IN SEARCH OF CARDIOVASCULAR BIOMARKERS FOR PRE-ECLAMPSIA

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Introduction

In pregnancy, modifications of the utero-ovarian arterial network cause a significant increase in blood volume distributed to the placenta and foetus. In pre-eclampsia, these modifications of the utero-ovarian arterial network is compromised, which results in a reduced perfusion of the placenta with corresponding negative implications for the foetus. An improved mechanistic understanding and the identification of new cardiovascular-based biomarkers would help stratify treatment of these patients.

Methods

The framework proposed here combines a range of maternal non-invasive measurements with cardiovascular pregnancy models [1]. The main measurements are displayed in Figure 1. Template models of pregnancy are personalised in a 2-step parameter optimisation approach, which tunes scaling parameters for the vascular compliance, blood volume, vascular resistance and vessel areas such that measurement outputs are mimicked [2].

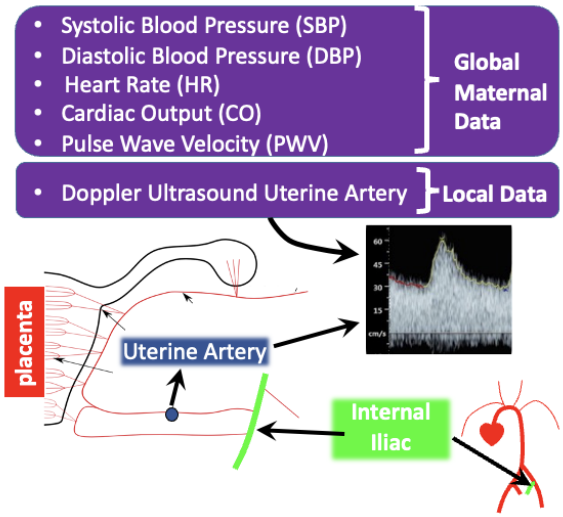

Figure 1: Overview of input parameters for the personalisation of the pregnant cardiovascular models.

This personalisation is performed on retrospective data from a group of 21 patients (9 pre-eclamptic, 12 normotensive) collected at the Maternal and Fetal Health Research Centre in Manchester.

Results

A range of dimensionless groups based on measured and model-predicted parameters was constructed in search of powerful new biomarkers for pre-eclampsia. These were compared with other proposed metrics such as pulsatility index and resistivity index. Results based on this patient dataset indicate that new biomarkers PPI and VI, based on blood pressure and velocity in the radial/arcuate arteries, respectively, outperform existing measures (Fig2).

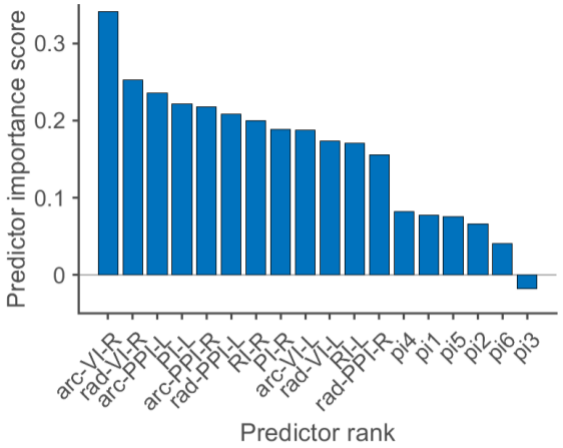

Figure 2: Ranking of a range of cardiovascular based classifiers for pre-eclampsia using the RELIEFF algorithm

Discussion

Promising novel classifiers have been identified based on the predicted velocities and pressures in the placental vascular beds using our personalised cardiovascular models. These metrics seem to perform better then maternal brachial pressure as a biomarker for pre-eclampsia and should be explored further. Future work will therefore focus on larger datasets captured longitudinally throughout pregnancy to see their ability to classify earlier on in pregnancy.

References

1. Carson et al., *Biomech Model Mechanobiol* 2019; 18: 1155–1176.
2. Carson et al., *Int J Numer Methods Biomed Eng*. 2020, doi: 10.1002/cnm.3267

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