Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

American Journal of Infection Control 50 (2022) 465–468

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Brief Report

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

Liang En Wee MRCP [a,*], Edwin Philip Conceicao BSc [b], Jean Xiang-Ying Sim MRCP [a,b], May Kyawt Aung MPH [b], Myat Oo Aung MBBS [b], Yang Yong PhD [b], Shalvi Arora BSc [b], Karrie Kwan-Ki Ko PhD [c,d], Indumathi Venkatachalam FRACP [a,b]

[a] Department of Infectious Diseases, Singapore General Hospital, Singapore
[b] Department of Infection Prevention and Epidemiology, Singapore General Hospital, Singapore
[c] Department of Molecular Pathology, Singapore General Hospital, Singapore
[d] Department of Microbiology, Singapore General Hospital, Singapore

Key words:
SARS-CoV-2
Hospital
Antigen test
Outbreak
Infection control
Nosocomial

A B S T R A C T

Sporadic clusters of health care-associated COVID-19 infection occurred in a highly vaccinated health care-workers and patient population, over a 3-month period during ongoing community transmission of the B.1.617.2 variant. Enhanced infection-prevention measures and robust surveillance systems, including routine-rostered-testing of all inpatients and staff and usage of N95-respirators in all clinical areas, were insufficient in achieving zero health care-associated transmission. The unvaccinated and immunocompromised remain at-risk and should be prioritized for enhanced surveillance.

Infection-prevention measures in health care settings may mitigate transmission of severe-acute-respiratory-syndrome-coronavirus-2 (SARS-CoV-2), resulting in lower secondary-attack-rates compared to community settings.[1] However, novel variants with higher transmissibility, including the SARS-CoV-2 delta variant (B.1.617.2), challenge containment efforts. Despite usage of appropriate personal-protective-equipment (PPE), healthcare-associated outbreaks of B.1.617.2 have occurred.[2,3]

In Singapore, hospitals instituted extensive infection-prevention measures early-on.[3,4] However, community outbreaks of B.1.617.2 increased potential spillover into health care-facilities. A large nosocomial cluster arising from B.1.617.2 was reported in end-April 2021,[3] providing impetus for routine-rostered-testing (RRT) via polymerase-chain-reaction (PCR) testing for inpatients and health care-workers (HCWs).[5] We evaluated health care-associated transmission of SARS-CoV-2 in a large health care-campus during an ongoing community surge of B.1.617.2.

METHODOLOGY

Institutional setting and study period

Our health care-campus handles COVID-19 and non-COVID-19-admissions, hosting a 1,785-bed acute-hospital, a 545-bed community-hospital, and 4 specialist's centers. Patients were admitted in cohorted general-wards (5-12 beds/bay, ~1.5 meters apart). Almost 13,000 HCWs work on-campus. The study-period lasted from 27th June 2021 to 29th September 2021.

Admission triage strategies

Patients with epidemiological risk (close-contact) were admitted directly to the isolation-ward (negative-pressure isolation-

* Address correspondence to Liang En, Wee, Department of Infectious Diseases, Singapore General Hospital, The Academia, 20 College Rd, Singapore 169856, Singapore.
E-mail address: ian.wee.l.e@singhealth.com.sg (L.E. Wee).
Conflicts of interest: The authors report no conflicts of interest.
Ethics approval and consent to participate: This study was conducted as part of outbreak-investigation; ethics approval was not required under our institutional-review-board guidelines.

