Heart Rate and Heart Rate Variability as Indicators of Stress in Emergency Medicine Residents during Simulation

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Background

- When confronted with a stressful event, the human body responds by activating the sympathetic nervous system pathway.
- This pathway includes the release of epinephrine, which induces higher heart rate, and can lead to increased heart rate variability.
- Studies have shown a relationship between stress-induced heart rate increases and cognitive performance.
- Certain cognitive tasks, such as memory recall and information processing, in many cases are negatively affected by such stress responses.
- However, stress-induced physical responses can increase cognitive performance with other tasks.
- In a previous study performed by Dr. Jenks, significant stress response was shown in emergency medicine residents during regular shifts.

Purpose

- Our goal for the project was to measure stress-induced heart rate and heart rate variability of Baylor College of Medicine emergency medicine residents during simulated a case, specifically, a PEA arrest scenario.
- In addition to these vitals, and a few others, we also tested the resident's cognitive performance before and during the simulation.
- We aim to compare the stress response shown in simulation to the results shown in the previous study of residents on shift as a way to evaluate how well simulation mimics real shift.

Hypothesis

Our hypothesis for the project was that the residents would not show a significant stress response in heart rate and heart rate variability, and their cognitive performance would not be greatly affected.

Methods

Empatica Device

- We used Empatica E4 devices to measure heart rate, heart rate variability, galvanic skin resistance, skin conductivity, and skin temperature.
- The residents wore the devices the simulation case, and data was uploaded for analysis.

Figure 1. Empatica E4 device.

Simulated Scenario

- We used a 15 minute PEA arrest scenario.
- Vitals were displayed on an iPad using a simulated monitor app
- The residents were supplied with a some supplies to perform interventions with (ET tube, BVM, etc.), and the rest they were told to verbalize.
- A full body CPR/trauma manikin was used as the patient.
- Regardless of the residents interventions or treatment, no response was shown on the monitor or told by the proctor. This was to keep the stress level induced the same regardless of performance.

Trail-making test

- Before the trial and at minute 10, the residents were given a timed trail-making test.
- The trail-making test was explained to the residents before hand, and there were two different versions, which were randomized for which would be first.

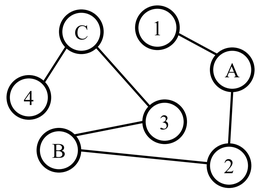

Figure 2. Example of a trail-making test.

Preliminary Results

Table 1. Average Measures of Heart Rate and Heart Rate Variability

Measure	Average
Minimum heart rate (bpm)	65.85
Maximum heart rate (bpm)	113.44
Peaks between 90-100 bpm	2.33
Peaks between 100-120 bpm	2.66
Peaks above 120 bpm	1.50

- The average range of heart rates was 65.85 – 113.44. The total range of of heart rates was 41.74 – 160.27.
- The average number of heart rate peaks between 90-100, 100-120, and above 120 bpm, were 2.33, 2.66, and 1.5

Table 2. T-test of the Cognitive Exam Times

	Mean (s)	Mean difference (s)	Significance of t-test
Test before case	53.0 ± 7.4		
Test during case	44.6 ± 6.1	8.4 ± 3.6	$p = .048$

- A paired t-test was performed on the data from the cognitive exam. The t value was shown to be 2.285, with a significant p value of .048 ($p < 0.05$), at a 95% confidence level.

Conclusion

- As expected, the heart rate and heart rate variability show far less indication of a stress response than those in the previous study in shifts.
- The cognitive exam showed significant results, which tells us that the simulation case stimulated cognitive arousal that allowed the residents to perform better mid-simulation than they had before. However, this could have been a result of the residents learning from the first test, and improving in the second.

Future Steps

- Next semester, Dr. Jenks and I will continue the project. We hope to trial the other 32 Baylor emergency medicine residents.
- We aim to have trialing done by the end of next semester.
- In the future, we could measure the other data measured by the Empatica devices: Temperature, EDA, and BVP.

References

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