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ORIGINAL ARTICLE

Intubation amidst COVID-19: how mask protocols and communication impact SARS-CoV-2 transmission among medical staff

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Abstract

Objective: To describe the sequence of (Severe acute respiratory syndrome corona virus 2) infection following endotracheal intubation in Coronavirus disease 2019 patients.
Design: A retrospective case series study. This analysis focuses on cases involving hospital medical staff who contracted SARS-CoV-2 after performing endotracheal intubation on a COVID-19 patient on August 2, 2021, at Hoan My Thu Duc Hospital, a private hospital treating COVID-19 patients in Vietnam. The participants were 13 medical staff members involved in aerosol-generating procedures.
Results: The infection spread to eight healthcare workers directly involved in emergency intubation. Five were suspected of contracting SARS-CoV-2 immediately following the emergency treatment of COVID-19 patients, and three were infected via transmission from their colleagues. The improper fit of N95 masks and failure to wear them during interpersonal communication were identified as significant risk factors.
Conclusions: The research underscores the critical need for proper N95 mask fit during aerosol-generating procedures. Healthcare professionals treating COVID-19 patients must consistently use masks when communicating with colleagues, even outside of work hours, to curb the spread of SARS-CoV-2 among medical staff.

Keywords: *COVID-19; SARS-CoV-2; endotracheal intubation; epidemiology; medical staff*

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Commencing on July 29, 2021, the Hoan My Thu Duc Hospital initiated the admission and medical management of patients infected with SARS-CoV-2, commonly known as COVID-19. By the early days of August 2021, the medical facility had accommodated and provided treatment for approximately 100 COVID-19 patients. It is noteworthy that all members of the hospital's healthcare staff had been fully vaccinated and received both doses of the COVID-19 vaccine, prior to August 2, 2021. This scholarly inquiry aims to scrutinize specific risk behaviors that may contribute to SARS-CoV-2 transmission among vaccinated healthcare workers. This study is particularly concerned with a nosocomial transmission chain of SARS-CoV-2 among healthcare professionals who were involved in the medical management of a critical COVID-19 patient. This patient experienced cardiac arrest and respiratory failure, necessitating cardiopulmonary resuscitation (CPR) and endotracheal intubation. These clinical events occurred within the premises of Hoan My Thu Duc Hospital, located in Ho Chi Minh City, Vietnam. The objective of this study is to describe the sequence of SARS-CoV-2 infection following endotracheal intubation in COVID-19 patients. This analysis aims to provide insights and lessons for managing future respiratory infectious diseases.

Background

The new coronavirus (SARS-CoV-2) belongs to the family of coronaviruses and can cause mild symptoms (such as the common cold) to more severe conditions, such as progressive acute respiratory distress, which threatens the lives of patients (1). As of early August 2021, more than 204 million people worldwide had been infected with SARS-CoV-2, and over 4.3 million deaths had been recorded, becoming a serious global health burden, with

some studies reporting more than 50 long-term consequences after COVID-19 (2, 3). The SARS-CoV-2 virus is transmitted directly from person to person through respiratory droplets, aerosols, and contact transmission.

In hospitals treating COVID-19 patients, healthcare workers who directly care for patients are at a 10 times higher risk of contracting COVID-19 than the general population (4, 5). Particularly, workers performing breathing procedures such as non-invasive ventilation (NIV), high-flow nasal cannula oxygen therapy (HFNC), and endotracheal intubation for patients are at increased risk of COVID-19 infection (6). Performing endotracheal intubation is a factor that increases the risk of COVID-19 infection in healthcare workers, with an RR of 1.34; 95% CI: 1.14–1.57 (7). In addition to frequently caring for patients and performing breathing procedures, some reasons leading to an increased risk of infection in healthcare workers are prolonged exposure to infected individuals, poor adherence to infection control measures, inadequate mask-wearing, improper hand hygiene, inadequate social distancing, and the ineffective use of personal protective equipment (PPE), which can also contribute to the transmission of the virus (8, 9).

