

Characterisation of haemodynamic responses to haemodialysis using frequency analysis of continuous blood pressure measurements

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INTRODUCTION

Intradialytic haemodynamic instability remains a significant problem, leading to ischaemic end-organ damage. Extrema points (EP) frequency analysis of blood pressure (BP) is a method of assessing beat to beat variation in BP, which may have relevance to end-organ perfusion. Our aim was to utilise this method to describe the patterns of individual cardiovascular response to haemodialysis (HD), study its variability and identify factors associated with higher BP frequencies.

METHODS

50 participants aged >18 years receiving in-centre HD were recruited. Participants had continuous non-invasive monitoring of BP and haemodynamics using pulse wave analysis (Finapres NOVA). Data were analysed by identifying the frequency and amplitude of local EPs (maxima and minima) for mean arterial pressure (MAP) as previously described. As higher EP frequencies have been shown previously to associate with ischaemic injury in the brain, we hypothesised that a ratio of high (HFC) to low (LFC) EP frequency values would characterise patients' risk of end-organ hypoperfusion during HD. We defined HFC as EP frequencies that were occurring within the same frequency range as heart rate and LFC as those occurring in frequency range of ≥ 3 cardiac cycles. Participants were then divided into 2 groups: Group 1 had a higher proportion of low EP frequencies (HFC/LFC ratio ≤ 0.5 , n=21) and Group 2 a higher proportion of high EP frequencies (HFC/LFC ratio >0.5 , n=22).

RESULTS

In total, 43 participants completed all three dialysis sessions with continuous haemodynamic monitoring. 61% were males, mean age was 62.3 ± 16 yrs, 43% had diabetes and 26 (59.1%) were on at least one antihypertensive medication. Median Charlson comorbidity score was 6 (IQR 4).

Median EP MAP frequencies of mid-week HD session was 0.54 Hz (IQR: 0.18) and correlated with dialysis vintage ($r=0.315$, $p=0.039$), NT pro-BNP levels ($r=0.318$, $p=0.038$), baseline baroreflex sensitivity ($r=0.316$, $p=0.039$) and average real variability (ARV, the average of the absolute change in the BP between consecutive measurements during the entire monitored duration) of SBP ($r=0.334$, $P=0.029$), ARV MAP ($r=0.571$, $P<0.0001$) and ARV DBP ($r=0.464$, $p=0.002$).

Median HFC/LFC ratio was 0.517 (IQR: 0.42). In Group 1, there was trend towards gradual decline in HFC/LFC ratios during HD, whereas in Group 2 there was gradual rise (Figure 1). MAP was positively correlated with Cardiac Power Index (CPI) in each hour of dialysis, but not with total peripheral resistance index (TPRI) in group 1 (Table 1, Figure 2a and 2b). In contrast, in Group 2, MAP correlated with CPI in first

hour of dialysis only, however MAP did correlate with TPRI in each hour of dialysis (Table 1, Figure 2c and 2d).

CONCLUSIONS

We have utilised the previously described EP frequency analysis and developed the method further. HFC/LFC ratio distinguishes participants with different baseline characteristics and compensatory responses to the haemodynamic stress of dialysis, thus indicating that they may respond differently to the various interventions to prevent intradialytic hypotension (IDH). Further studies are required to evaluate the significance of HFC/LFC ratio on clinical outcomes and organ perfusion, whether it is modifiable and if this will allow personalised approaches to reduce IDH.