

EMERGENCY MEDICINE RESIDENTS LACK THE NECESSARY AUTONOMIC NERVOUS SYSTEM BALANCE AND SHORT RELAXATION TECHNIQUES ARE INSUFFICIENT TO SOLVE THIS

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Key words: heart rate variability, burnout, emergency medicine, mindfulness, stress resilience, residency training, human performance optimisation.

Summary

Study objective. Heart rate variability (HRV) is an objective, easy-to-obtain parameter that can be used to monitor person's balance of autonomous nervous system, which in turn decides one's ability to cope with stress. HRV has been used extensively in professional athletes and the military with the purpose of performance optimisation and burnout prevention. The aim of our study was to investigate the balance of EM residents' autonomic nervous system, as indicated by fluctuations in day-to-day HRV readings, and the feasibility of short relaxation techniques to increase their stress-resilience.

Methods. We conducted a two-month long prospective cross-over double blinded randomized study. Computer randomization was used to divide the EM residents into intervention (A) and control (B) groups. Controls were instructed to listen to a 12 min. relaxation audio file every morning, while the intervention group was equipped with a 12 min. guided meditation that combined rhythmic breathing and attention focusing techniques. After one month, cross-over of the interventions took place.

Results. After pooling pre-shift and post-shift HRV data, we identified differences of statistical significance with post-shift HRV readings being higher ($p=0.028$, $p<0,05$). Individual HRV trend analysis showed significant fluctuations in day-to-day HRV readings. We could not identify the impact of short re-

laxation techniques on the EM residents HRV trends. **Conclusion.** Our findings suggest the lack of autonomic nervous system balance among EM residents, as indicated by big fluctuations in their day-to-day HRV trends. During the course of the study, the HRV reading fluctuations did not stabilise, indicating the limited use of our selected short relaxation techniques to increase residents' stress resilience. We also identified paradoxical findings of higher post-shift HRV readings which could true be due to unique population in the setting of EM.

Introduction

In order to provide complex treatments in humane and efficient manner, contemporary health care specialists are required to demonstrate maximum levels of empathy, honesty and expertise. Naturally, these values are incorporated into medical training programs. However, the clinical environments expose junior doctors to much different reality. Death, suffering, continuous multitasking, night shifts and hectic pace often lead to unfavourable emotional and health states in medical trainees [1]. This results in growing burnout rates among physicians and nurses [2-4]. It is well established that empathy decreases during the course of medical education [5-7].

If we want future physicians to excel in their training and to flourish as specialists, more attention needs to be paid at their health, mental and emotional well-being. To achieve this, we need tools that would allow junior doctors to cope with growing challenges of the medical field. A good example is the US Department of Defence (DOD). Acknowledging the importance of human factors in mission success, the military came up with concepts of Precision Performance,

Human Performance Optimization (HPO) and Total Force Fitness [8, 9]. These paradigms emphasize multi-monitoring of various parameters and personalisation of recommendations for nutrition, hydration, psychological, spiritual, social, medical and other domains of an individual's life in order to create the "Shield of Health". According to HPO, human being is recognised as complex system of systems, where multiple aspects have to be taken into account in order to achieve optimal performance and mission success.

Similar paradigm shift needs to happen in healthcare and medical education. We are spending billions on multimodal monitoring approaches for our patients, leaving the inner states of doctors, i.e. life & death decision makers, completely ignored. Luckily, there are objective, easy-to-obtain parameters, like heart rate variability (HRV), which can demystify one's inner well-being. HRV can monitor person's balance of autonomous nervous system, which decides the ability to cope with physical, cognitive and emotional stress [10-13].

Emergency medicine (EM) residents and physicians are among those with the highest risk of developing stress related health illnesses [14, 15]. Being stress resilient is of vital importance in the field of EM, where quickly making difficult decisions while managing multiple patients is the norm of practice.

Table 1. Baseline participant characteristics.

