TOWARDS THE PERSONALIZATION OF THE DIALYTIC THERAPY: AN EXPLAINABLE APPROACH TO PREVENT INTRADIALYTIC HYPOTENSION

Giustina Casagrande (1) Cristiana Larizza (2), Antonino Nocera (2), Silvana Quaglini (2), Riccardo Bellazzi (2), Andrea Ambrosini (3), Pietro Cippà (4), Carla Colturi (5), Gianvincenzo Melfa (6), Reto Venzin (7), Maria Laura Costantino (1)

1. Dpt. of Chemistry, Materials and Chemical Engineering, Politecnico di Milano, Milano, Italy; 2. Dpt.of Electrical, Computer, and Biomedical Engineering, University of Pavia, Italy; 3. Renal Transplant Unit, Azienda Ospedaliera Ospedale di Circolo e Fondazione Macchi, ASST Sette Laghi, Varese, Italy; 4. Unit of Nephrology, Ente Ospedaliero Cantonale, Lugano, Switzerland; 5. Division of Nephrology, ASST Valtellina e Alto Lario, Sondrio, Italy; 6. Division of Nephrology, Ospedale Sant'Anna, ASST Lariana, Como, Italy; 7. Division of Nephrology, Dpt.of Internal Medicine, Cantonal Hospital Graubünden, Chur, Switzerland.

Introduction

Intradialytic hypotension (IDH) is one of the most common complications occurring in haemodialysis (HD) patients. Several works have analysed its epidemiological impact, trying to identify predictors of IDH onset with risk calculators. Deriving suitable risk models is a complex task, further emphasized by the absence of a consensus definition of IDH as mentioned by several authors [1], [2], [3].

A pre-dialysis robust evaluation of the risk of IDH onset may suggest proper session settings, avoiding later emergency interventions. This work aims to analyse the IDH definitions associated with increased mortality in the medium-long-term horizon and assess their predictability with data already available at the start of the haemodialysis treatment.

Methods

A multi-centric database, made available by Interreg DialysIS and InterACTIVE-HD 2.0 projects was used.

Among the definitions of IDH in the most recent literature, we have considered the ones associated with an increase in mortality in the medium to long term: ΔSBP40 by Shoji et al. [4]; Nadir90 and Nadir100-90 by Flythe et al. [5], ΔSBP30-Nadir90 by Sands et al. [6]. The overlap between them was initially investigated. We first developed linear, explainable, machine learning models by using the entire dataset. Further, we move to a neural network, applied to subsets of data, gradually including groups of features, to maintain explanability. Subsets were characterized by semantically related sets of predictors. SHapley Additive exPlanation (SHAP) analysis was used to evaluate the significance of the variables and their influence on IDH.

Results

Nadir90 and Nadir100-90 IDH definitions have the highest incidence (27.78% and 28.81% respectively). ΔSBP40 has an incidence of 22.55%, while ΔSBP30-Nadir 90 of 12.49%.

The results of the preliminary analyses with linear models did not bring statistically significant results (Accuracy, Precision, Recall, and F1<0.8), justifying the choice of non-linear, more complex models. The most informative features by SHAP differ for each definition, with some commonality. Among the patient-related variables, the presence of cardiopathy, together with low pre-dialytic pressure and advanced age are all risk factors for IDH, as well as a low Sodium plasmatic concentration at the dialysis start.

Looking at the dialysate composition, low Chloride concentration is related to hypotension all over the definitions. A low calcium concentration seems associated with Nadir 100-90 episodes; in contrast, a high Calcium concentration correlates with ΔSBP40 and ΔSBP30-Nadir90 definitions.

Discussion

The results confirm the importance of some predictors already reported in the literature but also highlight the importance of the treatment settings (electrolyte concentrations and other dialyzer parameters), thus demonstrating that the in-depth analysis of pre-dialysis data is promising for the prediction of intradialytic hypotension. The limitations that have emerged from the use of linear machine-learning models suggest the need for more complex machine-learning models, which, unfortunately, are black boxes. The proposed approach, of gradual inclusion of features, could be used in order not to lose explainability while using complex models.

Creating the conditions to be able to move from a predictive to a preventive approach is a great challenge.

References

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