American Journal of Polymer Science 2023, 12(1): 17-21
DOI: 10.5923/j.ajps.20231201.03

Findings of Air Quality Monitoring in Special Hospital Indoors to Detect SARS-COV-2 Virus (COVID-19)

B. K. Nurmatov, B. B. Rakhimov., G. Sh. Tashmetova

Tashkent Medical Academy, Tashkent, Uzbekistan

Abstract Indoor air quality are the important factors influencing the infectious diseases such as SARS-COV-2 virus. This study is aimed to explore the associations between air quality and spreading of COVID-19 virus indoor condition. The study was conducted from February 20 to March 3, 2020, at the Zangiota-2 in-patient unit specializing in the treatment of COVID-19 patients. 100 air samples were taken in Hospital from various departments. And also, indoor air quality parameters (microclimate factors, amount of fine dust particles, carbon monoxide (II) concentration, and amount of formaldehyde) were studied simultaneously with sampling. Two out of 100 air samples taken at different locations in hospital wards tested positive for the presence of SARS-CoV-2. In conclusion, hospital room air and its quality can be a potential source of SARS-CoV-2 infection.

Keywords Indoor air quality, SARS-COV-2 virus, Spreading of COVID-19

1. Introduction

On December 31, 2019, a new type of coronavirus causing severe pneumonia with acute respiratory syndrome was discovered in Wuhan of China, and quickly spread worldwide. The World Health Organization had declared a pandemic. As of May 7, 2020, it was reported that 3.5 million people worldwide had been infected and about 250,000 people had died from the disease (WHO, 2020a; WHO, 2020b; Noorimotlagh, 2021). The first case of infection in our country was detected on March 15, 2020, in a woman who had been arrived from France; the laboratory examination confirmed COVID-19 disease.

High level of COVID-19 spread in the world required serious research to determine clinical characteristics of the new coronavirus infection, its complications and possible ways of its transmission, including airborne. According to previous studies and WHO guidelines, the main route of transmission of the new coronavirus disease is human-to-human transmission (prolonged and unprotected exposure), and there is much discussion about other routes of transmission, such as airborne transmission (Guan et al, 2020; Van Doremalen et al., 2020; Sohrabi et al., 2020; WHO, 2020b; Holshue et al., 2020; Ghinai et al., 2020; Morawska and Cao, 2020; Noorimotlagh et al., 2020). The transmission and epidemiology of the two zoonotic coronaviruses, Middle East respiratory syndrome (MERS-CoV) and SARS-CoV-1, are known to science, and airborne transmission has played an important role in their spread.

Received: Jun. 6, 2023; Accepted: Jun. 26, 2023; Published: Jul. 8, 2023
Published online at http://journal.sapub.org/ajps

In view of the limited and unevidenced-based data on airborne transmission of SARS-CoV-2, researchers are encouraged to conduct additional research in this area. Detection of airborne transmission of SARS-CoV-2 is one of the most important debates among researchers to better understand and manage the SARS-CoV-2 pandemic and to protect the health of both medical professionals and the public. Therefore, we sought to investigate air quality indicators within hospital rooms treating patients with confirmed COVID-19 disease to determine the potential spread of SARS-CoV-2 in the hospital.

2. Material and Methods

The study was conducted from February 20 to March 3, 2020, at the Zangiota-2 in-patient unit specializing in the treatment of COVID-19 patients. Air samples were taken from the intensive care unit, treatment room, doctor's office and waiting room. In this research It was used an imager containing DMEM (Dulbecco's Modified Eagle's Medium) nutrient medium, which traps airborne microorganisms. A high-efficiency indoor air sampling pump (Gil Air Plus Personal air sampler) was used to collect and transfer air samples to the special nutrient medium. Air samples were taken at a distance of 1.5 m from the patient's bed at a height of 1.5 m above the ground for one hour at a flow rate of 4 l/min-1. Pump calibration was performed twice, before and after analysis, using a Gilibrator 2 Wet Cell Calibrator. Samples were transported to the laboratory for real-time reverse transcription polymerase chain reaction (RT-PCR) in a special thermostable bag. In addition, indoor air quality parameters (microclimate factors, amount of dust particles,

carbon (II) oxide concentration, and amount of formaldehyde) were studied simultaneously with sampling.

The samples were immediately transported to the laboratory of the same hospital for SARS-CoV-2 RNA analysis by real-time reverse transcription-polymerase chain reaction (RT-PCR). The analysis was performed using the SARS-CoV-2 nucleic acid detection kit according to the manufacturer's instructions (Bio-Rad, Feldkirchen, Germany). All samples were analyzed according to WHO recommendations.

Statistical analysis: Statistical analysis was performed using SPSS software version 26.0 (SPSS Inc.). The interquartile range distribution was completed in descriptive statistics.

