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Original article

SARS CoV-2 Detection and Survival Within the Admission Area of Confirmed Cov-2 Patients; A Multicenter study

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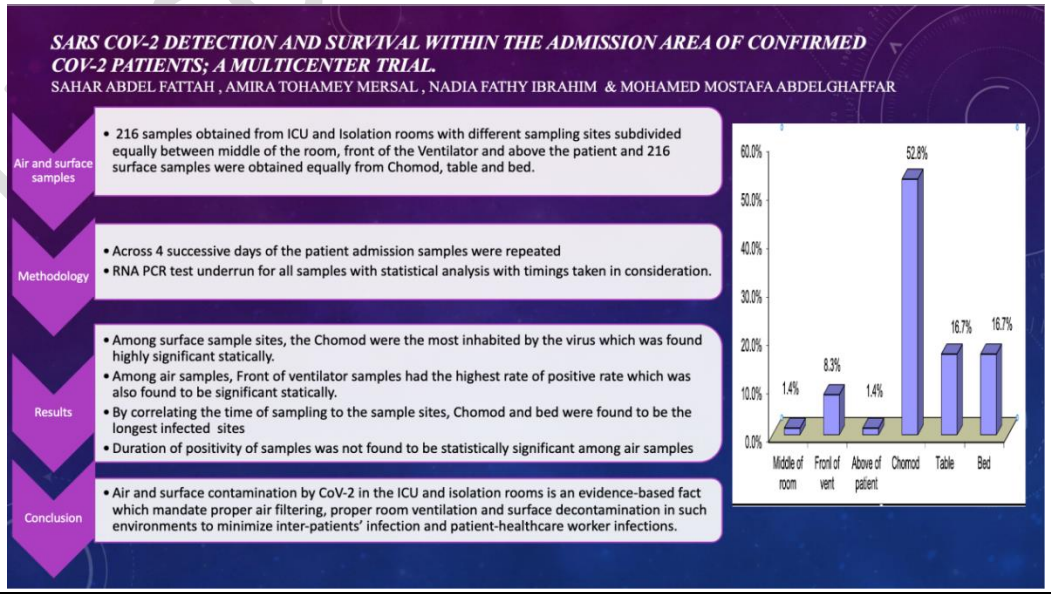
ABSTRACT

The SARS-CoV-2 virus has been one of the most challenging infections in recent times, making surveillance and infection control mandatory. To achieve this, it is essential to understand the particle size distribution in the air, patterns of environmental contamination, and the lifespan of SARS-CoV-2. Better control of the clinical sequelae of SARS-CoV-2 infection can be achieved through more effective infection control measures, which require knowledge of the biochemical kinetics and nature of the virus. To clarify the specific infection sources (air, surface, etc.) and the lifespan of the virus in the working environment, thereby specifying infection control measures and isolation timings, and minimizing nosocomial infections among patients and healthcare workers. Our study is a multicentric observational study performed in Egypt within the General Organization of Teaching Hospitals and Institutes. We obtained 216 air samples and 216 surface samples from Intensive Care Units (ICUs) where SARS-CoV-2 confirmed patients were admitted for four successive days during the period from May 2022 to April 2024. It showed that 208 (96.5%) of the air samples were negative, with only 3.7% testing positive. In the surface samples, 28.7% were positive, while 71.2% were negative. On day 3, 3% of the total samples were positive, increasing to 13% on day 4. The environment around SARS-CoV-2 patients is a potential source of infection transmission for at least four days of admission, necessitating proper surface decontamination, air filtration, and basic infection control measures among patients and healthcare workers.

Graphical abstract



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1. Introduction

Being the nightmare of the century, the extensive study of the SARS-CoV-2 virus and its effects has become essential to improve mortality and morbidity among patients and healthcare workers. The presence and prevalence of SARS-CoV-2 in the healthcare environment have been the subject of numerous studies employing various air and surface sampling methods [1].

High-contact surfaces, including computers, bed rails, and door handles, have been found to contain SARS-CoV-2 RNA. Surface contamination has been detected to varying degrees, ranging from 0.8% to 70%. Air contamination is more prevalent than surface contamination. The level of surface contamination can also differ between ward types; some studies have detected little to no surface contamination in Intensive Care Units (ICUs) but widespread contamination in general wards. In contrast, other studies have reported higher positivity rates within the ICU setting [2].

The studies published so far have not considered the time gap between symptom onset and the sampling date. Most of them relied on the positivity of Reverse Transcription PCR (RT-qPCR) results without correlating it with symptom onset or duration of admission. One of the unanswered questions is whether the infectivity of SARS-CoV-2 depends on the positivity of the RNA Polymerase Chain Reaction (PCR) [3, 4].

