Non-Respiratory Droplet Transmission of COVID-19 in the Isolation Ward of a Secondary Hospital in Oman

A Return to Isolation Basics

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Front-line health care workers are among the most vulnerable groups at risk for acquiring COVID-19, yet the exact mechanisms of how infections occur in health care settings are yet to be identified.

Objectives: To review the epidemiologic and environmental factors surrounding a cluster of nosocomially acquired COVID-19 cases with possible non respiratory droplet transmission indicating the importance of strict adherence with isolation procedures for patients and staff.

Methods: Contact and environmental investigations were completed to determine the source and possible routes of hospital transmission of COVID-19.

Results: Seven cases of COVID-19 occurred in the COVID-19 isolation ward of a secondary hospital from 12/04/2020 to 01/05/2020. Analysis also included first four COVID-19 patients admitted to this facility. Epidemiologic links included exposure to massive bowel movements of two infected patients in adjoining rooms on the same day. Serious gaps in infection control practices lead to further spread the virus and cross infection between the staff.

Conclusion: Despite preparedness to combat pandemics, the infection control precautions taken at this facility were found not sufficient to prevent nosocomial spread of COVID-19. Issues were identified with compliance, enforcement, and failure to update to the most current guidance. Urgent review of ongoing hygiene and isolation practices in hospitals of this type is indicated. Further studies are required to better understand the role of fecal oral transmission and environmental contamination in the transmission of COVID-19.

Key Words: Oman, COVID-19, HCW, cluster, fecal oral, nosocomial, Health Care Worker

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As of November 8, 2020, the number of total confirmed cases of COVID-19 in Oman was 117 167. Globally, the number of confirmed cases had reached over 49.7 million, with 1.2 million deaths.[1] In 2020, COVID-19 continues to have an exponentially increasing impact globally from various medical, social, economic, and political perspectives.[2] As a novel virus with no known previous infection documented before 2019, much remains uncertain about the infectivity, transmission, and the human immune response.[3,4]

The health systems of all affected countries have been placed under huge stress in terms of preparing and coping with, both suspected and confirmed cases. This situation has been made worse in hospitals where nosocomial infection has occurred, negatively affecting staffing levels. This descriptive report describes once such nosocomial clusters in an isolation ward of a secondary hospital in Oman. The identified weakness in hygiene and isolation procedures are a reminder for strict adherence to current COVID-19 transmission reduction practices, especially those related to the fecal oral transmission and environmental contamination, to control further nosocomial viral spread.

MATERIALS AND METHODS

Study Facility

The cluster was located at a secondary hospital in Rustaq state that serves a population of 431,600[5] people. This facility receives patients from local primary health care providers and through its emergency department. It has 236 beds with a COVID-19 isolation ward of 16 beds, 5 of which are designated for critical care.

Screening and Isolation Procedures

As part of its preparation for the ongoing pandemic, the hospital converted its maternity ward into an isolation ward for the treatment of suspected and confirmed cases of COVID-19. The ward is located at the very end of the hospital, allowing an isolated pathway to the ward for patients referred from within the hospital and from outside. The ward was further divided into two wings, one for the suspected cases and one for the confirmed cases of COVID-19. Appropriate medical and paramedical staff were then assigned to solely work in the isolation section. They were advised to always remain in the ward until the end of their duties, practice hand washing and use respiratory precautions when exposed to the patients. No universal masking throughout the hospital was yet followed.

Patient samples for COVID-19 were sent to the Central Public Health Laboratory (CPHL) in Muscat. The hospital started to test samples using its own laboratory on the 23rd of April 2020, though only selected samples meeting the COVID-19 case definition were included. The hospital followed the case definitions approved by the Ministry of Health: a suspected case was defined as a person with acute respiratory syndrome (which included sudden onset of at least one of the following: fever ≥38 C, cough, shortness of breath, sore throat) and/or a person with pneumonia and/or a patient admitted with a severe acute respiratory infection (SARI) or one who developed a SARI while in hospital.

