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The Prediction of Fall Circumstances Among Patients in Clinical Care – A Retrospective Observational Study

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Abstract. Standardized fall risk scores have not proven to reliably predict falls in clinical settings. Machine Learning offers the potential to increase the accuracy of such predictions, possibly vastly improving care for patients at high fall risks. We developed a boosting algorithm to predict both recurrent falls and the severity of fall injuries. The model was trained on a dataset including extensive information on fall events of patients who had been admitted to Charité – Universitätsmedizin Berlin between August 2016 and July 2020. The data were recorded according to the German expert standard for fall documentation. Predictive power scores were calculated to define optimal feature sets. With an accuracy of 74% for recurrent falls and 86% for injury severity, boosting demonstrated the best overall predictive performance of all models assessed. Given that our data contain initially rated risk scores, our results demonstrate that well trained ML algorithms possibly provide tools to substantially reduce fall risks in clinical care settings.

Keywords. fall prediction, machine learning, clinical care, retrospective study

1. Introduction

Falls and their physical and psychological consequences represent an omnipresent danger for elderly people. Fall risk assessment tools, such as the highly used 'Morse Falls Scale' assessment tool have limited predictive power for fall risk [1]. Consequently, numerous approaches to deploy data-driven methods have been deployed within the last years. Yet, most papers focus exclusively on fall risk prediction, considering categories, such as demographic data [2,3], medication [2,4], pre-existing conditions [2,5], mobility [6] and leave fall circumstances unaddressed. Fall circumstances refer to context information available in relation to a fall, such as the location, cause, or injury.

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2. Methods

We deployed and evaluated a boosting algorithm to predict the probability of repeated falls and the severity of fall injuries. The present dataset from the university hospital Charité Berlin comprises a total of 8,874 reported fall accidents, each with 121 different reporting features, covering a total of 6,424 patients. We accounted for unequal distribution of the dependent variable use Synthetic Minority Oversampling Technique (SMOTE) for synthetic data generation. A range of features for fall events and medication were constructed using natural language processing. Two different prediction models for different fall circumstances are developed throughout this paper: prediction of multiple falls and the severity of fall injuries. By specifying a logistic regression, a random forest, a neural network and a support vector machine as alternate classifiers, we evaluated the predictive performance of the boosting model.

3. Results, Discussion and Conclusion

The results of our study show that the severity of injuries and multiple falls can be predicted with an accuracy of up to 86% and 74%, respectively, using a XGBoost classifier. Furthermore, we are able to show the most common fall circumstances for multiple falls, which include gait disorders or gait aids. Furthermore, the number of inpatient days and whether the patient was visiting the toilet have a significant influence. For the second model, it was shown that the severity of falls is significantly associated to hospital days, gender, but also to time of day and season. In addition, neurosurgical patients in particular appear to be at risk of more severe fall injuries. We extracted 104 features from the ambulant care dataset but only a small fraction of features have proven to usefully predict fall severity, while most features only contribute little or nothing. Relevant factors include demographic (Lee et al., 2020), inpatient (Hsu et al., 2020), or medication data (Beauchet et al., 2020) as well as assessment tools such as the GCS score or the NANDA classification for patient mobility [7]. We conclude that the objective of this work was to develop different models for predicting fall circumstances. The findings of this work can serve as a basis for further research in the area of fall circumstance prediction, offering improvements in preventive care interventions.

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