Identifying various modes of transmission can have significant implications for prevention, including enhancing cleaning protocols, adapting personal protective equipment, and adding air cleaning treatments to safeguard healthcare workers. Following terminal cleaning, SARS-CoV-2 RNA contamination was highly prevalent on patient room surfaces [5]. The purpose of this trial is to assess the presence of viable virus and the potential for fomite transmission. Additional research is required to achieve this purpose.

2. Methodology

This is a multicentric observational study conducted in Egypt within the General Organization of Teaching Hospitals and Institutes. We obtained 216 air samples and 216 surface samples from Intensive Care Units (ICUs) where SARS-CoV-2 confirmed patients were admitted for four successive days during the period from May 2022 to April 2024. Air samples were collected using an air incubator sampler from the middle of the room, in front of the beds, and in front of the ventilators. PCR swabs were exposed to air samples for one hour. Surface swabs were obtained from commodes, bed bars, and tables within the admission environment. All samples were tested for SARS-CoV-2 RNA using PCR.

Ethically, patients provided fully informed consent to participate. Verbal consent was the form of informed consent utilized in this retrospective study. Data security and confidentiality were ensured for all participants. Participants had the ability to withdraw from the research process at any time and were informed when this would no longer be possible. Additionally, they were able to withdraw their data if it was identifiable to them. Research participants were informed of any anticipated advantages and potential hazards.

Statistically, SPSS v26 (IBM Inc., Armonk, NY, USA) was employed to conduct the statistical analysis. The normality of the data distribution was assessed using the Shapiro-Wilks test and histograms. Qualitative data were analyzed using the Chi-square test or Fisher's exact test when appropriate and were presented as frequency and percentage. The p-value was considered significant if it was less than 0.050; otherwise, it was considered non-significant.

3. Results

The samples obtained during the admission of 20 patients in ICU and isolation rooms, brief Demographic screen shown in Table (1).

Table (1): Gender distribution, duration of stay, number of samples per day

		Total no. = 20
Gender	Female	7 (35.0%)
	Male	13 (65.0%)
N. of days	3 days	8 (40.0%)
	4 days	12 (60.0%)
No. of samples	6 samples/day	14 (100.0%)
Severity	Non severe	8 (40.0%)
	Severe	12 (60.0%)

Table (2): Samples taken from air in the ICU room

		Total No. = 72
Middle of room	Negative	71 (98.6%)
	Positive	1 (1.4%)
Front of vent	Negative	66 (91.7%)
	Positive	6 (8.3%)
Above of patient	Negative	71 (98.6%)
	Positive	1 (1.4%)

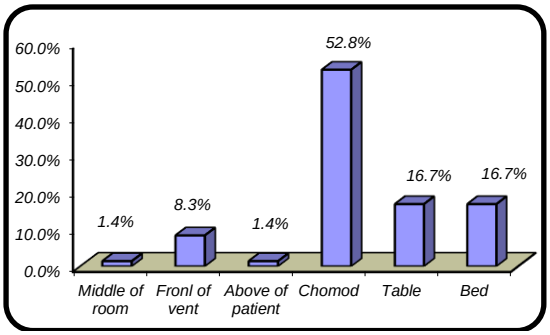

Figure (1): Comparison between surface sites.

For air samples, a total of 216 obtained from ICU and Isolation rooms with different sampling sites subdivided equally between middle of the room, front of the Ventilator and above the patient with 1.4% (n=1), 8.3% (n=4) and 1.4%(n=1) were positive for CoV-2 PCR respectively (Table 2). Among air samples, Front of ventilator samples had the highest rate of positive rate which was also found to be significant statically (Table 5) (Figure 2).

216 surface samples were obtained equally from the nightstands, table and bed where 52.8% (n=38), 16.7% (n=12) and 16.7 % (n=12) were positive for CoV-2 PCR test respectively (table 3). Among surface sample sites, the nightstands were the most inhabited by the virus which was found highly significant statically (Table 4) (Figure 1).

On Comparison, Surface samples had positive rate of 86.1% and 11.1 % positive air samples which was significant statistically (P value = <0.001) (Table 6).

By correlating the time of sampling to the sample sites, Nightstands and bed were found to be the longest habitated sites with 6 and 32 positive nightstands samples at day 3 and 4 respectively (P value = 0.001) while there were 0 and 12 bed positive samples at day 3 and 4 respectively (P value = 0.007). Duration of positivity of samples was not found to be statistically significant among air samples (Table 7).

Table (1): Samples taken from surfaces in the ICU room

		Total no.= 216
Nightstands	Negative	34 (47.2%)
	Positive	38 (52.8%)
Table	Negative	60 (83.3%)
	Positive	12 (16.7%)
Bed	Negative	60 (83.3%)
	Positive	12 (16.7%)

4. Discussion

Studying the transmission of SARS-CoV-2 between patients and healthcare workers is fundamental for minimizing its hazardous effects. In our study, we focused on assessing samples obtained from the peri-patient environment, including air and surfaces, aiming to develop new infection control measures to limit infection spread among patients and healthcare workers.

