Clinical Infectious Diseases
CORRESPONDENCE

Enhanced Infection Prevention Measures Including Universal N95 Usage and Daily Testing: The Impact on SARS-CoV-2 Transmission in Cohorted Hospital Cubicles Through Successive Delta and Omicron Waves

To the Editor—We read with interest the findings of Baker et al [1] in which rapid abatement of nosocomial transmission attributed to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) Omicron-variant was achieved after instituting universal usage of N95 respirators and daily SARS-CoV-2 inpatient testing at a large tertiary hospital; however, the relative contribution of N95 use vs daily testing could not be disentangled. We would like to share our experience with universal N95 usage and daily testing for coronavirus disease 2019 (COVID-19) cluster-control over a 9-month period, during successive waves attributed to the SARS-CoV-2 Delta and Omicron variants.

In Singapore, extensive infection prevention measures were implemented at onset of the COVID-19 pandemic, including universal N95 usage, mandatory surgical mask use for patients/visitors, visitor restrictions (2/day), employee vaccination programs, and free onsite testing for healthcare workers [2, 3]. However, a large nosocomial COVID-19 outbreak in April 2021 [4] provided impetus for inpatient surveillance via routine rostered testing (weekly polymerase chain reaction [PCR] and midweek rapid antigen testing) at our institution, the largest tertiary hospital in Singapore (1785 beds) [5]. Significantly, our patients are mostly housed in 5- to 6-bed cohorted cubicles with shared toilets, with beds spaced 6 feet apart, side to side. We classified possible hospital-onset SARS-CoV as follows [6]:

- Indeterminate hospital onset: PCR-positive 3–7 days after admission
- Probable hospital onset: PCR-positive 8–14 days after admission
- Definite hospital onset: PCR-positive ≥15 days after admission

Onward transmission (a COVID-19 cluster) was defined as ≥2 hospital-onset COVID-19 cases in the same cohorted cubicle, ending when no cases were diagnosed for 14 days. Whenever hospital-onset cases were identified, patients who had originally shared the cohorted cubicle were placed on enhanced surveillance (days 1/4/7 PCR and daily rapid antigen testing); however, new admissions were still continuously accepted to the cubicle. We describe the incidence of hospital-onset SARS-CoV-2 cases in cohorted cubicles from 21 June 2021 to 21 March 2022, and if there was onward transmission in the cohorted cubicle.

Over the study period, 294 hospital-onset COVID-19 cases were identified in cohorted cubicles, of which the majority (55.8%, 176/294) were probable/definite and the remainder were indeterminate. Up to December 2021, whole-genome sequencing revealed that all hospital-onset cases were attributable to the Delta variant (N = 42) [7]; hospital-onset cases formed 2.4% (42/1727) of all cases during the Delta wave. Conversely, by January 2022, all hospital-onset COVID-19 cases demonstrated S-gene dropout on PCR testing, indicative of the Omicron variant. Compared with the Delta wave, hospital-onset cases during the Omicron wave formed 17.0% (252/1483) of all cases (odds ratio, 8.21; 95% confidence interval [CI], 5.88–11.48), despite continuation of universal N95 usage and all other extensive infection prevention measures. Onward transmission occurred in 22.1% (65/294) of cases. On univariate analysis (Table 1) and multivariate logistic regression, being on enhanced surveillance (daily testing) was independently associated with lower odds of onward transmission (adjusted odds ratio [aOR], 0.19; 95% CI, .09–.39), whereas aerosol-generating procedures (aOR, 4.31; 95% CI,1.98–9.40), a cycle-threshold value of <20 on PCR testing (aOR, 2.12; 95% CI, 1.12–4.03), and being in a ward where the common toilet was shared with ≥1 cohorted cubicle (aOR, 1.92; 95% CI, 1.02–3.62) were independently associated with higher odds of onward transmission.

In conclusion, enhanced infection prevention measures including universal N95 usage did not fully abate nosocomial transmission of SARS-CoV-2 during successive waves attributed to the Delta and Omicron variants. However, daily SARS-CoV-2 inpatient testing for cluster control was associated with lower odds of onward transmission in cohorted cubicles. Our observations reinforce the importance of enhanced surveillance, especially in settings where infrastructural limitations make room sharing unavoidable, despite the high risk of transmission between patients in shared rooms [8].

Table 1. Analysis of Risk Factors for Onward Transmission of SARS-CoV-2 From Hospital-Onset COVID-19 Cases in Cohorted Cubicles (N = 294)