Hoan My Thu Duc International General Hospital, located in Thu Duc City, Ho Chi Minh City, Vietnam, became a critical facility during the COVID-19 pandemic. In August 2021, the hospital was converted into a dedicated COVID-19 treatment center to help manage the surge in cases. This transformation allowed the hospital to treat up to 200 COVID-19 patients, providing essential care during a significant outbreak. The hospital's efforts in managing COVID-19 included strict infection control procedures, advanced medical equipment, and a dedicated team of healthcare professionals. This response significantly alleviated the burden on public healthcare facilities during the peak of the pandemic.

Methods

Study population

Using administrative management records, employee work schedules, and hospital CCTV footage, the research team identified all healthcare workers who participated in the care of a COVID-19 patient, D.T.L., during the patient's hospitalization from August 1, 2021 to August 2, 2021. Additionally, those who had close contact with these healthcare workers were included in the study.

Inclusion criteria: Healthcare workers who tested positive for SARS-CoV-2 by real-time-Polymerase Chain Reaction diagnostic test on August 5, 2021.

Exclusion criteria: Healthcare workers who tested negative for SARS-CoV-2 by real-time-PCR diagnostic test on August 5, 2021.

Study methods

The study design is a case series description, and the sample size is 13 healthcare workers and a patient D.T.L.

Data Collection Tools: A structured questionnaire was used to capture data on the healthcare workers' care processes, interactions with the patient D.T.L., and interactions with colleagues from August 1 to August 5, 2021. Additionally, details on the diagnostic and treatment trajectory of D.T.L., presumed to be the primary source of SARS-CoV-2 transmission, were recorded. Key data included clinical tests, emergency care timing, and outcomes. This study also collected information on demographics, occupation, Body Mass Index, risk-associated behaviors, location during exposure, vaccination dates and side effects, SARS-CoV-2 test outcomes, and Ct values (if positive) from the 13 healthcare workers involved in D.T.L.'s care from August 2 to August 30, 2021. Their personal assessments of transmission risk situations were also solicited. Upon detection of SARS-CoV-2, affected healthcare workers were promptly isolated and treated. Immediate contact tracing was initiated. All personnel in contact with the infected individuals or involved in direct patient care, including intubation, were monitored for 28 days post August 2, 2021.

SARS-CoV-2 real-time-PCR testing

Specimens for Real-time-PCR testing comprised single samples of pleural fluid and sputum, collected in line with the Vietnamese Ministry of Health's guidelines. Initial sampling began on August 5, 2021 and continued every 2–3 days until SARS-CoV-2 results were negative. The tests were conducted at the Hoan My Thu Duc Hospital using the abGenix system from AIT Biotech and the REALTIME PCR SACYCLER-96 machine from Sacace Biotechnologies, with the ONE-STEP RT-PCR COVID-19 KIT THAI DUONG as the testing reagent.

Data processing and analysis

We used Microsoft Excel 2019 software to manage and analyze the data. We collected health examination and vaccination information of the study participants from the employee health records stored at their respective hospitals. Additionally, we conducted in-depth interviews to inquire about their exposure to others. We also extracted camera footage from appropriate locations and common areas to verify the participants' contact history. Furthermore, we gathered residency information and agency vehicle usage times to identify off-duty contact patterns of the participants. For variables such as age, BMI, Ct value, time between the two vaccine doses, and the time from receiving the second dose to the occurrence of the risky situation (on August 2, 2021), we reported the mean, median, minimum, and maximum values. For categorical variables such as gender and occupation,

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we reported the frequency and proportion. This study included interviews with healthcare workers to document their risky behaviors related to SARS-CoV-2 infection.

Research ethics

The patient's information was collected from the patient's medical record, which ensured that the patient's personal information could not be identified, ensuring research ethics principles. The information on the contact status of healthcare workers was obtained through the hospital's routine investigation activity, could not identify individuals, and was obtained with the consent of the healthcare workers. The study had minimal risk to the research subjects.

