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Evaluation of pH of Saliva and SpO_2 with PPE usage: A Pilot study

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Abstract

Aim: This pilot study aims at measuring any changes in salivary pH and SpO_2 with PPE.

Objectives : To evaluate effect of PPE and surgical mask usage on the oxygen saturation levels.

To evaluate effect of PPE and surgical mask usage on pH levels of saliva.

Methodology: This study was performed on 25 subjects. Base line values of SpO_2 were recorded in morning without any mask usage. Values were recorded after usage of surgical mask and PPE. Changes in salivary pH performed on days without PPE usage with a gap of 4 hours and again on days of PPE usage. Values were tabulated and statistically analysed.

Results: Statistical analysis of SpO_2 and pH values with mean of 98.3±0.4, p =0.07 and 6.55± 0.1, p=0.004 respectively were found in groups using PPE.

Conclusion: Within the limitations of study, PPE has effect on SpO_2 and pH of saliva with significant changes in respect to slaiva pH. As SpO_2 and pH evaluated are multifactorial dependent, research towards a larger multicentric study further required to validate these results.

Introduction

On 30 January 2020, the World Health Organization (WHO) declared that CoVID-19 as a "public-health emergency of international concern" (Li et al,2020). The virus outbreak soon evolved into a public health crisis and has spread exponentially to other parts of the world.The outbreak of COVID-19 has led to guidelines recommending the routine use of facemasks by the populace, and healthcare workers in particular. Covid 19 virus, transmits through respiratory droplets and contact routes.[1] Hence the use of masks is recommended, so as to prevent and limit the spread of respiratory viral diseases. Facemasks are critical components of personal protective equipment (PPE) for healthcare workers, for reducing employee exposure to respiratory infections. Healthcare workers (HCWs) are at increased risk of respiratory infections, and frontline HCWs could have a 12-fold risk of COVID-19 infection compared with the general community.[2] N95 masks form an essential component of personal protective equipment (PPE) used by health care workers. Due to prolonged shifts performed by HCWs in COVID 19 environment, there are many challenges associated with wearing the N95 masks and PPE for longer durations, such as nausea, shortness of breath, complaints of visual challenges, headache, light headedness, and difficulty with communication. Focusing on complication from using PPE and N95 masks, very little information is available in the literature. A study by Rebmann et al, stated that prolonged use (≥12 hrs) of N95 masks is associated with headaches, light -headedness, shortness of breath and decrease in blood oxygen saturation.[3] Prolonged use of N95 masks also associated with "mask mouth syndrome". Data is scanty on whether there is any alteration in salivary pH on using N95 masks. So, the aim of this pilot is measuring any changes in salivary pH and SpO_2 with PPE and N95 masks.

Materials and methods

This pilot study was performed on 25 subjects (dentists) at ADC(R&R) who were detailed to perform emergency dental treatments in the institution wearing PPE and N95 masks. Selected subjects were in age group of 24-35 years, non-smokers and without any chronic lung disease were selected for the study. They were afebrile, hemodynamically stable, breathing room air, with no previous history of Corona virus infection or any positive contact history or any travel history.

The subjects were wearing PPE and N95 masks for continuously for a period of 4 hrs. The same pulse oximeter (BPL Smart Oxy 04) was used to measure the blood oxygen saturation during the study. Salivary pH was evaluated using saliva pH strips (Saliva-Check BUFFER, GC America) which detects change in pH and shows it as color change . Participants were encouraged to speak and behave in their usual manner throughout the period of examination hand. The study was performed for 3 consecutive days. Blood oxygen saturation (in percentage) and saliva pH of each subject were recorded before wearing a mask (Figure 1). Then subjects were asked to wear PPE with N95 mask and instructed not to remove it till the end of an examination (approximately 4 hrs). After the said period, again blood oxygen saturation and salivary pH were checked for each subject by using the same pulse oximeter (Figure 2). Subjects were trained on how to wear and remove PPE and N95 mask with proper sanitization technique.

Data obtained was compiled on a MS Office Excel Sheet. Data was subjected to statistical analysis using Statistical package for social sciences (SPSS v 26.0, IBM). Normality of numerical data was checked using Shapiro-Wilk test & was found that the data followed a

normal curve; Paired T-test was performed. For all the statistical tests, $p < 0.05$ was considered statistically significant.

Fig 1: Pulseoximeter

Fig 2: Saliva pH strips

Fig 3: SpO_2 and salivary pH before PPE and N95 mask usage

Fig 4: SpO_2 and salivary pH after PPE and N95 mask usage

Results

Table 1			
SpO_2	Mean	t- value	P value
Before	98.36	1.90	0.07
After	98.02		
Table 2			
pH	Mean	t- value	P value
Before	6.95	3.44	0.006
After	6.25		

