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Concise Communication

Differences in the incidence of nosocomial-onset COVID-19 among hospitalized patients with exposure to SARS-CoV-2

Masataka Nakagawa RN, CNIC[1], Yumiko Fujishiro RN, CNIC[1], Yohei Doi MD, PhD[2,3], Junichi Yamakami MHS[4] and Hitoshi Honda MD, PhD[1,2]

[1]Division of Infection Control, Department of Quality and Safety in Healthcare, Fujita Health University Hospital, Aichi, Japan, [2]Department of Infectious Diseases, Fujita Health University School of Medicine, Aichi, Japan, [3]Division of Infectious Diseases, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA and [4]Department of Quality and Safety in Healthcare, Fujita Health University Hospital, Aichi, Japan

Abstract

We evaluated the secondary COVID-19 incidence among uninfected hospitalized patients after nosocomial COVID-19 exposure. An exposure source of SARS-CoV-2 was hospitalized patients or healthcare personnel (HCP) newly diagnosed as having COVID-19. Patients exposed to a COVID-19-infected patient in a shared room more frequently developed COVID-19 than those exposed to an infected HCP.

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Introduction

Nosocomial transmission of SARS-CoV-2 remains a significant challenge, especially during COVID-19 upsurge.[1] Despite the continuing implementation of universal masking for both hospitalized patients and healthcare personnel (HCP), the transmission of SARS-CoV-2 can occur, potentially leading to nosocomial outbreaks of COVID-19.[2] Moreover, many Japanese hospitals accommodate most of the patients in four-bed shared rooms separated only by curtains, and single private rooms account for a much smaller portion since the latter requires significant copays. Infection of hospitalized patients with SARS-CoV-2 can lead to negative clinical outcomes and also prolong their hospitalization, which significantly impacts overall healthcare resource utilization. We therefore evaluated whether transmissibility of SARS-CoV-2 to hospitalized patients differs based on room types and the source of transmission.

Methods

We retrospectively assessed hospitalized patients who developed nosocomial-onset (NO) COVID-19 (ie, secondary COVID-19) following a nosocomial exposure to SARS-CoV-2 between August 2022 and October 2023 at Fujita Health University Hospital, a 1,376-bed academic tertiary care medical center in Aichi, Japan. NO-COVID-19 was defined as the development of COVID-19 in patients hospitalized for over three calendar days. The trigger of SARS-CoV-2 testing was at the discretion of primary care physicians or infection control department. During the study period, Japan faced a nationwide upsurge of COVID-19 in January 2023, April 2023, and September 2023.[3] At the study institution, a universal masking policy was implemented, and COVID-19 patients were hospitalized in a designated ward throughout this period. Routine asymptomatic preadmission screening for SARS-CoV-2 was in place until its discontinuation in November 2022.[4]

The infection control department personnel identified hospitalized patients who came into close contact with COVID-19 individuals. The definition of close contact with a COVID-19 individual in the nosocomial setting included (1) a COVID-19 uninfected hospitalized patient who had contact with a newly diagnosed COVID-19 individual (either a hospitalized patient or an HCP) within 1 meter for a duration of longer than 15 minutes without both parties using a surgical mask or (2) a COVID-19 uninfected hospitalized patient who shared room with a hospitalized patient with newly diagnosed COVID-19. When determining close contact with a COVID-19 individual, we considered the period of infectiousness as 48 hours before the diagnosis of COVID-19 according to the infectivity of COVID-19 described in the guidance from the Centers for Disease Control and Prevention.[5] All hospitalized patients who came into close contact with COVID-19 individuals were isolated in a private room following the hospital isolation policy for a total of 6 days from the last day of COVID-19 exposure, and the isolation was subsequently discontinued with a negative SARS-CoV-2 antigen or polymerase chain reaction test on day 6. Isolated patients underwent additional SARS-CoV-2 testing if they became symptomatic during the isolation period. The circumstances related to the secondary COVID-19 cases were investigated. The study was approved by the institutional review board of Fujita Health University (#HM23-304).

Results

During the study period, 40,346 patients were hospitalized, and the monthly average number of admissions was 2,690 (range: 2,425–2,981). In total, 539 hospitalized patients had close contact with COVID-19 individuals (ie, exposure to an index hospitalized patient with newly diagnosed COVID-19 or an HCP with newly diagnosed

Corresponding author: Hitoshi Honda; Email: hitoshihonda@fujita-hu.ac.jp

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Table 1. Proportion of nosocomial-onset COVID-19 stratified by their patient location and exposure source