Results

Detection of transmission chains

On August 5, 2021, Hoan My Thu Duc hospital conducted regular SARS-CoV-2 testing for its staff. Among the staff who were tested, the hospital identified 10 healthcare workers with positive real-time-PCR results for SARS-CoV-2. Of these, a transmission chain involving eight staff members was identified, related to an emergency endotracheal intubation case 4 days prior (on August 2, 2021), including five staff members directly involved in the care of the COVID-19 patient and three staff members who had close contact with these five staff members.

Source of transmission (Patient 1)

Patient D.T.L. was admitted to the Hoan My Thu Duc Hospital on August 1st, 2021, with symptoms of cough and shortness of breath. After screening and SARS-CoV-2 testing, the results showed that the patient was positive for SARS-CoV-2 by real-time RT-PCR with a Ct value of < 30. The patient was diagnosed with severe pneumonia caused by SARS-CoV-2, accompanied by type 2 diabetes and hypertension.

Table 1. Characteristics of healthcare workers (n = 8)

	SARS-CoV-2 positive (n = 8)
Age	
Mean	29.8
Median	27.5
Min-Max	23–43
Gender (male)	1 (12.5%)
BMI	
Mean	20.9
Median	20.0
Min-Max	16.4–26.3
Occupation	
Doctor	3 (37.5)
Nurse	5 (62.5)

At 2:00 a.m. on August 2nd, 2021, the patient stopped breathing and had no pulse. The medical staff called the emergency team urgently. The emergency team arrived and provided resuscitation, including CPR, intubation, and manual ventilation. The emergency group and anesthesiologist placed the patient on a ventilator. During the resuscitation, the patient had a lot of respiratory secretions, and the emergency team had to suction them continuously. At 4:43 a.m. on the same day, the patient was transferred to the Intensive Care Unit for continued resuscitation and mechanical ventilation. However, at 5:00 a.m. on the same day, the patient had cardiac arrest and died.

Risk of infection exposure

During the entire process of treating the patient in the General Internal Medicine and Emergency Intensive Care Unit, there were 13 healthcare workers involved, of whom five were infected with SARS-CoV-2. Subsequently, three healthcare workers were infected with SARS-CoV-2 as a result of sharing living spaces and resting with the five healthcare workers directly involved in the patient's emergency treatment. Of the five healthcare workers infected with SARS-CoV-2 during the patient's emergency treatment, one doctor performed intubation (referred to as N.T.N.B., encoded as SA1); two healthcare workers used an Ambu bag to assist the patient's breathing (P.T.T. and N.T.T.Y., encoded as SA2 and SA3, respectively); one healthcare worker administered adrenaline (N.T.T.T., encoded as SA4); and one healthcare worker suctioned respiratory secretions, removed the endotracheal tube, and changed the patient's clothes after their death (B.T.H., encoded as SA5).

Doctor SA1 was in charge of the patient's emergency care team and had the longest exposure time to the patient, from the time of the patient's emergency care until his/her death. SA1 performed intubation and conducted chest compressions on the patient while transferring them from the general hospital ward to the Emergency Intensive Care Unit. After the patient's death, SA1 continued to provide counseling to the patient's family and completed the medical record for the patient D.T.L. and other patients until the end of their shift. Another doctor, N.T.D. (encoded as SB1), was an intensive care anesthesiologist who also participated in the intubation procedure but was only confirmed to have COVID-19 on August 5th, 2021.

P.T.T. and N.T.T.Y. (SA2 and SA3) were two healthcare workers who took turns using an Ambu bag to assist the patient's breathing, with an average bagging time of approximately 10–15 min per session and 2–3 sessions per patient during the emergency care period. SA2 and SA3 stood near the patient's airway while using the Ambu bag.

Both healthcare workers were confirmed to be infected with SARS-CoV-2 on August 5th, 2021, with Ct values of 37.8 and 36.5. However, both healthcare workers tested negative for SARS-CoV-2 two days later on August 7th, 2021, and remained negative for at least 28 days thereafter. In addition to SA2 and SA3, N.T.Y.H. (SB2) also participated in assisting with the Ambu bag but tested negative for SARS-CoV-2 on August 5th, 2021, and remained negative for at least 28 days thereafter.