Characteristic	Group	
	A - Intervention at the beginning	B - Control at the beginning
Sex		
Male, <i>n</i> (%)	3 (37,5%)	2 (25%)
Age in years, <i>mean</i> (SD)	27,0 (2,07)	25,88 (1,25)
Resident status		
Junior, <i>n</i> (%)	4 (50%)	6 (75%)
Senior, <i>n</i> (%)	4 (50%)	2 (25%)
Practising mindfulness, meditation or prayer		
"Never", <i>n</i> (%)	5 (62,5%)	6 (75%)
"Sometimes", <i>n</i> (%)	3 (37,5%)	2 (25%)
Usual sleep hours, <i>mean</i> (SD)	7,0 (1,04)	6,56 (1,45)
Night shifts per month, <i>median</i> (range)	4 (1 - 8)	3 (2 - 4)
Monthly workload (hours), <i>mean</i> (SD)	175,0 (20,7)	200 (30,2)
Religious		
No, <i>n</i> (%)	6 (75%)	6 (75%)
Active smoker		
Yes, <i>n</i> (%)	2 (25%)	5 (62,5%)
Coffee intake		
"Several cups a day", <i>n</i> (%)	5 (62,5%)	4 (50%)
Alcohol intake		
"Once a week or more", <i>n</i> (%)	3 (37,5%)	3 (37,5%)

The aim of our study was to investigate the balance of EM residents' autonomic nervous system, as indicated by fluctuations in day-to-day HRV readings, and the feasibility of short relaxation techniques (listening to relaxation music and performing a guided meditation) to increase their stress-resilience.

Methods

Study design. We conducted a two-month long prospective cross-over randomized blinded study in the Lithuanian University of Health Sciences. The study took place between October and November in 2016.

Procedure. Consent for the study was obtained from local bioethics committee.

All EM residents were invited to the study. Sixteen agreed to participate. In a pre-study meeting, residents were instructed how to perform the relaxation exercises, how to use HRV monitoring devices and the necessary smart phone application. Instructions were also sent to each member personally via email. Research team consisted of the residency coordinator, senior EM resident and a medical student, who was collecting and blinding data prior to presenting it to

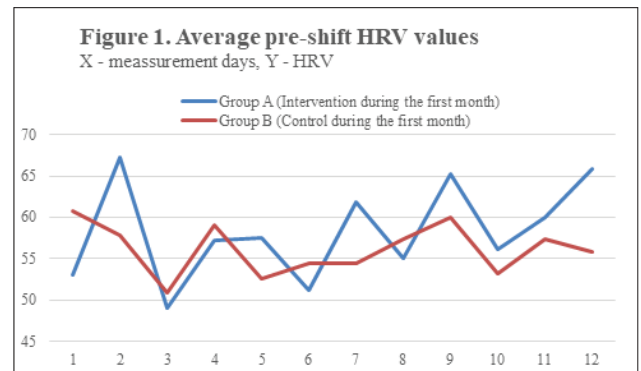


Figure 1. Average pre-shift HRV values.

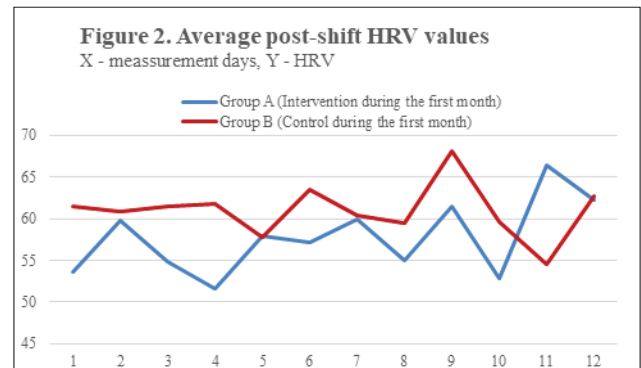


Figure 2. Average post-shift HRV values.

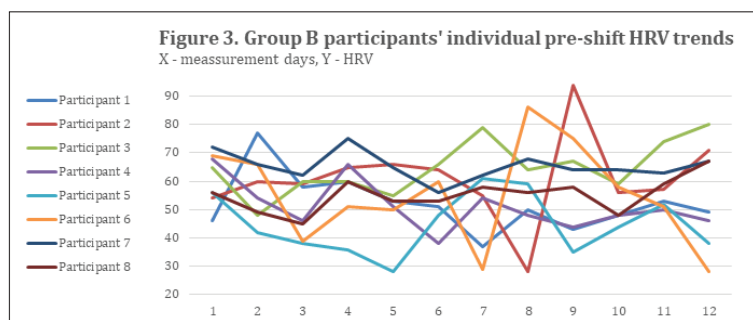


Figure 3. Group B participants' individual pre-shift HRV readings trends.