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Laboratory Methods

COVID-19 was confirmed based on reverse transcriptase polymerase chain reaction (RT PCR) completed in the (CPHL). Respiratory samples, including nasopharyngeal and oropharyngeal swabs, were sent to CPHL in approved national and international viral transport media (VTM, UTM by COPAN, Italy),[6] packed in a triple package set for safety and to enhance recovery of the viral agent. At CPHL, new real time PCR machines introduced and along with the new testing kits (Liferiver, Shanghai, China; Sansure, Changsha China; Kingfisher, Waltham USA; Cobas 6800 Basel Switzerland), some of which also had gained US FDA emergency use authorization (EUA).[7,8] The different RT PCR kits were used to allow the laboratory to target more than a single gene, giving the tests higher sensitivity (71 to 98%) and specificity (90 to 100%).[7–9] Validation of the machines and kits used was done prior to use, and all assays included positive and internal controls to assure test accuracy.

Ethical Considerations

This study was exempt from ethical approval by the institutional research committee, because it was a public health outbreak investigation.

RESULTS

Cases 1, 2, 3 and 4 were the first four confirmed cases ever identified at this facility. They were admitted to the isolation ward on 12th, 17th, 18th and 20th of April. The first patient, Case 1 was a 42 years old male, with no significant past medical history, who developed fever and cough on 7th April and was admitted for two days. The Case 2 was a 68-year-old female with diabetes and hypertension. She presented to the emergency department on 15th April with a two-day history of cough, dizziness, and fever. She was discharged home because she was clinically stable, though her initial COVID-19 test was positive. Two days later, she was returned in worsening condition and was admitted. She died on 23rd May. The Case 3 was a 67-year-old male, who also had history of diabetes and hypertension. He was a contact of the Case 2, and, therefore was tested for COVID-19 on 17th April. The next day his result was positive and he was admitted due to complaints of intermittent chest pain, fever, cough, vomiting and loose stools. He was discharged on 16th May. Case 4 was a 67 years old male, with history of hypothyroidism, and asthma, developed fever, shortness of breath and cough on 15th April, and was discharged from hospital on 2nd May.

Subsequently cases began to occur among health care workers (HCWs). The first HCW, Case 5, was diagnosed on the 22nd of April, followed by five other HCWs cases: One doctor and three nurses, along with a custodian from the ward. It is worth mentioning, that until this cluster had happened, there was no requirement to wear the masks in the hospital nor in the isolation ward outside patient rooms. Masking was only recommended when dealing with suspected or confirmed patients with COVID-19.

After diagnosing the second HCW, the hospital administrator requested support from the public health department to control the cluster through a thorough investigation.

The onset of symptoms for the first diagnosed HCW (Case 5) occurred on 20th April. This was a female nurse reporting job stress while working on the COVID-19 ward. She was suffering from severe anxiety, according to her colleagues who noted behaviours such as wearing three sterile gloves at once, using double masks, and donning full sterile gear when it was not required by the hospital's infection control procedures. She had night shifts on the 17th and 18th of April. She was assigned to take care of the Cases 2 and 3; this was her first exposure to laboratory confirmed COVID-19 patients.

Early in the morning of 19th April, both her patients (Cases 2 and 3) suddenly developed excessive diarrhoea, particularly the male patient. They were in separate but neighbouring rooms, and one HCW was assigned to manage both patients, while all respiratory isolation precautions were in place. They both had increased frequency and fecal urgency, to the extent that the second patient released a profuse amount of loose stool that spilled over a large area of the bed and floor. Shortly thereafter, this patient's respiratory status rapidly deteriorated and required full ventilatory support that afternoon.

HCWs began to develop symptoms the next day. The Case 5 developed cough and sore throat. Next, a housekeeper (Case 6) and two other staff nurses on the COVID-19 ward (Cases 7 and 8), who had assisted the housekeeper in the clean-up of the profuse diarrheal episode mentioned above, developed symptoms on the 27th, 26th and 23rd of April, respectively. These HCWs were subsequently laboratory confirmed with COVID-19. The housekeeper was admitted for 2 days. The remaining physician (Case 9) and the fourth nurse in this cluster (Case 10) showed symptoms on the 24th and 26th of April, respectively. These two HCWs had not participated in clean up; however, they were both exposed to already-infected staff because masking was not required on the Ward outside patient room. Specifically, they had unprotected exposure several times on that day during their discussion in the ward with the ventilation nurse specialist (Case 8) and while having their break together.