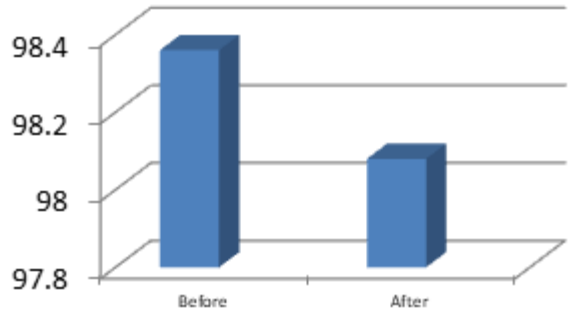

Fig. 5: SpO_2

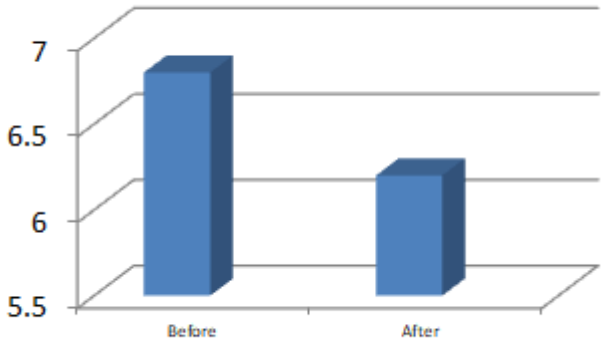

Fig 6: Salivary pH

Figure 5, shows comparison of SpO2 values of all subjects before and after wearing PPE and N95 mask. It was observed that before wearing PPE and N95 mask, mean of SpO2 values was 98.36±0.196 while after removing PPE and N95 mask, mean of SpO2 values was 98.02±0.235 (p=0.076). A statistically non-significant

difference was seen for the values between the time intervals.

Figure 6, shows comparison of salivary pH values of all subjects before and after wearing PPE and N95 mask. It was observed that before wearing PPE and N95 mask, mean of pH values was 6.95 while after removing PPE and N95 mask, mean of pH values was 6.25. A statistically significant difference was seen for the pH values between the time intervals with p value = 0.006.

Discussion

In this study, we observed that there is non-significant level of reduction in blood oxygen saturation, significant lowering of salivary pH levels after wearing PPE and N95 mask.

N95 masks and PPE are protective devices used in numerous workplaces to reduce airborne particulate exposures. An N95 respirator is a respiratory protective device designed to achieve a very close facial fit and very efficient filtration of airborne particles. The edges of the respirator are designed to form a seal around the nose and mouth. Surgical N95 Respirators are commonly used in healthcare settings and are a subset of N95 Filtering Facepiece Respirators (FFRs), often referred to as N95. N95 filters are made of several layers of woven synthetic material treated to sustain an electrostatic charge. In the healthcare setting, N95 filters provide adequate protection from most airborne pathogens (e.g., influenza, tuberculosis).[4]

An N95 respirator user experiences some level of breathing resistance, even though these masks are designed to minimize breathing resistance as much as possible. Enough breathing resistance results in a reduction in the frequency and depth of breathing due to decreased oxygen (O_2) level and increased carbon dioxide (CO_2), known as hypoventilation. Hypoventilation is a primary cause of significant discomfort while wearing an N95 masks (Williams 2010).[5]

According to study by Roberge et al. in 2010, it indicated that hypoventilation did not cause a significant risk to healthcare workers over the course of less than one hour of continuous N95 use.[6]

Lim et al in their study stated that when healthcare workers are working for longer hours without a break while continuously wearing an N95 mask, blood CO2 levels may increase past the 1-hour mark, which could have a significant physiological effect on the wearer.[7]

Gaikwad R P et.al. in their study concluded that prolonged use of N95 mask during COVID-19 has caused adverse effects such as reduction in blood oxygen saturation level signififcantly.[8]

In a study by A Beder et al concluded that pulse rates of the surgeon's increase and SpO2 decrease after the first hour. This early change in SpO2 may be either due to the facial mask or the operational stress.[9]

In our study also there was reduction in oxygen saturation levels, but not statistically significant. This transient reduction of oxygen saturation may not have any immediate detrimental effects which warrant usage of PPE and N95 masks. During this COVID 19 era use of these PPE and N95 had become new normal to dental practice., To warrant any adverse effects with usage of PPE and N95 masks, healthcare workers are advised to find a safe place to properly take off the respirator to reduce CO2 build-up and the negative physiological effects associated with it. Breaks during work shifts are vital to individual’s health and safety; therefore work shifts may be planned accordingly. To avoid any adverse effects, the balance between the protection afforded by N95 respirators and the burden of these respirators must be met with a plan to mitigate the burden and further studies involving measurement of gas tensions over

time, both from blood and from samples obtained under the mask are required.

Salivary secretion is strongly affected by the neural control of the autonomic nervous system, which indirectly regulates the salivary flow rate. Carbonic acid is known to decrease blood pH, and salivary secretion always requires adequate supply of nutrients from the blood. The change in salivary pH depends on the level of CO2 in the blood.[10] With an increase in the blood CO2 level, CO2 is transferred from the blood to the saliva at a higher rate, with a subsequent decrease in salivary pH.[11] With the use of PPE and N95 masks there is increase in build up of CO_2 which may contribute to increase in blood CO_2 levels. In this study we observed significant reduction in salivary pH which may be attributed to increase in CO_2 build up combined with dehydration. Dehydration can be a significant problem when wearing PPE and N95 masks. The effects of dehydration may contribute to the experience of the physiological burden such as headache, dizziness, strong sensation of thirst, and reduced cognition. Therefore, healthcare workers must be aware of the need for proper hydration especially if wearing PPE causes significant sweating from heat exposure.

Mere drop in SpO_2 doesn't warrant use of PPE or N95 masks against their advantages during this pandemic era, as the change is transient and further evaluation of CO_2 levels, further studies involving measurement of gas tensions over time, both from blood and from samples obtained under the mask (in order to evaluate build-up of CO2 under the mask) have to be carried out to elucidate this issue. As saliva pH is multifactorial dependent, evaluation of other parameters such as salivary buffer capacity, salivary flow rate would have generated more standardised results.

Conclusion

Within the limitations of study, PPE and N95 masks has effect on SpO_2 and pH of saliva with significant changes in respect to saliva pH. As SpO_2 and pH evaluated are multifactorial dependent, research towards a larger multicentric study involving greater sample size and evaluation of other important parameters is further required to validate these results.

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