In the first cohort, we sampled air from various regions of the patient environment to obtain a more conclusive pattern of air contamination. Samples taken in front of the ventilator showed the highest rates of positive results, highlighting the need of protective measures for healthcare workers attending to the ventilator or during close clinical examination. Additionally, we have obtained samples from in front of the patients and the middle of the room which showed insignificant positive results. However, this cannot be considered definitive due to small sample size, but it still underscores the need for proper room ventilation and air filtration in ICUs and COVID-19 admission bays. A systematic review was conducted, including 24 cross-sectional observational studies. In total, 82 of 471 air samples (17.4%) from close patient environments were positive for SARS-CoV-2 RNA. The positivity rate was significantly higher in intensive care unit settings, indicating that the air near and far from patients with COVID-19 was frequently contaminated with SARS-CoV-2 RNA [5]. An additional observational study conducted in single-bed ICU rooms revealed that 76% of 100 surfaces samples and 30% of 40 air samples contained viral RNA environmental contamination. The study also indicated that a high-flow nasal cannula system did not produce more viral aerosolization than a mechanical ventilation system in patients with COVID-19; however, this information was not analyzed in our study [6].

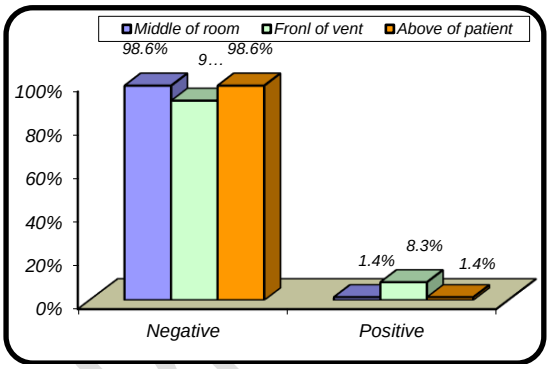

Figure (2): Comparison between air sites.

In the second cohort, we examined surface samples obtained from nightstands, tables and bed bars, which were more frequently contaminated by the virus. This suggested a more cautious approach to handling and disinfecting the peri-patient surfaces. This finding is corroborated by a multi-center study conducted during the initial wave of the COVID-19 outbreak in England, which demonstrated that SARS-CoV-2 RNA was detected on 30 (8.9%) of 336 environmental surfaces with a concomitant low bacterial count. The study concluded that effective cleaning could reduce the risk of fomite (contact) transmission [7]. However, our trial did not investigate the bacterial count, which may be a limitation that can be addressed in future research. A study of environmental SARS-CoV-2 contamination in hospital rooms of patients with acute COVID-19 in France detected SARS-CoV-2 RNA by RT-qPCR in 34%, 12%, 50%, and 10% of surface, air, patient mask, and HCW mask samples, respectively [8]. This provides evidence that airborne aerosols can be source for air contamination as well as solid objects like masks and health care worker clothes and masks. In this context, infection control policies should consider healthcare worker clothing changes and proper decontamination, as well as masks frequent changes between patients and at proposed time intervals, which should be further decided based on evidence.

Table (4): Comparison between surface sites

	Nightstands	Table	Bed	Test-value	P-value	Sig.
Negative	34 (47.2%)	60 (83.3%)	60 (83.3%)	30.586*	<0.001	HS
Positive	38 (52.8%)	12 (16.7%)	12 (16.7%)			

P-value > 0.05: Nonsignificant; P-value < 0.05: Significant; P-value < 0.01: Highly significant
*: Chi-square test.

Studying the duration of the surface contamination showed that surfaces can remain contaminated be up to four days. This requires proper surface disinfection during this period. Since these samples were taken during patient admission, we cannot precisely conclude whether it was a day-one contamination or renewed infection.

Therefore, no specific recommendations could be made regarding the time interval of disinfection or room evacuation between patients. There is scanty literature on this topic, which could be an interesting area for further research.

