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HEART RATE VARIABILITY RELATED TO N95 RESPIRATOR USE IN INTERNS DURING COVID-19 PANDEMIC

Physiology

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ABSTRACT

Introduction: COVID19 is caused by SARS-CoV-2 which is primarily transmitted through respiratory droplets and contact routes. WHO recommended the use of personal protective equipment (PPE) for prevention and N95 respirators are critical components of PPE. Breathing through N95 respirator will impart stress in the individual and that can be assessed by heart rate variability (HRV). HRV measures the variation in time between each heartbeat controlled by autonomic nervous system (ANS), which is a non invasive reliable index to identify the ANS imbalances.

Aims And Objectives: This study is aimed at assessing the HRV of Interns working in COVID19 wards using N95 respirators.

Methodology: This study included 100 interns in whom short term HRV was recorded using the standard protocol. Lead II of ECG was recorded using AD instruments (ADI) 8channel polygraph and HRV was analysed using Labchart 8pro software. The recordings were taken before and 1hour after wearing N95 respirator.

Results: Overall HRV (SDRR) was found to decrease significantly after wearing N95 respirator for 1hr (p=0.000). Similarly, indices representing the parasympathetic component (RMSSD and HF) were also found to decrease significantly with the use of N95 respirator. Low frequency (LF) power and LF/HF ratio increased significantly with N95 respirator use (p=0.000).

Conclusion: We conclude that using N95 respirator increased sympathetic activity reflecting decreased HRV in our subjects Hence we recommend that it is better to change the duty pattern for interns.

KEYWORDS

HRV, SDRR, RMSSD, LF, HF

INTRODUCTION

COVID-19 is caused by the novel coronavirus SARS- COV2.The first case of COVID was reported from the city of Wuhan, China in December 2019. It has been declared as a pandemic by WHO on 11 March 2020. Since then, several variants have emerged and have caused devastating effects on the people around the World. According to the current evidence, the route of transmission of COVID 19 is through respiratory route and by contact.

WHO has recommended the use of personal protective equipment (PPE) in health care settings. N95 respirators are critical components of PPE and their use is mandated for the health care professionals They are used to protect the wearer from airborne particles and contamination of the face from liquids. The N95 respirator (N95) is a protective device which fits snugly on the face and filters airborne particles up to 0.3µm. N in N95 stands for "not resistant" to oil-based aerosols, and 95 represents 95% efficacy in filtering 0.3µm particles. As the interns use the N95 respirator for long hours, it is important to know the impact of N95 respirator on heart rate variability to assess the stress levels. N95 respirator causes high breathing resistance which makes it difficult for the subject to breathe and take in sufficient oxygen. Shortage of oxygen stimulates the sympathetic nervous system and increases heart rate [1]

Heart rate variability (HRV) is a measure of beat-to-beat variation which is controlled by the autonomic nervous system (ANS). HRV is a non-invasive method to identify the ANS imbalances and is described, using time-domain and frequency-domain measurements. Time-domain indices determine the amount of variability in measurements of the interbeat interval (IBI) observed during monitoring periods ranging from ~2 min to 24 h. Frequency-domain values determine the absolute or relative amount of signal energy within component bands[8] Time domain measures SDRR (standard deviation of RR intervals) and RMSSD (root mean square of standard deviation) can be used to analyse recordings of short durations of ~ 5minutes. Common frequency HRV domains include high frequency (HF) component in the frequency range of 0.15 – 0.40Hz and low frequency (LF) component in the frequency range of 0.04 - 0.15 Hz. HF component indicates parasympathetic activity and LF component indicates sympathetic activity. LF/HF ratio reflects sympathovagal balance. LF and HF are measured in normalised units (nu). Increased HF, reduced LF and LF/HF ratio indicate parasympathetic predominance whereas reduced HF, increased LF and LF/HF ratio indicate sympathetic predominance. Predominant parasympathetic activity favours good cardiovascular health. Predominant sympathetic activity is an important cardiovascular risk factor [6]. In most of the studies HRV variables changed in response to stress. Several researchers have conducted studies using HRV to measure stress assuming it as a reliable index of stress.

METHODOLOGY

This cross-sectional observational study was carried out on 100 interns working in COVID wards of Government General Hospital, Guntur, Andhra Pradesh. The study was performed in the Department of Physiology, Guntur Medical College, Guntur after obtaining approval from the Institutional Ethics Committee. All the subjects were informed about the details of the study and written consent was obtained.

Inclusion Criteria:

- Interns working in COVID wards of Government General Hospital
- Willing to participate

Exclusion Criteria

- Interns not willing to participate
- Hypertension
- Bronchial asthma
- Metabolic disorders
- Family history of metabolic disorders

After measuring the height and weight of all the subjects, BMI was calculated using the formula BMI = weight (kg) / [height^2 (m^2)]. SpO^2 was measured using the pulse oximeter and the respiratory rate was measured by using respiratory belt with AD-instrument. Blood pressure was recorded using the Sphygmomanometer under standard conditions. Lead-II of ECG is recorded in the supine position for 5 min (short term HRV) using the standard protocol with AD-instruments

(ADI) 8-channel polygraph 15T and The Time domain and Frequency domain parameters of HRV was analysed using Lab-chart 8-pro software. The Lomb Scargle Periodogram is used for HRV analysis. Unlike the FFT (Fast Fourier Transform), the Lomb method is less affected by ectopic or missing beats by excluding the ectopic beats. ECG was recorded without N95 respirator for 5 minutes and subjects were asked to use N95 respirator (Venus V-4400) for 1hr and at the end ECG was recorded for 5 minutes.

Statistical Analysis

Data is analyzed by using SPSS V22. Normality is checked by using Kolmogorov Smirnov test. Descriptive statistics is represented with percentages, Mean with SD. Paired t-test is applied based on the nature of the distribution. P<0.05 is considered as statistically significant.