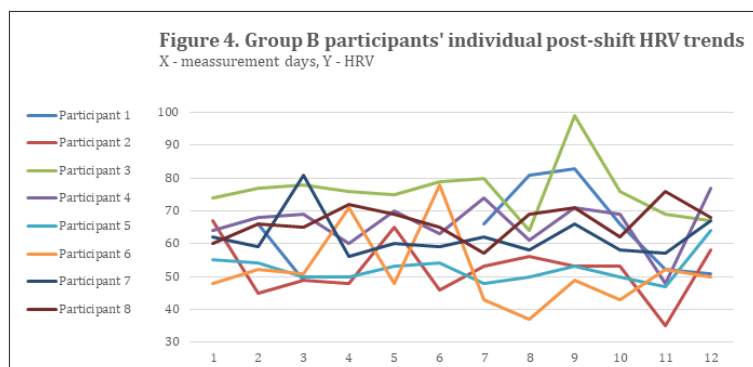


Figure 4. Group B (Control at the beginning) individual pre-shift HRV readings of the first study month.

other investigators.

Computer randomization was used to divide participants into intervention (A) and control (B) groups. Controls received a 12 min. long relaxation music audio file, while the intervention group was equipped with a 12 min. long guided meditation that combined rhythmic breathing and attention focusing techniques. Members were instructed to perform relaxation exercise once every morning. They were also asked not to share any information with other study members. After one month of the study, participants were dispatched with new audio files and were instructed to practise these relaxation exercises. They were not aware whether the new audio files were already used by other members.

Chest-strap HRV monitoring devices (Wahoo Tickr X Heart Rate Monitor©) and smartphone application Elite HRV© were used to collect the study data. The readings were taken on six random day-time emergency room (ER) shifts per month. The participants were informed (email and SMS) before the start of the shift to take the measurements. They were done before the start of the shift and right after it finished, in a silent room where there would be no interruptions.

Statistical analysis. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 24 (Armonk, NY: IBM Corp. Software). Descriptive characteristics were summarized and presented as absolute values, percentages, means \pm standard deviation. Comparisons between groups were performed by using Mann-Whitney (U), Wilcoxon

signed-rank, Friedman and Student's (*t*) tests for continuous variables. For testing hypothesis of independence, the Chi-square test was used.

The level of statistical significance by testing statistical hypothesis was 0.05.

Results

Baseline characteristics of the study participants are presented in table 1. The group consisted of 10 junior and 6 senior EM residents. Mean participant age was $26,4 \pm 1,75$ years. More than half of EM residents had never practiced mindfulness or meditation before. Seven were active smokers, more than a third consumed alcoholic beverages on a weekly basis.

Group HRV data is presented in figures 1 and 2. Two participants from group A failed continue participation in the study in the 2nd month due to sick leave. Although clinically significant differences and fluctuations can be noted visually, we failed to identify any statistical significance in day-to-day basis or when comparing groups A and B. Also, the day-to-day group HRV readings did not differ statistically significantly after cross-over of interventions. Interestingly, after pooling the pre-shift and post-shift HRV data, we identified differences of statistical significance where, paradoxically, post-shift HRV readings were higher ($p=0.028$, $p<0,05$).

Some of the exemplary individual pre-shift HRV trends are depicted in figures 3 and 4. Individual differences and big fluctuations in day-to-day HRV readings can be easily noted from the charts. Multiple incidents where day-to-day HRV values ranged from 30 to 80 in the same individual participant were noted.

Discussion

The absolute HRV values of EM residents were much lower than what we anticipated before the study, having in mind the young age of study participants. This indicates inadequate physical and mental preparedness for working conditions awaiting EM residents in the ERs. Very few participants indicated they are physically active more than once a week. A substantial amount were active smokers or consumed high amounts of caffeine daily. These factors contribute to lower stress resilience and longer

HRV recovery times [16, 17, 18, 19].

We identified clinically significant fluctuations in day-to-day HRV readings of individual EM residents. This is an indicator of impaired autonomic nervous system balance, poor stress resilience and higher risk for developing burnout. If such variations were witnessed in professional athletes, they would be suspended from further training in fear of overload, whereas this mainly goes undetected (or ignored) in the medical field, where over-worked and under-resilient healthcare workers are constantly face with life or death decisions.