3. Result and Discussion

The virus (COVID-19) appeared suddenly, spread rapidly in all developed and developing countries and caused a worldwide pandemic. In this study, we investigated the quality of viral air in the hospital to determine the possibility of airborne transmission of SARS-CoV-2. In this regard, Table 1 provides specific information about the condition of the indoor environment of hospital rooms and the concentration of particles of different aerodynamic diameters, chemical substances (CO_2, HCHO), microclimate (temperature, relative humidity, and air speed) during bioaerosol sampling. Tables 2 and 3 show the characteristics of air samples (bioaerosols) for the detection of SARS-CoV-2 in hospital room air. As shown in Table 1, there were 62 patients with confirmed COVID-19, ranging from severe and acutely severe to mild. Two out of 100 air samples taken at different locations in hospital wards tested positive for the presence of SARS-CoV-2. Our results contradict those of Faridi et al (2020) in a hospital complex in Tehran, where no positive samples were found among the air samples. Furthermore, Ong et al (2020) reported that airborne transmission of SARS-CoV-2 is not a pandemic causative agent. Moreover, in contrast to the above, Iranian scientists Azra Kenarkuhi et al. (2020) in a scientific study conducted at Shahid Mustafa Khomeini Hospital found SARS-CoV-2 virus RNA in 2 of 14 air samples. In addition, Santarpia et al. (2020) reported the presence of viral RNA in eleven air samples from isolation units and the common room at the University of Nebraska Medical Center. Santarpia et al. (2020) had a small limitation: the distance from the air sampling equipment to the patients' beds was not considered, which could certainly affect the interpretation of the results (Santarpia et al., 2020). Therefore, we took all samples as described above, at a distance of 1.5 m from the patient's bed, 1.5 m above ground level, for one hour. Another experimental study (Van Doremalen et al. (2020)) reported the possibility of aerosol transmission of SARS-CoV-2 in their experiments using a spray laboratory (Van Doremalen et al., 2020). The authors used a Collison nebulizer to create an aerosol and showed that viable SARS-CoV-2 virus could remain in the aerosol for up to 3 hours after spraying.

These results indicated that the role of air in the rapid global spread of SARS-CoV-2 is high (WHO, 2020a). On the other hand, it has been reported that SARS-CoV-2 can survive in virus-infected airborne aerosols for about 3 hours (Morawska and Cao, 2020; Van Doremalen et al., 2020).

Taking this into account, there is a possibility that airborne aerosols of different diameters produced when ingested by a person with COVID-19 may spread different distances depending on their size (large particles further in the external environment, small ones further in the external environment). internal environment (Faridi et al., 2020; Hadei et al., 2020). In another similar study, Liu et al. (2020) reported the aerodynamic properties and concentrations of SARS-CoV-2 aerosol RNA in hospitals in Wuhan, China, during the COVID-19 outbreak, and the resuspension process of viral aerosol on personal protective clothing or floor surfaces was confirmed to be a potential transmission factor. Thus, it has been shown that effective sanitation methods are necessary to minimize the spread of SARS-CoV-2 via aerosols.

Table 3 shows that the minimum duration of ICU treatment for patients is 2 days and the maximum is 9 days. The condition of patients in all 6 wards under treatment was reported to be severe, and the condition of a patient in one ward was extremely severe. According to the PCR-RT examination results, the patient lying near the place where the positive sample was taken was taken to the hospital in an extremely serious condition. Compared to patients in the ICU, the day of admission was significantly shorter, i.e., measurements were performed on the 2nd day after the patient's admission. Kailu Wang et al. in the research work carried out by was aimed at understanding the risk factors associated with the appearance of SARS-CoV-2 through the period when the patients were staying in the isolation wards. In this study found 6.6% of surface samples (133/2031 samples) and 2.1% of air samples (22/1075 samples) were positive, and positivity rates peaked within 2-3 days of admission to the ward.

Thus, according to the above-mentioned studies, hospital room air can be a potential source of SARS-CoV-2 infection, as 3 out of 100 samples tested positive in our study. (Azra Kenarkuhi et al., 2020, Liu et al., 2020; Hadei et al., 2020; Moravska and Cao, 2020).

Disease symptoms (cough, difficulty breathing, talking, etc.) in patients are among the causes that play a major role in the spread of viruses to the internal environment (Faridi et al., 2020). In addition, we propose to use more in-depth analysis methods to quantify viruses detected in the air. Based on the relevance of the research work, it is very important to conduct examinations in all hospital departments. Based on the results, it is possible to develop operational measures to protect the health of health care workers working in the hospital.

Table 1. Indicators of air quality in hospital wards

Hospital departments /total count	Room size m^2	Air samples			Air temp., ℃*	Relative humidity, %	Air speed, m/s	CO_2, ppm	PM_{10}, $\mu g/m^3$	$PM_{2.5}$, $\mu g/m^3$	F**, ppm	Door / Windows	Number of health-care workers/ patients	Ventilation types
		Total samples	A**	B**										
ICU/7	80	70	35/1	35/0	23.6 [21.3-24.9]	32.5 [29.8-36.5]	0.03 [0.01-0.05]	402 [355-408]	55 [39.1-69.4]	37.7 [27.4-49.2]	0.17 [0.13-0.29]	1/4	20/25	mechanical
Wards/13	15	26	13/2	13/0	23.8 [22.6-24.4]	37.1 [33.8-43.5]	0.02 [0.01-0.03]	400 [351-540]	66 [52.9-84.1]	43.4 [33.9-57.3]	0.23 [0.15-0.46]	1/1	17/37	mechanical
Staff room/1	15	2	1/-	1/-	18	47.7	0.04	480	54.6	33	0.08	1/1	2/-	natural
Reception/1	15	2	1/-	1/-	19.24	47.7	0.1	650	75.7	57.8	0.05	1/1/	4/-	natural

* - median with inter quartile rate (IQR), A** – Number of air samples taken before disinfection and positive results, B** - Number of air samples taken after disinfection and positive results,
F** - Amount (concentration) of formaldehyde detected in indoor air.