Case 11 in this cluster was an 80-year-old female with diabetes, hypertension, and ischemic heart disease, who was already bed ridden. She was admitted with chief complaint of dyspnoea on 17th April. Though she had no history of fever or other upper respiratory tract symptoms, she was considered a suspect case. She was roomed next to the second and third patients from 18th to 20th April on the COVID-19 ward. Since her admission COVID-19 test from the 18th April was negative, she was transferred from the COVID-19 ward to the female general medical ward where she remained until 22nd April. Six days after discharge she developed a rhinorrhoea, cough, headache, and shortness of breath. Her second COVID-19 test was positive. Thus, she was readmitted on 1st May and died on 9th May.

This patient was linked to the cluster, because the only remarkable epidemiological exposure she had was during her first admission with a number of above mentioned HCWS (Cases 9 and 10) and especially the housekeeper (Case 6).

The two HCWs (case 8 and 9) and the patient (case 11) from the hospital cluster resulted in six cases among family contacts, while patients (case1,2,3 and 4) resulted in an additional 12 cases among family contacts.

There were several major gaps in the practice of infection control in the ward, which may have led to this chain of infection. Some of the staff assigned to the COVID-19 ward had no previous experience in caring for patients with communicable diseases. There was no required staff training specific to COVID-19 or infection control, in general. The ward was congested including the corridor with a lot of staff and computer desks, some unnecessary staff such as the security guard were allowed to use the staff changing room within the ward. There was easy and unmonitored movement of the staff within the ward with no reminders nor special precautions required when moving between patients in the same ward. Waste containers containing used masks etc. were full and open. Dedicated spillage kits for large biohazard clean up were not available in the ward.

A total of 40 hospital staff were exposed to these cases when they had insufficient protection and were furloughed for 14 days

on home-isolation. Following the investigation, no additional cases were diagnosed in relation to this cluster.

Figure 1 demonstrates the distribution of the cases among the HCWs and patients by date of onset and duration of admission.

DISCUSSION

We reported the first report nosocomial and possibly non-respiratory transmission cases of COVID-19 among HCWs in Oman and the Gulf Cooperation Council and at the time of this cluster, few cases had been reported elsewhere.[10–12] A more recently published study from Oman found that majority 61.3% (n=125) of HCWs infections had occurred from the community, followed by hospital acquired infections 25.5% (n=52), while those with no source identified were 13.2% (n=27).[13]

The four cases (Cases 1-4) admitted before the nosocomial transmission that resulted in symptomatic HCW were the first ever COVID-19 patients admitted to this facility. It is unlikely that the first admitted patient was the source of this cluster, because none of the health care workers who developed the disease were exposed to him except for the physician who examined him only once on 14th April, while he developed symptoms 10 days later. Since this patient remained in an isolation room, with acceptable respiratory precautions being followed and no exposures to bodily fluid to or from this patient occurred, it seems unlikely this patient (Case 1) was the source[13,14] and, likewise, for the patient (Case 4).

The second and third patients admitted (Cases 2 and 3) were the likely sources of transmission in the ward. These infections could have occurred through direct respiratory transmission; however, the unexpected and excessive loose bowel movement produced by both patients in the early morning of 19th April made contact with infected bodily fluid equally possible. Their assigned nurse was terrified of working on the COVID-19, and in addition to the sudden stress imposed by two patients requiring urgent care, her attention may have been diverted from other important procedures like thorough handwashing for 20 second. Indeed, COVID-19 itself is considered an independent risk factor for the stress among HCWs.[15]

The amount of the watery stool allowed to seep onto the beds and floors was excessive, and a great deal of time had to be spent cleaning the area. A large area of the environment and the patients' surroundings were thus contaminated for quite a long time. Two nurses assisted the housekeeper in the cleaning up of the stool, but the housekeeper herself was neither fully aware nor sufficiently experienced or trained in the necessary infection control practices. She was also involved for the routine cleaning of the entire ward where all four staff directly involved in this episode became infected.

Case 11 most likely acquired the infection from the ward during her admission to the COVID-19 ward as a suspected case which overlapped the diarrheal episode on the 19th. The housekeeper may have distributed the infection to other rooms while cleaning them or while removing the waste containers. She may, however, have acquired the infection through contact with any infected pre-symptomatic HCWs.