We did not identify superiority of the short, guided meditations in increasing EM residents' HRV values when compared to listening to relaxation music in the morning. This does not mean to say that guided meditations and relaxation techniques fail to increase stress resilience in general. Rather, such methods are mostly unfamiliar to healthcare workforce, which limits their applicability in a study setting. In fact, we received feedback from the study participants about not feeling pleasant doing the guided breathing or attention focusing techniques, which resulted in not complying with study protocol in some cases.

Main factors that pose limitations to our study are group sizes of the participants and the quality control of prescribed relaxation techniques. There is a crucial need of large scale studies which look into the effects of mindfulness techniques, physical activities, nutritional and dietary modifications in optimising healthcare specialists' performance.

Advices on how to stay healthy in EM are popular among emergency bloggers and FOAM community of the specialty [20]. However, the widespread of culture of health needs to happen in the education of healthcare specialists, if we want to provide the health sector with sustainable and stress-resilient workforce. The paradigm shift of precision performance and human performance optimisation that is underway in the military, needs to happen in the medical setting as well. We cannot build a strong system on strained individuals.

Conclusion

Our findings suggest the lack of autonomic nervous system balance among EM residents, as indicated by big fluctuations in their day-to-day HRV trends. During the course of the study, the HRV fluctuations did not stabilise, indicating the limited use of our selected short relaxation techniques (daily listening to relaxation music or performing a guided meditation) to increase residents' stress resilience. We also identified paradoxical findings of higher post-shift HRV readings among the trainees which could be true due to unique population in the setting of EM.

These findings prompt for further research to identify fea-

sible monitoring methods and interventions that can increase the well-being and stress resilience of healthcare specialists, especially in the field of EM.

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SKUBIOSIOS MEDICINOS REZIDENTAI NETURI REIKIAMO AUTONOMINĖS NERVŲ SISTEMOS BALANSO IR TRUMPŲ RELAKSACINIŲ TECHNIKŲ NEUŽTENKA TAM IŠSPRĖŠTI

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Raktažodžiai: širdies veiklos variabilškumas, perdegimo sindromas, skubioji medicina, atsparumas stresui, rezidentūros studijos, žmogaus veiklos optimizavimas.

Santrauka

Tyrimo objektas. Širdies ritmo variabilškumas (ŠRV) yra objektyvus ir lengvas tyrimo metodas, galintis matuoti autonominės nervų sistemos balansą, nuo ko priklauso asmens gebėjimas valdyti stresą. ŠRV yra plačiai naudojamas profesionalaus sporto bei karybos sektoriuose, siekiant optimalių veiklos rezultatų ir išvengiant perdegimo sindromo. Mūsų tyrimo tikslas buvo naudojantis ŠRV nustatyti skubiosios medicinos (SM) rezidentų autonominės nervų sistemos balansą bei trumpų atsipalaidavimo metodikų tinkamumą padidinant gydytojų atsparumą stresui.

Metodai. Atlikome dviejų mėnesių trukmės randomizuotą dvigubai aklą kryžminį tyrimą. SM rezidentai buvo suskirstyti į intervencijos (A) ir kontrolės grupes (B). Kontrolės grupės tiriamieji kiekvieną rytą klausė 12 min. trukmės relaksacinės muzikos įrašą, o intervencinės grupės – kiekvieną rytą atliko 12 min. trukmės vedamą meditaciją, kurioje buvo ritmiško kvėpavimo bei dėmesio sukaupimo komponentų. Po mėnesio įvykdytas intervencijų apkeitimasis.

Rezultatai. Sudėjus visus ŠRV duomenis „prieš budėjimą“ ir „po budėjimo“, gauti statistiškai reikšmingi rezultatai – ŠRV reikšmės po budėjimo buvo aukštesnės ($p=0,028$, $p<0,05$). Analizuojant individualias ŠRV kreives, pastebėti labai ženklūs svyravimai kasdienėse rezidentų ŠRV reikšmėse. Mums nepavyko nustatyti trumpų relaksacinių technikų įtakos SM rezidentų autonominės nervų sistemos balansui.

Išvados. Tyrimo rezultatai rodo sutrikusį autonominės nervų sistemos balansą tarp SM rezidentų. Tyrimo eigoje stebimųjų ŠRV kreivės nesidarė stabilesnės, todėl negalima teigti, jog parinktos relaksacinės technikos turėjo įtaką SM rezidentų streso atsparumui. Nustatėme netikėtus radinius – santykinai didesnes ŠRV reikšmes „po budėjimo“ – tai galima sieti su unikalia populiacija, dirbančia skubios pagalbos skyriuose.

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