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Case Report

Monitoring Autonomic Progress Using Outlier Analysis of Heart Rate Variability: A Case Study

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Abstract

This report describes a method of monitoring neurological (autonomic) progress (or lack thereof) where two different natural interventions were used for an individual patient: Chiropractic care and exercise. Not much progress was made initially with the chiropractic care but was observed after the implementation of exercise, evidenced in this case by outlier analysis. Though this progress was short-lived, it nonetheless suggests that the intervention of exercise should be more fully explored

Introduction

Heart rate variability (HRV) is a measure of autonomic health, where in general, greater variability indicates a healthier (more adaptive) autonomic nervous system [1]. Natural methods of improving HRV include chiropractic care [2-3] and exercise [4]. This case study pertains to a patient of the author's who initially received chiropractic care and then initiated an exercise program. The purpose of the study was to: a) demonstrate how HRV can be used on a visit-by-visit basis to monitor neurological progress (or lack thereof) following different interventions, and b) show how outlier analysis can be used to determine the statistical unusualness of an apparent substantive change in HRV compared to baseline.

Case Presentation

A 50-year-old adult female consulted the author in the April of 2019 complaining of low back pain. The author explained that his practice objective was to determine if she had a chiropractic subluxation, conceptually defined as a slight vertebral misalignment that is disturbing nearby spinal nerves and/or cord. If a subluxation is found, then a chiropractic adjustment is recommended to improve neurological function so patients can better heal themselves of what ails them. The patient consented to care and to this case report. The operational definition of subluxation in the study was based on the exam procedures at Hart Chiropractic which included: a) neurological (autonomic) assessment using HRV and b) spinal alignment assessment using manual palpation. The neurological assessments were used for determining when to adjust while the palpation was used for direction of the misalignment. The author's focus is on the upper cervical spine, specifically the atlas (C1) so that is where the palpation was applied.

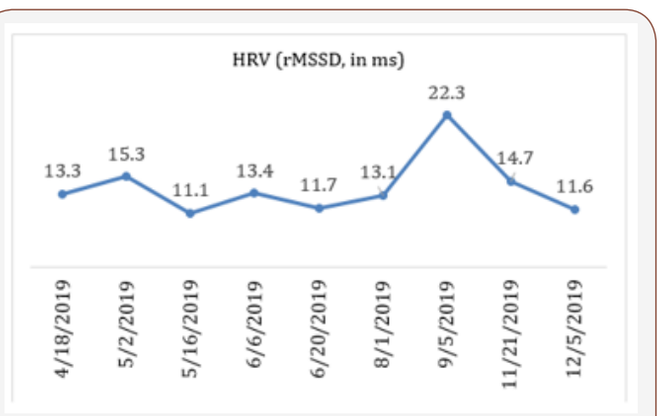

Figure 1: HRV by date. Largest (best) HRV value (on 9-5-19) is an outlier.

HRV was recorded using the Heart Rate Variability Logger app [5] in conjunction with the Kyto ear clip sensor [6]. The sensor sends a Bluetooth signal to the smartphone app and the set-up has good agreement with standard ECG technology [6-7]. A recording lasted 1 minute with the patient in the seated position after a seated rest period of at least 5 minutes. The time domain measure of root mean square of successive differences between heart beats

(rMSSD), measured in milliseconds (ms) was used. The terms rMSSD and HRV are used interchangeably in this paper. For her age, a minimum healthy rMSSD value is approximately 20-28 ms [8-9]. By June though it became apparent that neurological progress was unsatisfactory (Figure 1).

The author recommended a second natural method of improving HRV, namely, exercise. The patient began running short distances at this time, namely, twice around her block where she lived. By the September check-up there was substantial improvement (increase) in the HRV to 22.3 ms (Figure 1).

Curious as to whether this improvement was statistically unusual, the author performed an outlier analysis using the inter-quartile method [10]. The method used the conventional factor of 1.5 for moderate outlier detection, multiplying it by the interquartile range (IQR) to obtain the fence limits:

Lower fence = Quartile 1 – (1.5 * IQR)

Upper fence = Quartile 3 + (1.5 * IQR)

Observed values outside the fences are considered outliers (statistically unusual findings).

The improved HRV reading on the 9-5-19 visit was calculated as an outlier, as it was greater than the upper fence in outlier analysis (Table 1).

Table 1: Summary statistics.

Date	HRV (rMSSD, in ms)
4/18/2019	13.3
5/2/2019	15.3
5/16/2019	11.1
6/6/2019	13.4
6/20/2019	11.7
8/1/2019	13.1
9/5/2019	22.3
11/21/2019	14.7
12/5/2019	11.6
Quartile 1	11.7
Quartile 3	14.7
IQR	3
Lower fence	7.2
Upper fence	19.2
Smallest	11.1
Largest	22.3

Following this, though, the HRV decreased (worsened) as it was before. Thus, the improvement was only temporary.

Discussion

Initially, HRV was consistently less-than-optimal HRV, from April to the August 1 visit (Figure 1). Perhaps another technique of spinal adjustment may have obtained better results during this time. As a medical doctor told me years ago though, "nothing works for everybody." The author's other published works using HRV are examples of his chiropractic success in other cases [11-13].

There was a hint on the September 5 visit that the exercise was working, that it was producing a beneficial autonomic effect evidenced by the HRV improvement. The improvement was substantiated by the outlier analysis. However, the HRV returned to the worsened state on the next visits (November 21 and December 5). Nonetheless, the improvement noted on September 5 is still a clue that the exercise was the right call and that it should be continued. The author plans to work with the patient to explore possible modifications to her exercise program (e.g., increase the distance and/or intensity of the running). The hope is to make the improvement long lasting.

Acknowledgement

The author thanks the patient for her consent in publishing her case.

Conflict of Interest

No Conflict of interest.

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