While it is possible that the infections could have originated from an exposure in the community rather than the hospital, the epidemiological investigation done for each case of this cluster did not reveal alternative exposure to known cases in the community. In addition, since it was still early in the pandemic in Oman, the number of cases in the community were still limited to few clusters and all were under the surveillance and control of the regional public health authority. Thus, the epidemiological linkages presented for this cluster are the best available explanation for transmission in the cluster in the in the absence of genome sequencing.

While not considered a main source of transmission for COVID-19, there is evidence that to suggest contaminated fomites may have played a role in this cluster. The environment, especially the floor and the patients' surroundings, were grossly contaminated with stool. Since SARS-CoV-2 virus may be persistently shed in the stool for more than a month, stool itself may have been transferred by the housekeeper to other areas of the ward such as the staff changing room, the work tables and laptops, and the nursing stations. Earlier studies from China have raised the alert of the possibility of transmission through fecal oral route. In one of them, it was found that almost 53% of patients tested positive for SARS-CoV-2 RNA in stool, while 23.29% continued to show positive results in stool, when the respiratory samples were negative.[16] In a meta-analysis, the pooled prevalence of positive stool samples with viral RNA was 48.1% (95% CI, 38.3–57.9), whereas, 70.3% of them remained positive after respiratory clearance.[17] Studies have also demonstrated how the virus shed in the stool could also lead to large contamination in the environment.[18] Environmental samples, for instance, were collected for a COVID-19 patient in Singapore who was admitted with symptoms of cough but no diarrhoea, had 2 positive stool samples for SARS-CoV-2 by RT-PCR. Results were positive for 13 of 15 room sites (including air outlet fans) and 3 of 5 toilet sites (toilet bowl, sink, and door handle), while the anteroom and corridor samples were negative.[19]

Fomites have played a significant role in the nosocomial transmission of other corona viruses.[20,21] A recently published study found that the coronavirus particle may remain viable up

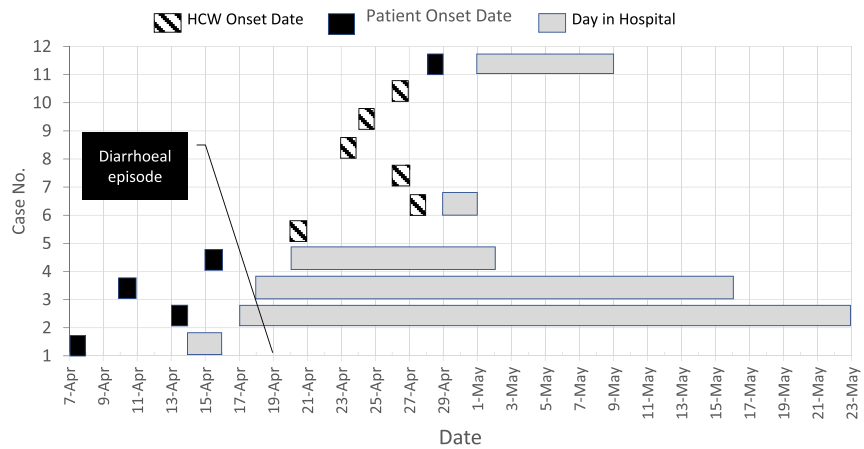

FIGURE 1. Distribution of the cases among the HCWs and patients by date of onset and duration of admission.

to 9 days on the inanimate surfaces at room temperature depending on their composition.[22]

Although the exact contribution of hand hygiene in the reduction of COVID-19 transmission has not been proved yet, certain laboratory data and experiences, have shown that SARS-CoV-2 can be inactivated using the alcohol-based hand rub (ABHR) provided that alcohol concentration is within the acceptable range (60%-95%).[23–25] It is equally important to consider hand washing with water and soap for at least 20 seconds, especially when hands are visibly soiled before eating or after using the restroom.[26] It is also possible in this scenario and especially with the unstrict infection control measures, lack of experiences in dealing with COVID-19, and the growing stress of the staff, that careful and thorough hand washing was not properly performed. Again, some of the staff may have also had contaminated their clothes not only their hands, leaving some moist areas on their clothes. This may require them to have full shower, and change their clothes, and PPEs to ensure full decontamination.