https://doi.org/10.1016/j.ajic.2022.01.009
0196-6553/

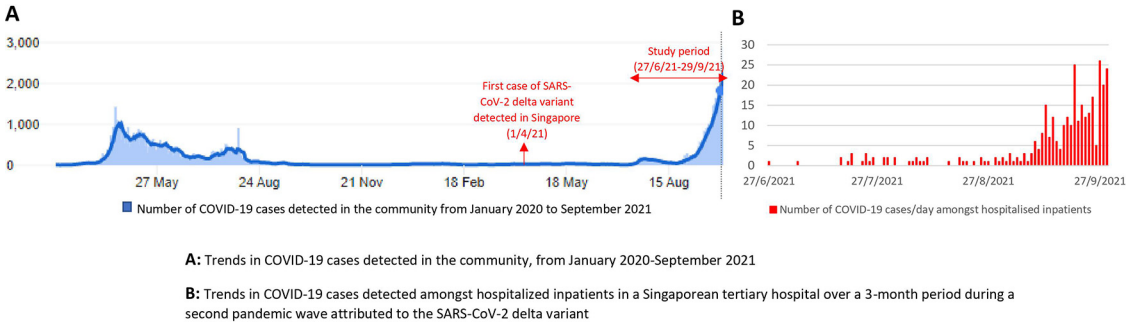

Fig. 1. Trends in COVID-19 cases detected in the community and amongst hospitalized inpatients in a Singaporean tertiary hospital over a 3-month period during a second pandemic wave attributed to the SARS-CoV-2 delta variant.

rooms with antechamber), whereas patients without epidemiological risk presenting with clinical-syndromes compatible with COVID-19 were isolated in modified cohort cubicles with reduced bed-density in the "respiratory-surveillance-ward (RSW)" while awaiting PCR.[4] From 27th June 2021, all inpatient admissions were additionally screened using the BD-Veritor-SARS-CoV-2-antigen rapid-test-kit.[6] Patients with positive antigen-tests were isolated till PCR confirmation.

Enhanced surveillance via RRT of staff and inpatients

From April 2021, RRT via PCR-testing of respiratory samples for SARS-CoV-2 was conducted fortnightly for asymptomatic vaccinated HCWs and weekly for non-vaccinated HCWs.[5] Symptomatic HCWs received free testing at our staff clinic. From 19th June 2021, universal inpatient screening was instituted. Asymptomatic patients were tested on admission and weekly subsequently; testing could be performed more frequently at clinician-discretion if patients turned symptomatic.[5]

Enhanced campus-wide infection-control measures

All HCWs in general-ward donned N95-respirators as a mandatory-minimum. HCWs in isolation-ward/RSW donned N95-respirators and disposable gloves, gowns and faceshields. COVID-19 vaccination uptake amongst HCWs was high, with 89.6% fully-vaccinated by end-April 2021. Similarly, 75.0% of inpatients were fully-vaccinated. Pre-pandemic inpatient-areas were cleaned with 1:1,000

