Biphasic Blood Pressure Response Subtypes Following Orthostasis Identified Using Pattern Recognition Techniques

C Finucane[1, 2], CW Fan[2], D Hade[2], L Byrne[2], G Boyle[1], RA Kenny [2, 3], C Cunningham [2, 3]

[1] Dept. of Medical Physics and Bioengineering, St James's Hospital, Dublin

[2] Falls and Blackout Unit, St James's Hospital, Dublin.

[3] Dept. of Medical Gerontology, Trinity College Dublin, Dublin.

Introduction

The clinical definition of Orthostatic Hypotension (OH) based on the degree of systolic or diastolic blood pressure drop belies the complex and varied range of blood pressure patterns seen following orthostasis. Pattern recognition techniques such as cluster analysis are a group of approaches designed to systematically undercover hidden patterns in large databases. We hypothesized that two-step cluster analysis would identify a number of BP response patterns in OH.

Methods

Consecutive patients (n = 252; 144 (57%) women), age 68.6 (CI: 66.2–70.9) years undergoing active stands, were diagnosed with OH following active stands at a regional falls unit. We recorded the following features from SBP records: baseline (SBP_B), nadir (SBP_N), drop in SBP (ΔSBP), time to recovery of SBP (SBP_{RT}), standing baseline (SBP_{SB}) and difference in pre-post baseline (ΔSBP_{pp}) (See Figure 1). Two-step cluster analysis based on log-likelihood distance measures was then performed to identify naturally occurring patient data clusters. The optimum number of clusters was identified using Akaike Information Criterion technique. Age, weight, height, symptoms during standing was also recorded. One-way ANOVA and stepwise logistic regression using SPSS (v14.0) was used to analyze data. Significance was assumed at ($p<0.01$).

Results

Four subtypes (See Figure 1) were identified automatically; fast (F), slow phase I dominant (SPI), slow phase II dominant (SPII) and pure autonomic failure (AF). On analysis group differences in SBP_B ($F_{(3,248)} = 5.2$, $p=0.002$;eta=0.06), SBP_N ($F_{(3,248)} = 5.3$, $p=0.001$;eta=0.06), ΔSBP ($F_{(3,248)} = 34.9$, $p<0.001$;eta=0.3), SBP_{RT} ($F_{(3,248)} = 140.7$, $p<0.001$;eta=0.7), SBP_{SB} ($F_{(3,248)} = 37.7$, $p<0.001$;eta=0.3), ΔSBP_{pp} ($F_{(3,248)} = 6.8$, $p<0.001$;eta=0.8) and Age ($F_{(3,248)} = 6.8$, $p<0.001$;eta =0.07) were statistically significant.

Post hoc comparisons using Tukey's HSD test indicated that group F's SBP_N 105mmHg (SD ± 24) was greater then group AF's SBP_N 80.5mmHg (SD ± 19) $p=0.002$. ΔSBP in all groups were significantly different (F was 34mmHg (SD ± 16), group SPI 43mmHg (SD ± 18) vs.group SPII 57mmHg (SD ± 23) vs. AF 79mmHg (SD ± 23); $p<0.01$). Differences in 3 groups (AF NA) existed for SBP_{RT} (group F = 23.6 secs (SD ± 15) vs. group SPI = 46.3 secs (SD ± 28.9) vs. group SPII = 95.1 secs (SD ± 14);$p<0.001$). A statistically significant difference for Age F 64 years (SD ± 21) vs. SPII 78 years (SD ± 28.9) existed $p<0.001$. ΔSBP_{pp} was different between all groups (F 15.8mmHg (SD ± 8.6) vs. SPI –3.0 mmHg (SD ± 5.7) vs. SPII –28 mmHg (SD ± 6.1) vs. AF -60.8mmHg (SD ± 21.4)).

Multivariate logistic regression, found that subtype group membership did not independently predict symptom likelihood

Conclusion

Pattern recognition techniques were shown to be a useful adjunct to standard analysis of large databases of SBP responses during active stands. Four subtypes were identified: fast, slow (PI and PII) and autonomic failure. *Fast* responders were younger, with smaller blood pressure drops and SBP overshoot. Older responders typically demonstrated *slower biphasic responses* with larger BP drops.