It is also important to mention, that other HCWs could had been infected but remained asymptomatic. Screening hospital staff for asymptomatic infections was not practicable here. However, a study conducted in a large tertiary hospital in Egypt found the frequency of positive tests was more among subjects with minor symptoms (50%) compared to completely asymptomatic HCWs (16.1%).[27]

Immediate and serious control measures were taken to correct the obvious lapses of infection control, including full fumigation of the whole isolation ward using hydrogen peroxide. With exception of the corridor in the isolation ward for both the suspected and confirmed wings, other areas including; toilets, staff changing rooms, and patients' rooms were fumigated by trained staff. This important and critical procedure along with immediate isolation of infected HCWs and their contacts seemingly worked well to stop further transmission. The prompt disinfection and cleaning of potentially contaminated surfaces were also recommended upon detection of infected SARS-CoV-2 virus on patients' surroundings in Korea.[28] A recently published study has also demonstrated that hydrogen peroxide acts as an efficient disinfectant in health care settings; however, it requires well-trained technical staff for effective use, and it can cause eye and nose irritation at high concentrations. As a result, there is time required following disinfection before a room can be used again.[29]

The chain of infection in this case was identified as extending to 18 additional contacts of the infected HCWs to their families. It is also suggested that the cycle of transmission between the hospital and the community be interrupted by establishing what is known as enhanced control traffic bundling (eTCB), which has proved its effectiveness in countries such as Taiwan.[30]

It is always important to adopt a holistic and systematic approach in the epidemiological investigations of the cases by looking into unusual routes of transmission of such viruses especially during the current pandemic, however, it is more important either to return to the basics of common routes of transmission such as respiratory droplets.

As a case series this investigation was limited by the lack of a comparison group and small sample size preventing multivariate analysis of risk factors. However, the findings were consistent with other published investigations.

CONCLUSIONS

The hospital appears to have been insufficiently prepared to deal with cases of COVID-19, especially those with gastroenteric symptoms where transmission by droplets and fomite contamination were occurring. Increasing training among frontline HCWs and other hospital staff not involved in direct patient care and ensuring adherence to the infection control guidelines are the major areas for improvement. This pandemic has shown the absolute need for continuous reinforcement of basic of the infection control.

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REFERENCES

1. Weekly epidemiological update - 10 November 2020. Accessed November 16, 2020. https://www.who.int/publications/m/item/weekly-epidemiological-update—10-november-2020.
2. Gupta M, Abdelmaksoud A, Jafferany M, et al. COVID-19 and economy. *Dermatol Ther*. Published online April 8, 2020. doi:10.1111/dth.13329.
3. Hui DS, I Azhar E, Madani TA, et al. The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health - The latest 2019 novel coronavirus outbreak in Wuhan, China. *Int J Infect Dis*. 2020;91:264–266.
4. Weston S, Frieman MB. COVID-19: knowns, unknowns, and questions. *mSphere*. 2020;5(2):e00203–e00220, /msphere/5/2/mSphere203-20.atom. doi:10.1128/mSphere.00203-20.
5. Population - data Portal. Accessed November 16, 2020. https://data.gov.om/amxduh/population.
6. Products. Accessed November 16, 2020. https://products.copangroup.com/.
7. Yap JC-H, Ang IYH, Tan SHX, et al. COVID-19 science report: diagnostics. Published online February 27, 2020. doi:10.25540/E3Y2-AQYE.
8. In-depth: 32 FDA-approved COVID-19 testing kits. Published April 23, 2020. Accessed June 25, 2020. https://hitconsultant.net/2020/04/23/in-depth-32-fda-approved-covid-19-testing-kits/
9. Watson J, Whiting PF, Brush JE. Interpreting a COVID-19 test result. *BMJ*. 2020;369:m1808. doi:10.1136/bmj.m1808.
10. Wei XS, Wang XR, Zhang JC, et al. A cluster of health care workers with COVID-19 pneumonia caused by SARS-CoV-2. *J Microbiol Immunol Infect*. 2021;54: –. Published online April 27, 2020. doi:10.1016/j.jmii.2020.04.013.
11. Wee LE, Sim XYJ, Conceicao EP, et al. Containment of COVID-19 cases among healthcare workers: The role of surveillance, early detection, and outbreak management. *Infect Control Hosp Epidemiol*. 2020;41(7):765–771.
12. Piapan L, De Michieli P, Ronchese F, et al. COVID-19 outbreak in healthcare workers in hospitals in Trieste, North-east Italy. *J Hosp Infect*. 2020;106(3):626–628.
13. Al Maskari Z, Al Blushi A, Khamis F, et al. Characteristics of healthcare workers infected with COVID-19: A cross-sectional observational study. *Int J Infect Dis*. 2021;102:32–36.
14. Linton NM, Kobayashi T, Yang Y, et al. Incubation Period and Other Epidemiological Characteristics of 2019 Novel Coronavirus Infections with Right Truncation: A Statistical Analysis of Publicly Available Case Data. *J Clin Med*. 2020;9(2):538.
15. Backer JA, Klinkenberg D, Wallinga J. The incubation period of 2019-nCoV infections among travellers from Wuhan, China. *medRxiv*. Published online January 30, 2020:2020.01.27.20018986. doi:10.1101/2020.01.27.20018986.
16. Spoorthy MS, Pratapa SK, Mahant S. Mental health problems faced by healthcare workers due to the COVID-19 pandemic–A review. *Asian J Psychiatry*. 2020;51:102119.
17. Xiao F, Tang M, Zheng X, et al. Evidence for gastrointestinal infection of SARS-CoV-2. *Gastroenterology*. 2020;158(6):1831–1833.e3.
18. Cheung KS, Hung IFN, Chan PPY, et al. Gastrointestinal Manifestations of SARS-CoV-2 Infection and Virus Load in fecal Samples From a Hong Kong Cohort: Systematic Review and Meta-analysis. *Gastroenterology*. 2020;159(1):81–95.

