MACHINE LEARNING ALGORITHMS TO PREDICT IN-HOSPITAL MORTALITY IN PATIENTS WITH DIABETIC FOOT ULCERATION

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e-DIABETES2021
XXIII CONGRESSO DA SOCIEDADE BRASILEIRA DE DIABETES

Introduction

Up to 34% of people with diabetes will develop foot ulceration in their lifetime. A non-healing ulcer can lead to lower limb amputation with permanent disabilities and is frequently associated with mortality in hospitalized patients. By applying artificial intelligence, more precisely Machine Learning (ML) models, it would be possible to identify the risk of mortality in patients with diabetic foot ulceration (DFU). In this way, a continuously trained intelligent model with patient data would work as a triage tool and as an adjunct to a clinical decision for healthcare professionals.

Objective

We investigated the accuracy of 5 ML models for a fully automated prediction of in-hospital mortality of DFU patients and the feature importance of variables as predictors.

Method

Retrospective electronic medical data of adults with DFU admitted to the Hospital Risoleta Tolentino Neves at Minas Gerais/Brazil, from 2015 to 2017, were used and analyzed. Our data set contains 20 variables of 326 patients such as demographic data, Wound, Ischemia and Foot Infection (WIfI) scores, clinical and physical examination findings and laboratory data, overtime of the hospital admission. The target "mortality" is a binary feature (0 – survived and 1 – died). The ML models compared were: Logistic Regression (LR), Support Vector Machine (SVM), Light Gradient Boosting Machine (LGBM) and two deep learning models, namely, Convolutional Neural Network (CNN) and Attentive Interpretable Tabular Learning (TabNet). Models were trained using a 5-fold cross-validation methodology, an oversampling technique to tackle the imbalance class problem named "Adaptive synthetic sampling approach for imbalanced learning" on each training set, and Bayesian Optimization for hyperparameters' tuning.

Keywords: diabetic foot, machine learning, mortality

Results

Table 1 shows the results of the 5 techniques tested, where SVM presented the best predictive ability by reaching a true positive rate (sensitivity) of 94.44% and an area under the receiver-operating-characteristic curve (AUC) of 83.17%, including the WIfI classification scores as predictors. In addition, we identified 5 variables with the most impact: bed-bound condition, age, hemoglobin, creatinine and WIfI amputation risk.

Table 1: Binary classification results of the best models by technique for predicting mortality of DFU patients with/without WiFI scores as predictors

WIfI	Metric (%)	LR	SVM	LGBM	TabNet	CNN
Yes	AUC	79.13	83.17	77.76	70.85	74.4
	Sensitivity	77.78	94.44	77.78	66.67	83.33
	Specificity	75.32	72.08	74.68	74.03	71.1
No	AUC	78.88	83.77	75.83	75.65	76.02
	Sensitivity	77.78	88.89	75.22	66.67	77.78
	Specificity	68.18	72.08	74.68	75.65	71.43

Conclusion

Results demonstrated that predicting the mortality of DFU patients with good accuracy is possible and feasible for practical purposes

References

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