Covariates (Index Cases)	Onward Transmission Among Hospital-Onset Cases (N%)	95% CI[a]	*P*-Value
Clinical characteristics			
Aged <60 y	15/70 (21.4)	1.00	1.00
Aged ≥60 y	50/224 (22.3)	1.05 (.55–2.02)	
Female	21/112 (18.8)	1.00	.313
Male	44/182 (24.2)	1.38 (.77–2.48)	
ISARIC score <7[b]	15/75 (20.0)	1.00	.747
ISARIC score ≥7	50/219 (22.8)	1.18 (.62–2.26)	
Not on hemodialysis	56/242 (23.1)	1.00	.462
On hemodialysis	9/52 (17.3)	0.70 (.32–1.51)	
Not immunocompromised	40/191 (20.9)	1.00	.557
Immunocompromised	25/103 (24.3)	1.21 (.9–2.14)	
Not mobile	30/112 (26.8)	1.00	.148
Mobile	35/182 (19.2)	0.65 (.37–1.14)	
Not fully vaccinated (<2 doses of mRNA vaccination)	15/62 (24.2)	1.00	.731
Fully vaccinated (≥2 doses of mRNA vaccination)	50/232 (21.6)	0.86 (.45–1.67)	
Ward characteristics			
Single toilet for each cohorted cubicle	22/131 (16.8)	1.00	.060
Toilet shared between ≥1 cohorted cubicles	43/163 (26.4)	1.78 (1.00–3.16)	
General ward	44/212 (20.8)	1.00	.433
Hematology/oncology/renal ward	21/82 (25.6)	1.31 (.72–2.39)	
Admission events			
Admitted for ≤7 d before diagnosis	25/117 (21.4)	1.00	.886
Admitted for >7 d before diagnosis	40/177 (22.6)	1.07 (.61–1.89)	
Not on enhanced surveillance (daily testing) prior to diagnosis	54/165 (32.7)	**1.00**	**<.001***
On enhanced surveillance (daily testing) before diagnosis	11/129 (8.5)	**0.19 (.10–0.39)**	
Did not use common toilet	26/98 (26.5)	1.00	.233
Used common toilet	39/196 (19.9)	0.69 (.39–1.22)	
No aerosol-generating procedure[c]	45/250 (18.0)	**1.00**	**<.001***
Aerosol-generating procedure	20/44 (45.5)	**3.80 (1.93–7.46)**	
No diarrhea	62/278 (22.3)	1.00	1.00
Ongoing diarrhea	3/16 (18.8)	0.80 (.22–2.91)	
SARS-CoV-2 testing results			
Cycle-threshold value ≥20	23/147 (15.6)	**1.00**	**.011***
Cycle-threshold value < 20	42/147 (28.6)	**2.16 (1.22–3.82)**	
Delta variant	8/42 (19.0)	1.00	.692
Omicron variant	57/252 (22.6)	1.24 (.55–2.83)	

Abbreviations: CI, confidence interval; COVID-19, coronavirus disease 2019; mRNA, messenger RNA; SARS-COV-2, severe acute respiratory syndrome coronavirus 2.

[a]χ^2 test.

[b]ISARIC score: risk stratification score that predicts in-hospital mortality for hospitalized COVID-19 patients, derived from the following variables: age, sex, number of comorbidities, respiratory rate, peripheral oxygen saturation, level of consciousness, urea level, and C-reactive protein (score range, 0–21 points).

[c]Aerosol-generating procedures defined as: nebulizers, high-flow nasal cannula, noninvasive positive pressure ventilation, intubation.

*$P < .05$.

Notes

Ethics statement. Because this study was conducted as part of outbreak investigation, ethics approval was not required under our institutional review board guidelines.

Financial support. This work was not grant funded. Funding for consumables was provided by the Singapore General Hospital.

Potential conflicts of interest. K. K.- K. Ko reports support unrelated to this manuscript by the NMRC Research Training fellowship from the National Medical Research Council (NMRC) Research Training fellowship, Singapore. All other authors report no potential conflicts.

All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

Liang En Wee,[1] Karrie Kwan-Ki Ko,[2,3] Edwin Philip Conceicao,[4] May Kyawt Aung,[4] Myat Oo Aung,[4] Yong Yang,[4] Shalvi Arora,[4] and Indumathi Venkatachalam[1,4]

[1]Department of Infectious Diseases, Singapore General Hospital, Singapore; [2]Department of Molecular Pathology, Singapore General Hospital, Singapore; [3]Department of Microbiology, Singapore General Hospital, Singapore; and [4]Department of Infection Prevention and Epidemiology, Singapore General Hospital, Singapore

References

1. Baker MA, Rhee C, Tucker R, et al. Rapid control of hospital-based SARS-CoV-2 Omicron clusters through daily testing and universal use of N95 respirators. Clin Infect Dis **2022**:ciac113. doi:10.1093/cid/ciac113.
2. Htun HL, Lim DW, Kyaw WM, et al. Responding to the COVID-19 outbreak in Singapore: staff protection and staff temperature and sickness surveillance systems. Clin Infect Dis **2020**; 71:1947–52.
3. 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**; 41:765–71.

4. Chow A, Guo H, Kyaw WM, etal. Rostered routine testing for severe acute respiratory coronavirus virus 2 (SARS-CoV-2) infection among healthcare personnel—is there a role in a tertiary-care hospital with enhanced infection prevention and control measures and robust sickness-surveillance systems? Infect Control Hosp Epidemiol **2021**. doi:10.1017/ice.2021.268.
5. Wee LE, Conceicao EP, Aung MK, et al. Rostered routine testing for healthcare workers and universal inpatient screening: the role of expanded hospital surveillance during an outbreak of COVID-19 in the surrounding community. Infect Control Hosp Epidemiol **2021**. doi:10.1017/ice.2021.366.
6. European Centre for Disease Prevention and Control. Surveillance definitions for COVID-19. **2021**. Available at: https://www.ecdc.europa.eu/en/covid-19/surveillance/surveillance-definitions. Accessed 27 September 2021.
7. Wee LE, Conceicao EP, Sim JX, et al. Sporadic outbreaks of healthcare-associated COVID-19 infection in a highly-vaccinated inpatient population during a community outbreak of the B.1.617.2 variant: the role of enhanced infection-prevention measures. Am J Infect Control **2022**; 50:465–8.
8. Karan A, Klompas M, Tucker R, Baker M, Vaidya V, Rhee C. The risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission from patients with undiagnosed coronavirus disease 2019 (COVID-19) to roommates in a large academic medical center. Clin Infect Dis **2022**; 74: 1097–100.

Correspondence: W. Liang En, Department of Infectious Diseases, Singapore General Hospital, Singapore 169608 (ian.wee.l.e@singhealth.com.sg).

Clinical Infectious Diseases®

https://doi.org/10.1093/cid/ciac320