19. Persistence, transmission, and infectivity of SARS-CoV-2 in inanimate environments. *Elsevier Enhanced Reader*. doi:10.1016/j.cscee.2020.100047
20. 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.
21. Gupta S, Parker J, Smits S, Underwood J, Dolwani S. Persistent viral shedding of SARS-CoV-2 in faeces—a rapid review. *Infectious Diseases (except HIV/AIDS)*; 2020. doi:10.1101/2020.04.17.20069526
22. Chen Y-C, Huang L-M, Chan C-C, et al. SARS in Hospital Emergency Room. *Emerg Infect Dis*. 2004;10(5):782–788. doi:10.3201/eid1005.030579.
23. Kampf G, Todt D, Pfaender S, et al. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *J Hosp Infect*. 2020;104(3):246–251. doi:10.1016/j.jhin.2020.01.022.
24. Kratzel A, Todt D, V'kovski P, et al. Inactivation of severe acute respiratory syndrome coronavirus 2 by WHO-recommended hand rub formulations and alcohols. *Emerg Infect Dis*. 2020;26:1592–1595. doi:10.3201/eid2607.200915.
25. Siddharta A, Pfaender S, Vielle NJ, et al. Virucidal Activity of World Health Organization–Recommended Formulations Against Enveloped Viruses, Including Zika, Ebola, and Emerging Coronaviruses. *J Infect Dis*. 2017;215(6):902–906. doi:10.1093/infdis/jix046.
26. CDC. Coronavirus disease 2019 (COVID-19). Centers for Disease Control and Prevention. Published February 11, 2020. Accessed November 25, 2020. https://www.cdc.gov/coronavirus/2019-ncov/hcp/hand-hygiene.html.
27. Kassem AM, Talaat H, Shawky S, et al. SARS-CoV-2 infection among healthcare workers of a gastroenterological service in a tertiary care facility. *Arab J Gastroenterol*. 2020;21(3):151–155. doi:10.1016/j.ajg.2020.07.005.
28. Lee S-E, Lee D-Y, Lee W-G, et al. Detection of Novel Coronavirus on the Surface of Environmental Materials Contaminated by COVID-19 Patients in the Republic of Korea. *Osong Public Health Res Perspect*. 2020;11(3):128–132.
29. Humayun T, Qureshi A, Al Roweily SF, et al. Efficacy of hydrogen peroxide fumigation in improving disinfection of hospital rooms and reducing the number of microorganisms. *J Ayub Med Coll Abbottabad*. 2019;31(suppl 4):646–650.
30. Yen MY, Schwartz J, Chen SY, et al. Interrupting COVID-19 transmission by implementing enhanced traffic control bundling: Implications for global prevention and control efforts. *J Microbiol Immunol Infect*. 2020;53(3):377–380.