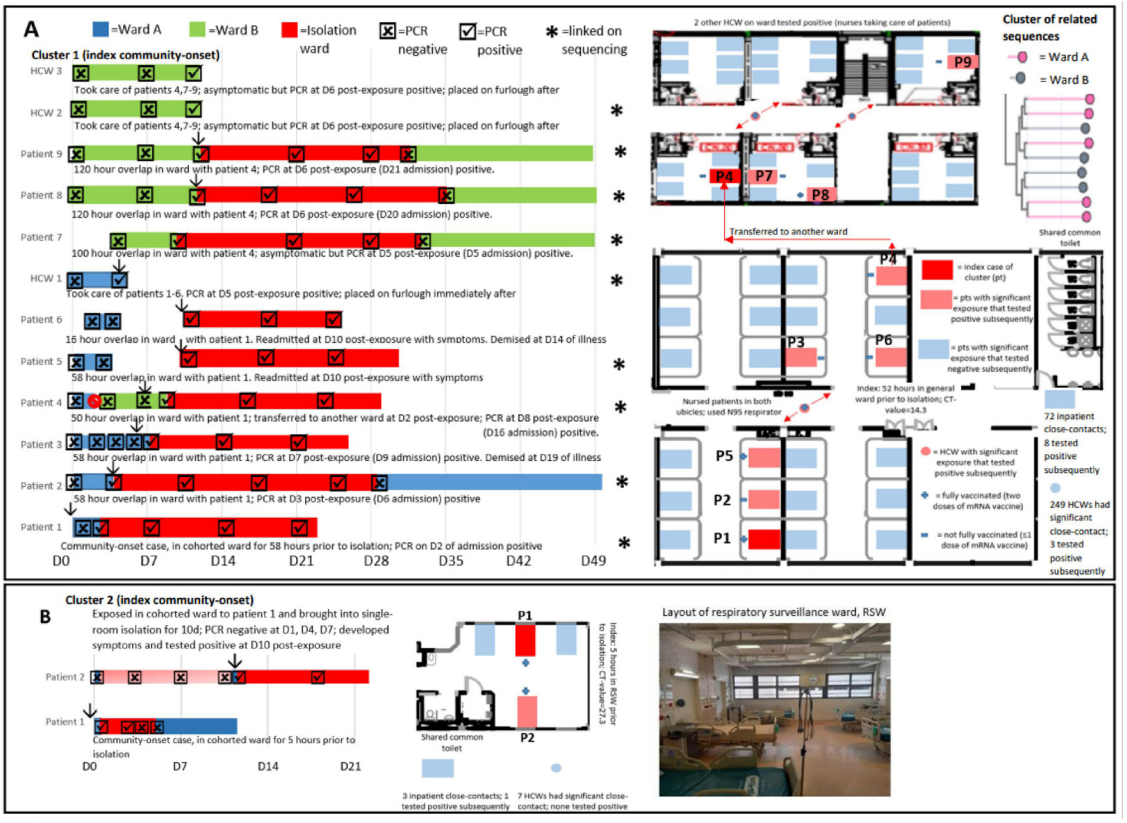

Fig. 2. Epidemiological clusters of potential health care-associated COVID-19 cases amongst hospitalized inpatients in a Singaporean tertiary hospital with high vaccination uptake, enhanced infection-prevention, and surveillance measures.