Table 2. Location of sampling points in the ICU

Number of air samples	Number of health-care workers	Number of patients	Status of patients	Patients treated day (average)	Samples result	Status of patients' use of Personal protective equipment
1	3	3	severe	6	negative *	An oxygen apparatus connected
2	3	6	severe	8	negative	An oxygen apparatus connected
3	2	4	severe, critical	2	positive**	An oxygen apparatus connected
4	3	3	severe	7	negative	An oxygen apparatus connected
5	2	4	severe	8	negative	An oxygen apparatus connected
6	2	4	severe	8	negative	An oxygen apparatus connected
7	5	1	severe	9	negative	An oxygen apparatus connected

*PCR-RT a negative (no virus detected) sample according to the test; **PCR-RT a positive (virus detected) sample according to the results of the test.

Table 3. Location of sampling points in the general wards

Number of air samples	Number of health-care workers	Number of patients	Status of patients	Patients treated day (average)	Status of patients' use of Personal protective equipment	Samples result
1	1	3	Confirmed and mild	8	mask	negative *
2	1	3	Confirmed and mild	9	no mask	negative
3	1	3	Confirmed and mild	5	no mask	positive **
4	0	3	Confirmed and mild	6	mask	negative
5	0	3	Confirmed and mild	7	mask	negative
6	1	2	Confirmed and mild	7	mask	negative
7	3	3	Confirmed and mild	9	mask	negative
8	0	3	Confirmed and mild	8	mask	negative
9	1	2	Confirmed and mild	7	mask	negative
10	0	3	Confirmed and mild	5	mask	positive
11	3	3	Confirmed and mild	6	no mask	negative
12	3	3	Confirmed and mild	8	no mask	negative
13	3	3	Confirmed and mild	9	mask	negative

*PCR-RT a negative (no virus detected) sample according to the test;
**PCR-RT a positive (virus detected) sample according to the results of the test.

REFERENCES

[1] Noorimotlagh, Z., Jaafarzadeh, N., Martínez, S. S., & Mirzaee, S. A. (2021). A systematic review of possible airborne transmission of the COVID-19 virus (SARS-CoV-2) in the indoor air environment. *Environmental research*, *193*, 110612. https://doi.org/10.1016/j.envres.2020.110612.

[2] Guan WJ, Ni ZY, Hu Y, et al. Clinical Characteristics of Coronavirus Disease 2019 in China [published online ahead of print, 2020 Feb 28]. N Engl J Med. 2020; 10.1056/NEJMoa2002032.

[3] van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *N Engl J Med*. 2020; 382(16): 1564-1567. doi:10.1056/NEJMc2004973.

[4] Sohrabi, Catrin et al. "World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19)." *International journal of surgery (London, England)* vol. 76 (2020): 71-76. doi:10.1016/j.ijsu.2020.02.034.

[5] Holshue, Michelle L et al. "First Case of 2019 Novel Coronavirus in the United States." *The New England journal of medicine* vol. 382, 10 (2020): 929-936. doi:10.1056/NEJMoa200119.

[6] Morawska L, Cao J. Airborne transmission of SARS-CoV-2: The world should face the reality. Environ Int. 2020 Jun; 139: 105730. doi: 10.1016/j.envint.2020.105730. Epub 2020 Apr 10. PMID: 32294574; PMCID: PMC7151430.

[7] Faridi, Sasan et al. "A field indoor air measurement of SARS-CoV-2 in the patient rooms of the largest hospital in Iran." *The Science of the total environment* vol. 725 (2020): 138401. doi:10.1016/j.scitotenv.2020.138401.

[8] Ong SWX, Tan YK, Chia PY, et al. Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient. *JAMA*. 2020; 323(16): 1610-1612. doi:10.1001/jama.2020.3227.

[9] Kenarkoohi A, Noorimotlagh Z, Falahi S, et al. Hospital indoor air quality monitoring for the detection of

SARS-CoV-2 (COVID-19) virus. *Sci Total Environ*. 2020; 748: 141324. doi:10.1016/j.scitotenv.2020.141324.

[10] Morawska L, Cao J. Airborne transmission of SARS-CoV-2: The world should face the reality. *Environ Int*. 2020; 139: 105730. doi:10.1016/j.envint.2020.105730.

[11] Wang, Kailu et al. "Risk of air and surface contamination of SARS-CoV-2 in isolation wards and its relationship with patient and environmental characteristics." *Ecotoxicology and environmental safety* vol. 241 (2022): 113740. doi:10.1016/j.ecoenv.2022.113740.