Table (5): Comparison between air sites

	Middle of room	Front of vent	Above of patient	Test-value	P-value	Sig.
Negative	71 (98.6%)	66 (91.7%)	71 (98.6%)	6.490*	0.039	S
Positive	1 (1.4%)	6 (8.3%)	1 (1.4%)			

P-value > 0.05: Nonsignificant; P-value < 0.05: Significant; P-value < 0.01: Highly significant
*: Chi-square test

Table (6): Comparison between air and surface regarding positivity

	Surfaces	Air	Test-value	P-value	Sig.
Negative	10 (13.9%)	64 (88.9%)	81.063*	<0.001	HS
Positive	62 (86.1%)	8 (11.1%)			

Table (7): Relation between number of days and the sample sites

		No. of days		Test value	P-value	Sig.
		3 days	4 days			
Middle of room	Negative	23 (95.8%)	48 (100.0%)	2.028	0.154	NS
	Positive	1 (4.2%)	0 (0.0%)			
Front of vent	Negative	22 (91.7%)	44 (91.7%)	0.000	1.000	NS
	Positive	2 (8.3%)	4 (8.3%)			
Above of patient	Negative	24 (100.0%)	47 (97.9%)	0.507	0.476	NS
	Positive	0 (0.0%)	1 (2.1%)			
Nightstands	Negative	18 (75.0%)	16 (33.3%)	11.146	0.001	HS
	Positive	6 (25.0%)	32 (66.7%)			
Table	Negative	20 (83.3%)	40 (83.3%)	0.000	1.000	NS
	Positive	4 (16.7%)	8 (16.7%)			
Bed	Negative	24 (100.0%)	36 (75.0%)	7.200	0.007	HS
	Positive	0 (0.0%)	12 (25.0%)			

P-value > 0.05: Nonsignificant; P-value < 0.05: Significant; P-value < 0.01: Highly significant
*: Chi-square test

5. Conclusion

Air and surface contamination by CoV-2 in the ICU and isolation rooms is an evidence-based fact which mandate proper air filtering, proper room ventilation and surface decontamination in such environments to minimize inter-patients' infection and patient-healthcare worker infections. Further studies are needed to clarify duration of isolation and decontamination along with the type of decontamination.

References

1. Chia, P. Y., Coleman, K. K., Tan, Y. K., Ong, S. W. X., Gum, M., Lau, S. K., & Marimuthu, K. (2020). Detection of air and surface contamination by SARS-CoV-2 in hospital rooms of infected patients. *Nature communications*, *11*(1), 2800. doi.org/10.1038/s41467-020-16670-2.
2. Zhou, J., Otter, J. A., Price, J. R., Cimpeanu, C., Garcia, D. M., Kinross, J., & Barclay, W. S. (2020). Investigating SARS-CoV-2 surface and air contamination in an acute healthcare setting during the peak of the COVID-19 pandemic in London. *medRxiv*, 2020-05. doi.org/10.1093/cid/ciaa905.
3. Santarpia, J. L., Rivera, D. N., Herrera, V. L., Morwitzer, M. J., Creager, H. M., Santarpia, G. W., & Lowe, J. J. (2020). Aerosol and surface contamination of SARS-CoV-2 observed in quarantine and isolation care. *Scientific reports*, *10*(1), 12732. doi.org/10.1038/s41598-020-69286-3.
4. Zhang, H. L., Kelly, B. J., David, M. Z., Lautenbach, E., Huang, E., Bekele, S., & CDC Prevention Epicenters Program. (2022). SARS-CoV-2 RNA persists on surfaces following terminal disinfection of COVID-19 hospital isolation rooms. *American Journal of Infection Control*, *50*(4), 462-464. doi.org/10.1016/j.ajic.2022.01.014.
5. Birgand, G., Peiffer-Smadja, N., Fournier, S., Kerneis, S., Lescure, F. X., & Lucet, J. C. (2020). Assessment of air contamination by SARS-CoV-2 in hospital settings. *JAMA network open*, *3*(12), e2033232.doi.org/10.1001/jamanetworkopen.2020.33232
6. Lebreil, A. L., Greux, V., Glenet, M., Huguenin, A., N'guyen, Y., Berri, F., & Andreoletti, L. (2022). Surfaces and air contamination by severe acute respiratory syndrome coronavirus 2 using high-flow nasal oxygenation or assisted mechanical ventilation in intensive care unit rooms of patients with coronavirus disease 2019. *The Journal of Infectious Diseases*, *225*(3), 385-391. doi.org/10.1093/infdis/jiab564.
7. Moore, G., Rickard, H., Stevenson, D., Aranega-Bou, P., Pitman, J., Crook, A., & Bennett, A. (2021). Detection of SARS-CoV-2 within the healthcare environment: a multi-centre study conducted during

the first wave of the COVID-19 outbreak in England. *Journal of Hospital Infection*, *108*, 189-196. doi.org/10.1016/j.jhin.2020.11.024

8. Nagle, S., Tandjaoui-Lambiotte, Y., Boubaya, M., Athenaïs, G., Alloui, C., Bloch-Queyrat, C., & Delagrèverie, H. (2022). Environmental SARS-CoV-2 contamination in hospital rooms of patients with acute COVID-19. *Journal of Hospital Infection*, *126*, 116-122. doi.org/10.1016/j.jhin.2022.05.003.