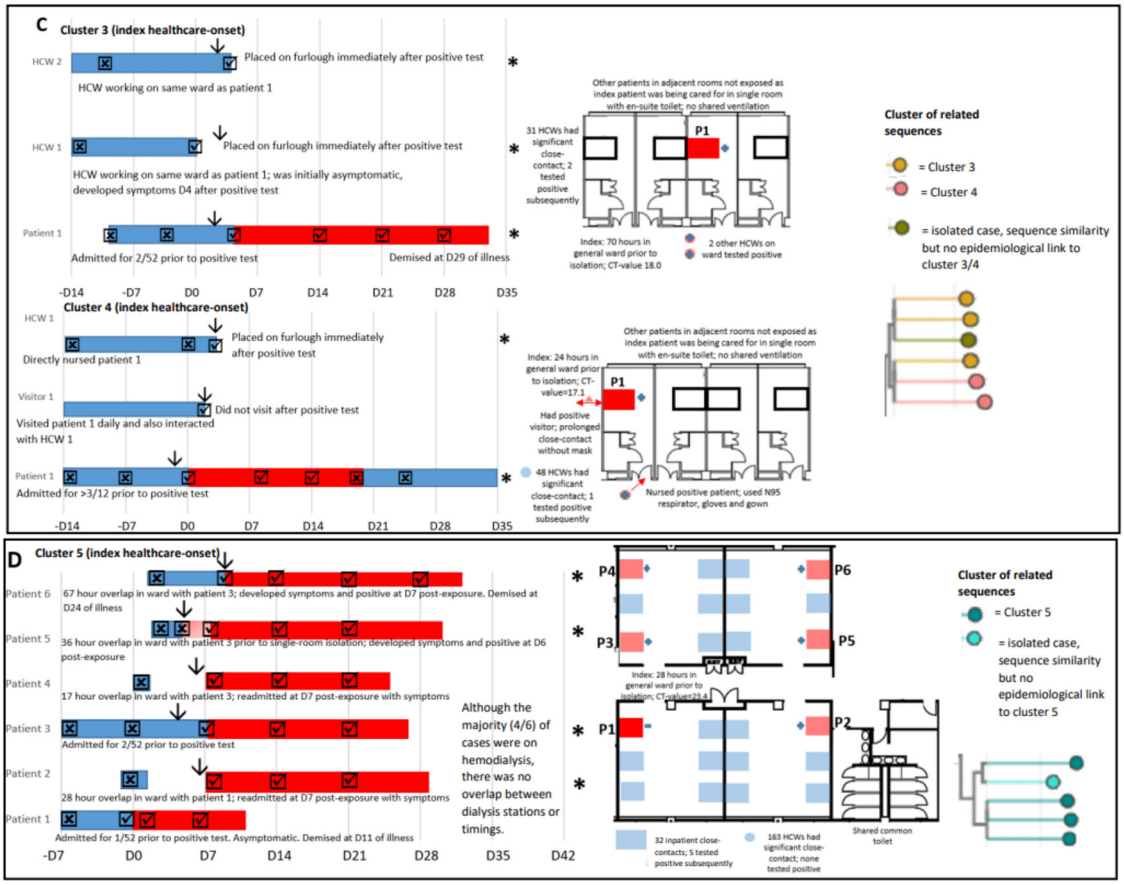

Fig. 2 Continued.

hypochlorite-based disinfectant 3x-a-day. Regular cleaning and hand-hygiene-compliance were reinforced.[4] UV-C disinfection was also utilized for terminal-cleaning in isolation-areas. All visitors donned masks and if visiting for ≥30 minutes, required antigen-testing.[7] Two asymptomatic, fully-vaccinated visitors/inpatient/day were allowed at maximum.[7]

Definition of health care-associated COVID-19 infection

All newly-diagnosed inpatient cases were classified into community-onset or health care-associated infection:[8]

- Community-onset: PCR-positive ≤2 days postadmission
- Indeterminate-health care-associated: PCR-positive 3-7 days postadmission
- Probable-health care-associated: PCR-positive 8-14 days postadmission
- Definite-health care-associated: PCR-positive ≥15 days postadmission

Epidemiological clusters were defined as ≥2 cases in patients or HCWs associated with the same setting, ending when no cases were diagnosed for 14 days.[8] Significant close-contact was defined as contact within 2-metres of the index-case for ≥15 minutes, during the index-case's infectious-period.[8] Infectious periods were defined from 4 days before to 7 days after a positive PCR.[9] Patients and HCWs with significant close-contact underwent PCR on D1/D4/D7/D10 postexposure, regardless of symptoms. All exposed-patients were isolated; only HCWs who had not donned N95 respirators were furloughed. Whole-genome-sequencing was performed for inpatient and HCW-cases in the epidemiological clusters (Supplementary Material 1).

RESULTS

Over a 3-month community surge (Fig 1A), 6.7% (1219/17676) of admissions had concurrent COVID-19 infection. One-quarter (26.3%, 321/1219) were newly diagnosed during hospitalization (Fig 1B); the rest tested positive elsewhere prior. A minority of newly-diagnosed cases (6.9%, 22/321) were health care-associated, with the vast majority classified as community-onset (N = 299). Antigen-testing combined with epidemiological/clinical risk-stratification was highly successful in triaging suspected community-onset cases to isolation, with a sensitivity of 98.3% (95% CI = 96.1-99.5) (Supplementary Table 1). Almost all community-onset cases (95.0%, 284/299) were triaged to isolation from onset. Community-onset cases initially triaged outside of the isolation ward (N = 15) spent 8.7 hours (SD = 14.6) prior to isolation, seeding 2 clusters. The first cluster involved an asymptomatic index-case admitted to a cohorted ward with a negative antigen-test/PCR; PCR on D2 of admission returned positive (Fig 2A). A secondary cluster was seeded on another ward, with sequencing links between patients on both wards (Fig 2A). The second cluster involved a symptomatic index-case in a cohorted RSW (Fig 2B).

Amongst health care-associated cases (N = 22), 7 cases were definite, 12 probable, and the remaining 3 cases indeterminate. The majority (12/22) were unvaccinated; one-third (36.3%, 8/22) received immunosuppression or had malignancy; and one-third (36.3%, 8/22) received hemodialysis. Two-fifths (36.3%, 9/22) were first identified outside of isolation; the remainder were already on enhanced surveillance due to significant inpatient-exposure. Health care-associated COVID-19 cases initially detected outside of isolation (N = 9) spent 33.3 hours (SD = 22.2) prior to isolation, seeding 3 clusters.

Two clusters comprised definite health care-associated inpatient-cases and fully-vaccinated HCWs, with sequencing links (Fig 2C). A final cluster occurred on a cohorted renal ward (Fig 2D).

