomes.

Conflicts of interest