Patient exposure status	NO-COVID-19 (+)	NO-COVID-19 (−)	Incidence	Incidence rate ratio (95% confidence interval)	*P* value
A private room, exposure to infected HCP	3	35	7.89%	Reference	Reference
A four-bed room, exposure to infected HCP	5	55	8.33%	1.06 (0.27–4.16)	.94
A four-bed room, exposure to infected hospitalized patients	105	336	23.81%	3.02 (1.01–9.05)	.04

COVID-19). HCPs accounted for 18.2% (98/539), and hospitalized patients accounted for 81.8% (441/539) of the exposure sources, respectively. Patient locations of those with close contact with COVID-19 individuals included single private patient rooms (n = 38) and four-patient rooms (n = 501). All exposure to SARS-CoV-2 in private rooms (n = 38) occurred when infected yet undiagnosed HCPs provided care to uninfected hospitalized patients. Exposure to SARS-CoV-2 in a four-patient room (n = 501) occurred when infected HCPs provided care to uninfected hospitalized patients (12.0% [60/501]) or when hospitalized patients sharing rooms with uninfected patients developed COVID-19 (88% [441/501]).

Among 539 uninfected, hospitalized patients with close contact, 113 patients (21.0%) were diagnosed as having NO-COVID-19 (secondary COVID-19). The incidence of NO-COVID-19 stratified by patient location and exposure source is shown in Table 1. The relative risk of NO-COVID-19 among hospitalized patients with a SARS-CoV-2 exposure occurring in a four-patient room over those with a SARS-CoV-2 exposure occurring in a private room from infected HCPs was 3.02 (95% confidence interval, 1.01–9.05; $P = .04$).

Discussion

The present study revealed that NO-COVID-19 occurred significantly more frequently in hospitalized patients who were in a four-patient room exposed to newly diagnosed COVID-19 hospitalized patients than those who were in a single private room and exposed to newly diagnosed HCPs. Since proactive identification of hospitalized patients or HCPs with COVID-19 as sources of NO-COVID-19 is challenging, infection control measures should focus on mitigating nosocomial transmission. The finding suggests that private room availability for hospitalized patients may have a significant impact on the incidence of NO-COVID-19.

The high risk of NO-COVID-19 observed among hospitalized patients who were exposed to a roommate with COVID-19 is plausible. First, the net time of exposure, from the time of initial infectivity to the time of diagnosis, was likely much longer among roommates compared with HCP–patient contact. Patients hospitalized in a four-patient room are only separated from each other by curtains, which do not adequately prevent inhalation of exhaled breath aerosol if a COVID-19 patient is present in the same room. Air circulation by the ventilation system and air conditioning may cause the spread of air containing SARS-CoV-2 aerosols in multi-patient rooms. In fact, a ventilation fan is typically placed at the entrance of a patient room. The air conditioning system is placed at the center of patient rooms to control the room temperature effectively. Since it is challenging to renovate hospital ventilation and air conditioning systems, alternative solutions, such as placement of air purifiers in the setting of suboptimal air ventilation, might be considered.[6]

Moreover, some hospitalized patients might be minimally symptomatic or even asymptomatic despite having COVID-19, which also increases the opportunity of exposure.[7] Although universal masking is a hospital policy, hospitalized patients do not necessarily wear masks consistently, especially during the nighttime. In contrast, exposure from HCPs predominantly occurs in a private room when they provide meal assistance, rehabilitation, or other types of patient support. Given the limited encounter time and circumstances, the risk of nosocomial transmission of SARS-CoV-2 from infected HCPs is considered relatively smaller than in infected hospitalized patients.

The present study has some limitations. Although we performed contact tracing to determine the most plausible transmission route, unrecognized exposure to SARS-CoV-2 in the hospital might be present. Because the definition of NO-COVID-19 was based on its onset since the date of hospitalization (ie, the development of COVID-19 in patients hospitalized for over three calendar days), some cases classified as "NO-COVID-19" could have been due to exposure in the community prior to admission, leading to the overestimation on the incidence of NO-COVID-19. The impact of hospital visitors, a potential source of SARS-CoV-2 transmission on the incidence of NO-COVID-19, was not assessed in this study. Since SARS-CoV-2 genomic analysis was not performed, it is difficult to determine if NO-COVID-19 was in fact due to close contact. Lastly, the present study was conducted at a single institution, and the findings might not be generalizable to other institutions with different floor plans and ventilation systems.

NO-COVID-19 remains a significant challenge from the hospital infection prevention perspective, even after COVID-19 has entered an endemic phase. Our study suggests that the hospital occupancy and the source of SARS-CoV-2 contributed to the differential incidence of NO-COVID-19. An ideal hospital setting against the nosocomial spread of COVID-19 would be the universal use of private patient rooms. If the availability of private rooms is limited, then optimization of hospital room structures, including increases in the ratio of private patient rooms and renovation of ventilation/air conditioning systems, should be considered to prepare for future pandemics.

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