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Computational Modeling Towards Characterization of Pulse Wave Velocity in an Argentine Dialysis Cohort — Foundations for Potential Clinical Decision Support System

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INTRODUCTION

Arterial stiffness serves as a marker of arterial damage in various diseases, including chronic kidney disease (CKD) and renal replacement therapies such as Hemodialysis (HD) and Peritoneal Dialysis (PD). This study measures pulse wave velocity (PWV) in a dialysis population. Recent years have witnessed a paradigm shift in medicine, transitioning from evidence-based medicine to data science-oriented medicine. The main goal of this study is to delineate the features linked to PWV within an Argentine dialysis cohort, followed by elucidating the PWV distinction between PD and HD patients, leveraging machine learning techniques to forecast PWV. Incorporation of machine learning techniques in standard clinical procedures, especially in risk prediction, lay the foundations of an intelligent Clinical Decision Support System, which acts as an assistive tool for the medical professionals in harnessing machine learning for efficient risk predictions.

METHODS

A descriptive, cross-sectional study was conducted in two dialysis centers. Primarily, the relationship between PWV and each of the features was analyzed in the global cohort. Subsequently, patients from two subgroups (PD and HD) were studied, to analyze their distinguishing characteristics, followed by the development of computational models to assess the impact of the clinical features on PWV in the PD and HD cohorts.

Table 1 - Difference in variables associated with PVW between HD and PD subgroups

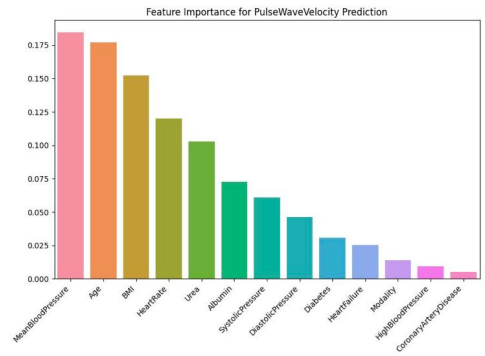
	HD (78)	PD (21)	p
PWV (m/s)	13.63 (10.41-16.63)	12.25 (10.38–13.66)	0.032
Age	55 (13)	57 (17)	0.53
DM2	13 (19%)	3 (11%)	0.54
HTA	66 (92%)	16 (57%)	<0.01
CAD	9 (13%)	4 (14%)	0.74
HF	29 (41%)	9 (23%)	0.64
RAASi	20 (28%)	19 (68%)	<0.01
BMI (kg/m2)	23.8 (21.7-26.3)	26.8 (23.4-32.4)	<0.01
SAP (mmHg)	120 (110-140)	125 (112-139)	0.87
DAP (mmHg)	73 (68-84)	70 (60-80)	0.18
MAP (mmHg)	74 (14)	88 (16)	<0.01
HR (bpm)	85.6 (14)	73 (14)	0.13
Urea (mg/dl)	137 (116-160)	158 (120-172)	0.15
Albumin (g/dl)	3.9 (0.4)	3.6 (0.5)	<0.01

DM2: Diabetes Mellitus type II HTA: Hypertension CAD: Coronary artery disease HF: Heart failure RAASi: Renin-Angiotensin-Aldosterone system blockade BMI: Body mass index SAP: Systolic arterial pressure DAP: Diastolic Arterial pressure MAP: Mean arterial pressure HR: Heart rate

RESULTS

PWV measurements were obtained from 99 patients. The median carotid-femoral PWV was 13.22m/s (IQR 10.50-16.20). Age, systolic and diastolic blood pressure, mean baseline blood pressure, and heart rate showed a moderate positive linear relationship with PWV. A history of diabetes, coronary artery disease (CAD), and heart failure was associated with higher PWV.

Figure 1 - Random Forest Model prediction of PWV in overall population



BMI, urea, and albumin exhibited a moderate negative linear relationship. Patients on PD had a lower median PWV than those on HD (Table 1). Multiple regression models using machine learning were developed. In the HD and PD cohorts, Random Forest models identified mean blood pressure and age respectively as the most important features in predicting PWV (Figure 1). A multiple linear regression model was selected as the best predictive model for PWV among PD and HD patients. However, after multivariate adjustment, modality lost statistical significance, and due to the limited number of patients, the model exhibited high collinearity.

DISCUSSIONS

This study is a first of its kind in Argentina describing variables associated with PWV as a surrogate for arterial stiffness in a dialysis population, differentiating characteristics between PD and HD. While acknowledging potential statistical limitations in developing predictive models for a small population, this endeavor presents the base for the potential development of a Clinical Decision Support System, incorporating dynamic datasets and prediction models tailored to local populations, aimed at impacting clinical decisions and improving the healthcare approaches in developing countries.