N.T.T.T. (SA4) was a nurse who participated in emergency care, established an IV line for the patient, and administered adrenaline directly to the patient throughout the entire emergency care period, approximately 45 min. SA4 stood near doctor SA1 and was in continuous close contact with the patient's airway, without any substitutes. SA4 was also part of the team that transferred the patient to the Emergency Intensive Care Unit. SA4 was confirmed to be infected with SARS-CoV-2 on August 5th, 2021.

B.T.H. (SA5) is a nurse who participated in the process of emergency care for the patient and performed sputum aspiration during the emergency care, thus posing a risk of exposure to respiratory secretions of the patient. In addition, SA5 also performed electrocardiography, endotracheal intubation, changed clothes for the patient, and replaced the bed sheets when the patient was declared dead. SA5 tested positive for SARS-CoV-2 with a Ct value of 23.3, the lowest among the staff members detected on August 5th, 2021. The person who shared the hotel room with SA5 did not contract SARS-CoV-2 on August 5th, 2021, or at least 28 days thereafter.

D.V.D., N.T.D.L., and H.P.T.H. (coded as SA6, SA7, and SA8, respectively) are healthcare workers who did not directly participate in the emergency care of the patient, D.T.L. SA6 is a physician who directly examined and treated the patient D.T.L. before the cardiac arrest and respiratory arrest occurred on the morning of August 2nd, 2021. SA7 and SA8 are two employees in the infection control department who did not directly participate in the emergency care of the patient D.T.L. However, SA7 had contact with many other healthcare workers during the rest period between work shifts, including physician SA6. SA8 shared a hotel room with SA7 from before August 2nd, 2021, until August 5th, 2021. The staff members SA6, SA7, and SA8 did not have any other situations of exposure to SARS-CoV-2.

Use of PPE

All healthcare workers wore PPE, including gloves, N95 masks, protective eyewear, protective clothing, and shoe covers when in contact with patients. The healthcare workers used N95 masks provided by the hospital according to the hospital's instructions. However, some healthcare workers who participated in the emergency care of the patient D.H.L. did not wear masks tightly due to the urgent situation and lack of familiarity with wearing protective clothing.

There were three healthcare workers who tested positive for COVID-19 (SA6, SA7, and SA8) who did not directly participate in the emergency care of the patient D.H.L. but were still identified as infected with SARS-CoV-2 in the test on August 5th, 2021. These three cases were identified as transmission of SARS-CoV-2 among healthcare workers during communal activities due to incomplete compliance with preventive measures. From August 2nd, 2021, to August 5th, 2021, these three healthcare workers lived in the hospital's cafeteria with five staff members in the emergency care group for the patient D.H.L. (SA1 to SA5). During the rest period between night shifts, SA7 drank water without wearing a mask near the area where many other healthcare workers passed by, sat at the same table with SA8, and discussed work with SA6. Additionally, because SA7 and SA8 shared a hotel room for hospital staff, the risk of transmission between these two staff members was increased.

Recovery after contracting COVID-19

In our study, all eight healthcare workers who tested positive for COVID-19 recovered without severe complications and resumed work. Six had high Ct values, suggesting a substantial viral load, while nurse SA5 and doctor SA1 had lower Ct values of 23.3 and 26.0, respectively. Notably, SA5, with the lowest Ct value, took the longest to test negative at 22 days post-detection, potentially due to the initial high viral load. Meanwhile, doctor SA1, who performed an aerosol-generating procedure on a patient, tested negative 16 days post-exposure, emphasizing the risks healthcare workers face. Those with higher Ct values remarkably tested negative just 2 days after the detection and remained so for the 28-day follow-up, illustrating an effective immune response even against high viral loads. This underscores the importance of early detection and strict infection control for a rapid recovery and return to work.

Discussion

In late August 2021, a pivotal period characterized by escalating tensions due to the COVID-19 pandemic in Ho Chi Minh City. In particular, the Hoan My Thu Duc Hospital emerged as one of the foremost healthcare facilities fervently dedicating its resources to the treatment of COVID-19 patients since August 2, 2021.