RESULTS

Table 1. Basal Cardiovascular And Respiratory Parameters

Parameters	Without N95 respirator		With N95 respirator		P-value
	Mean	SD	Mean	SD	
Heart rate (BPM)	81.91	9.67	83.73	10.51	0.000*
SBP (mm Hg)	121.88	13.47	123.07	12.65	0.000*
DBP (mm Hg)	77.23	13.73	78.14	12.94	0.000*
Respiratory rate (per minute)	19.21	1.92	21.05	2.30	0.001*
SpO2 (%)	98.78	0.77	98.54	0.76	0.000*

Table 2. Time Domain And Frequency Domain Components Of Heart Rate Variability

Parameters	Without N95 respirator		With N95 respirator		P-value
	Mean	SD	Mean	SD	
SDRR (ms)	42.68	18.88	40.93	19.11	0.000*
RMSSD (ms)	41.79	24.43	38.66	21.01	0.000*
Power (ms^2)	2224.91	1818.13	2562.30	1813.80	0.000*
LF (nu)	27.94	11.20	30.61	11.37	0.000*
HF (nu)	45.22	16.59	40.32	17.67	0.000*
LF/HF	0.71	0.73	1.07	1.08	0.000*

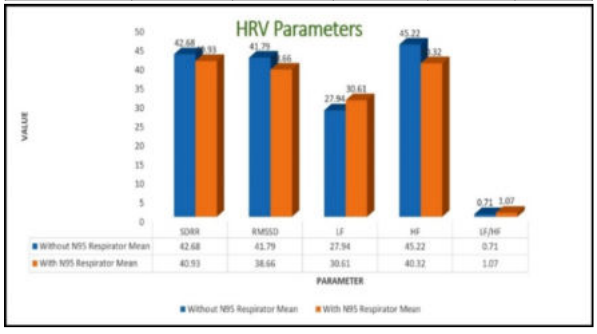

Table 1 shows that the heart rate, respiratory rate, systolic blood pressure and diastolic blood pressure were significantly higher while using N95 respirator but the parameters were within normal limits in both situations. Table 2 shows that in time domain SDRR and RMSSD decreased and in frequency domain total power, LF and LF/HF ratio increased whereas HF decreased with the use of N95 respirator.

DISCUSSION

HRV indicates autonomic nervous system activity. HRV is described using time domain and frequency domain measurements. In time domain SDRR, RMSSD and average HR are used for recordings of short durations (~5min) whereas in frequency domain total power, LF, HF and LF/HF are used. SDRR is the standard deviation of the normal to normal sinus initiated IBIs measured in milliseconds (ms). It reflects overall HRV in the period of recording. The RMSSD determines the beat-to-beat variance in heart rate and is used to estimate the vagally mediated changes reflected in HRV and is correlated with HF power [12].

In our study on HRV measurements in time domain, it is observed that SDRR values without N95 respirator is 42.68 ± 19.11 whereas with N95 respirator it is 40.93 ± 19.11 with p value 0.000, which correlates with the study of Zhixing Tian et. al, in which it was found that wearing a mask reduced the SDRR value in 80% of the test subjects after wearing a mask for 5 minutes[5] RMSSD level while wearing N95 respirator was 38.66±21.01 whereas without wearing N95 respirator the level was 41.79±24.43 with significant p value (p=0.000).

In frequency domain, LF showed increased values with N95 respirator (30.61±11.37) when compared to without N95 respirator (27.94±11.20) with a significant p value of 0.000, whereas HF showed significant decrease in values (45.22±16.59 to 40.32±17.67) while wearing the N95 respirator with p value of 0.000. LF/HF ratio showed increase in values while wearing the N95 respirator from 0.71±0.73 to 1.07±1.08 with the p value being 0.000.

There is significant increase in total power (p=0.000) while wearing the N95 respirator. There is significant increase in heart rate and respiratory rate while wearing N95 respirator which correlated with the findings of Kim et.al[12] which showed that N95 respirator use for 1 hour increased the heart rate (range, 5.7 - 10.6 beats per minute, P < .001) and respiratory rate (range, 1.4 - 2.4 breaths per minute (P < 0.05).

Rajesh Prabhakar Gaikwad et.al showed that SpO_2 values were 96.07±0.279 before wearing N95 mask and after wearing N95 mask with mean SpO_2 values 95.37±0.394 (p=0.000)[9]. Our study also showed similar decrease in SpO_2 levels with N95 respirator (98.78±0.77 to 98.54±0.76).

In our study overall HRV indicated by SDRR is found to decrease significantly after wearing N95 respirator for 1hr (p=0.000). Similarly, indices which represent the parasympathetic component RMSSD and HF were also found to decrease significantly with the use of N95 respirator. LF power which represents the sympathetic activity and LF/HF ratio increased significantly with N95 respirator use (p=0.000) which shows decrease in heart rate variability.

CONCLUSION

We conclude from our study that with N95 respirator usage, there is decrease in SDRR which signifies overall decrease in HRV and increase in the LF and LF/HF ratio indicates increased sympathetic activity and thus decreased HRV. Decrease in RMSSD and HF indicates decreased parasympathetic activity.

The cause could be explained by the high breathing resistance during the N95 respirator use making it difficult for the subjects to breathe and take in sufficient oxygen, which acted as a stimulus to the sympathetic nervous system thereby decreasing the heart rate variability. Hence N 95 respirator usage by interns during the COVID-19 pandemic has led to an increased sympathetic activity, which can result in suboptimal function during duty hours and detrimental health issues in the long run. Hence we recommended to adjust the duty timings of the interns to decrease stress induced sympathetic activity.

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