Amongst the 5 clusters (Fig 2A-D), 498 HCWs and 107 inpatients had significant close-contact; 1.7% (6/498) of HCWs and 13.1% (14/107) of exposed-inpatients subsequently tested positive. The odds-ratio of acquisition amongst exposed-inpatients, compared with HCWs, was 12.3 (95% CI = 4.6-32.9, $P < .001$). One-quarter (23.1%, 6/26) of unvaccinated/partially-vaccinated exposed-inpatients subsequently tested positive, compared with 9.8% (8/81) amongst fully-vaccinated exposed-inpatients (odds-ratio = 2.7, 95%CI = 0.9-8.8, $P = .08$).

DISCUSSION

Although enhanced infection-prevention measures mitigated potential health care-associated transmission of COVID-19, it was insufficient in achieving zero health care-associated transmission during widespread community spread. Admission-triage strategies ensured that 95% of community-onset cases were initially isolated, but a single asymptomatic case with negative antigen-testing still resulted in secondary transmission. Enhanced surveillance and rigorous contact-tracing remains crucial in outbreak containment; genomic analysis supplemented epidemiology investigations and facilitated rapid confirmation of clusters, allowing prioritization of infection-prevention resources. The small number of breakthrough infections amongst vaccinated HCWs caring for patients with unsuspected COVID-19 highlights the potential for transmission despite high PPE compliance (≥90%)[10] and widespread usage of N95 respirators. Asymptomatic visitors may escape detection at symptom-based triage and have been implicated in nosocomial clusters; however, screening asymptomatic visitors remains logistically challenging.[7] At our campus, ≥1200 visitors entered daily. No-visitor policies have been considered, but this poses potential psychological distress to patients. The unvaccinated and immunocompromised remain at-risk and should be prioritized for enhanced-surveillance.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.ajic.2022.01.009.

References

1. Thompson HA, Mousa A, Dighe A, et al. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) setting-specific transmission rates: a systematic review and meta-analysis. *Clin Infect Dis*. 2021;73:e754–e764.
2. Shitrit P, Zuckerman NS, Mor O, Gottesman BS, Chowers M, et al. Nosocomial outbreak caused by the SARS-CoV-2 Delta variant in a highly vaccinated population, Israel, July 2021. *Euro Surveill*. 2021;6:2100822.
3. Chow A, Guo H, Kyaw WM, Li AL, Lim RHF, Ang B. 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*, in press.
4. Wee LE, Sim XYJ, Conceicao EP, et al. Containing COVID-19 outside the isolation ward: the impact of an infection control bundle on environmental contamination and transmission in a cohorted general ward. *Am J Infect Control*. 2020;48:1056–1061.
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*, in press.
6. Wee LE, Conceicao EP, Sim XYJ, et al. Utilisation of rapid antigen assays for detection of SARS-CoV-2 in a low-incidence setting at emergency department triage: does risk-stratification still matter? *Infect Control Hosp Epidemiol*, in press.
7. Wee LE, Conceicao EP, Sim JX, Venkatachalam I, Wijaya L. Utilisation of SARS-CoV-2 rapid antigen assays in screening asymptomatic hospital visitors: mitigating the risk in low-incidence settings. *Int J Infect Dis*. 2022;114:132–134.
8. European Centre for Disease Prevention and Control. Surveillance definitions for COVID-19. 2021. Accessed 27, September 2021 https://www.ecdc.europa.eu/en/covid-19/surveillance/surveillance-definitions.
9. Lumley SF, Constantinides B, Sanderson N, et al. Epidemiological data and genome sequencing reveals that nosocomial transmission of SARS-CoV-2 is underestimated and mostly mediated by a small number of highly infectious individuals. *J Infect*. 2021;83:473–482.
10. Wee LE, Sim JXY, Conceicao EP, Aung MK, Ng IM, Ling ML. Re: 'Personal protective equipment protecting healthcare workers in the Chinese epicenter of COVID-19' by Zhao et al. *Clin Microbiol Infect*. 2020;26:1719–1721.