The hospital responded swiftly, ensuring that all healthcare workers tasked with direct patient care received COVID-19 vaccinations. This key initiative aimed to curtail the risk of infection within the ranks of the healthcare staff and, by extension, among the patient population under their care. Intriguingly, and somewhat alarmingly,

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despite the meticulous implementation of stringent infection prevention protocols, eight healthcare workers were infected with SARS-CoV-2 due to an emergency situation involving a COVID-19 patient. This incident underscores the persistent infection risk that healthcare workers face, even under strict preventive measures. Nonetheless, the treatment outcomes for all affected staff members were positive, substantiating the hospital's effective treatment protocols. Most staff registered a Ct value above 30 at the time of detection, which aligns with findings from similar studies conducted globally (10). Ct values exceeding 30 are indicative of a lower viral load, which, in turn, suggests a decreased risk of transmission.

Although the hospital has provided emergency training for frontline medical staff, the COVID-19 pandemic has brought to light a myriad of challenges faced by healthcare workers, and a prominent one among these is the effective utilization of PPE, such as N95 masks. Given the unprecedented nature of the pandemic, many healthcare workers, especially those not traditionally accustomed to the regular use of such PPE, found themselves in unfamiliar terrain. This unfamiliarity could result in improper use of the equipment, thereby jeopardizing their safety and effectiveness in patient care. Specifically, the mask N95 offers high-level protection against airborne infections, but this is contingent on its correct use and fit. The improper usage of such a crucial piece of equipment could lead to a false sense of security, while simultaneously increasing the risk of exposure to the virus (11).

For professionals accustomed to PPE before the pandemic, training might emphasize COVID-19 specific protocols. Conversely, those unfamiliar with PPE may need foundational guidance, from proper donning and doffing to identifying wear-out signs. A critical component of this training is addressing the challenges of prolonged PPE usage. Healthcare workers need strategies to alleviate discomfort without jeopardizing protection. An open communication culture should be encouraged, enabling workers to voice PPE-related concerns. Such feedback can refine training modules, ensuring their efficacy. Beyond training, rigorous adherence to PPE protocols is paramount. Regular supervisions and checks should validate consistent PPE use. Recognizing and rewarding compliance can further bolster these practices.

This study suggests that lapses in infection prevention possibly led to three workers contracting the virus, underscoring the vital importance of stringent control protocols. It is a misconception that only those directly interacting with COVID-19 patients face increased risk. The virus does not discern based on roles, making every healthcare worker susceptible and emphasizing universal protective measures.

The urgent need for comprehensive training extends beyond direct patient care staff to encompass everyone in healthcare settings. One vital step includes actively monitoring and ensuring correct and continuous mask usage during work.

However, these measures should transcend workplace boundaries. Adherence to safety protocols should permeate into healthcare workers' personal lives. This entails fostering efficient communication protocols during off-duty hours, promoting social distancing during breaks, mask-wearing in interpersonal meetings, and leveraging virtual communication modes where feasible. A holistic training initiative, blending theoretical infection control knowledge with practical exercises and constant feedback, can significantly curb transmission risks. Instituting a culture where healthcare professionals can candidly voice concerns or share experiential knowledge related to infection prevention can facilitate timely identification and rectification of adherence lapses, ultimately promoting a continuously evolving learning environment (12, 13).

Despite its insights, this study does harbor limitations. It failed to conduct antibody tests on affected healthcare workers during various infection stages. Moreover, the inability to pinpoint the exact SARS-CoV-2 variant involved presents a discernible knowledge void, with implications for gauging vaccine and treatment protocol efficacy. These limitations signal areas where subsequent research could delve deeper, aiming to furnish a more nuanced comprehension of COVID-19's ramifications on healthcare professionals, and by extension, fortifying our defenses against this health menace.

In summary, the research elucidates a SARS-CoV-2 transmission chain involving eight healthcare individuals within a dedicated COVID-19 treatment hospital. It underscores the need for rigorous compliance with infection prevention measures, especially mask integrity during aerosol-generating medical procedures. Furthermore, for those in the trenches against COVID-19, mask usage, both during work and personal hours, is non-negotiable to thwart transmission within the healthcare community.

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Conflict of interest and funding

The authors report no conflicts of interests. No funding was received.

Author contributions

In the spirit of full disclosure and in accordance with the ICMJE Disclosure Form, we declare the following regarding the submitted manuscript: Each author listed has

actively contributed to the study and preparation of the manuscript. We affirm our commitment to transparency, ensuring that the content of the manuscript remains unbiased and untainted by any potential interests.

Ethical approval

This study was approved by IRB/IEC of Hoan My Medical Group.

References

1. Guan WJ, Ni Zy, Hu Y, Liang W, Ou C, He J, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020; 382(18): 1708–20. doi: 10.1056/NEJMoa2002032
2. Aburto JM, Kashyap R, Schöley J, Angus C, Ermisch J, Mills MC, et al. Estimating the burden of the COVID-19 pandemic on mortality, life expectancy and lifespan inequality in England and Wales: a population-level analysis. J Epidemiol Community Health 2021; 75(8): 735–40. doi: 10.1136/jech-2020-215505
3. Lopez-Leon S, Wegman-Ostrosky T, Perelman C, Sepulveda R, Rebolledo PA, Cuapio A, et al. More than 50 long-term effects of COVID-19: a systematic review and meta-analysis. Sci Rep 2021; 11(1): 16144. doi: 10.1038/s41598-021-95565-8
4. Chang D, Xu H, Rebaza A, Sharma L, Cruz C. Protecting health-care workers from subclinical coronavirus infection. Lancet Respir Med 2020; 8(3): e13.doi: 10.1016/S2213-2600(20)30066-7
5. Mutambudzi M, Niedwiedz C, Macdonald EB, Leyland A, Mair F, Anderson J, et al. Occupation and risk of severe COVID-19: prospective cohort study of 120 075 UK Biobank participants. Occup Environ Med 2021; 78(5): 307–14. doi: 10.1136/oemed-2020-106731
6. Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. PLoS One 2012; 7(4): e35797. doi: 10.1371/journal.pone.0035797
7. Dzinamarira T, Nkambule SJ, Hlongwa M, Mhango M, Iradukunda PG, Chitungo I, et al. Risk factors for COVID-19 infection among healthcare workers. A first report from a living systematic review and meta-analysis. Saf Health Work 2022; 13(3): 263–268. doi: 10.1016/j.shaw.2022.04.001
8. Sepkowitz KA. Occupationally acquired infections in health care workers. Part I. Ann Intern Med 1996; 125(10): 826–34. doi: 10.7326/0003-4819-125-10-199611150-00007
9. O'Kelly E, Arora A, Pirog S, Ward J, Clarkson PJ. Comparing the fit of N95, KN95, surgical, and cloth face masks and assessing the accuracy of fit checking. PLoS One 2021; 16(1): e0245688. doi: 10.1371/journal.pone.0245688
10. Hao Ng C, Lim N, Bao L, Quek AML, Seet RCS. Mitigating SARS-CoV-2 transmission in hospitals: a systematic literature review. Public Health Rev 2022; 43: 1–12. doi: 10.3389/phrs.2022.1604572
11. Tian Z, Stedman M, Whyte M, Anderson SG, Thomson G, Heald A. Personal protective equipment (PPE) and infection among healthcare workers – what is the evidence? Int J Clin Pract 2020; 74(11): e13617. doi: 10.1111/ijcp.13617
12. Klompas M, Baker M, Rhee C. What is an aerosol-generating procedure? JAMA Surg 2021; 156(2): 113–4. doi: 10.1001/jamasurg.2020.6643
13. Atsawawaranunt K, Kochakarn T, Kongklieng A, Panwijitkul P, Tragoolpua R, Jaradilokkul K, et al. COVID-19 Transmission among healthcare workers at a quarantine facility in Thailand: genomic and outbreak investigations. Am J Trop Med Hyg 2021; 105(2): 421–4. doi: 10.4269/ajtmh.21-0344

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