Clinical Infectious Diseases

BRIEF REPORT

Rapid Control of Hospital-Based Severe Acute Respiratory Syndrome Coronavirus 2 Omicron Clusters Through Daily Testing and Universal Use of N95 Respirators

Meghan A. Baker,[1,2,3] Chanu Rhee,[1,2] Robert Tucker,[2] Amy Badwaik,[2] Cassie Coughlin,[3] Meghan A. Holtzman,[2] Candace Hsieh,[3] Angela Maguire,[2] Elizabeth Mermel Blaeser,[2] Saranya Seetharaman,[2] Ofelia Solem,[2] Vineeta Vaidya,[2] and Michael Klompas[1,2]

[1]Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston, Massachusetts, USA; [2]Infection Control Department, Brigham and Women's Hospital, Boston, Massachusetts, USA; and [3]Infection Control Department, Dana Farber Cancer Institute, Boston, Massachusetts, USA

The highly contagious severe acute respiratory syndrome coronavirus 2 Omicron variant increases risk for nosocomial transmission despite universal masking, admission testing, and symptom screening. We report large increases in hospital-onset infections and 2 unit-based clusters. The clusters rapidly abated after instituting universal N95 respirators and daily testing. Broader use of these strategies may prevent nosocomial transmissions.

Keywords. SARS-CoV-2; nosocomial infection; Omicron variant.

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) Omicron variant is 2–3 times more contagious than the Delta variant [1]. This has sparked a startling rise in SARS-CoV-2 case counts and a corresponding increase in healthcare-associated SARS-CoV-2. In England, the percentage of hospitalized patients with SARS-CoV-2 infections diagnosed >7 days after admission doubled with Omicron [2, 3].

The increase in hospital-onset Omicron cases presents a challenge to infection control programs since these infections are occurring in many cases despite high rates of vaccination, universal masking, testing all admissions, and contact tracing following hospital-onset cases. Hospital-onset Omicron infections can rapidly trigger clusters given Omicron's contagiousness and short incubation period [2, 4].

We describe an increase in hospital-onset SARS-CoV-2 cases in a large academic hospital coincident with an Omicron surge, 2 unit-based clusters, and their rapid control using a cluster response protocol requiring N95 respirators for all patient care on affected units regardless of patients' SARS-CoV-2 status, testing all uninfected patients daily, and limiting rooms to a single patient whenever possible.

METHODS

Brigham and Women's Hospital is an 803-bed tertiary referral hospital in Boston. The hospital's preexisting SARS-CoV-2 control program included polymerase chain reaction (PCR) testing of all patients on admission, retesting all inpatients 72 hours later (to identify infections incubating on arrival), universal use of surgical masks (by employees, patients, and visitors), eye protection, restricting visitors to 2 per day, an employee vaccination mandate, symptom attestations before each shift, contact tracing and exposure notifications, and free onsite, on-demand SARS-CoV-2 PCR testing for employees. Clinicians are encouraged to screen patients daily for new symptoms of SARS-CoV-2 and to test patients who have new symptoms. These policies were associated with very low rates of hospital-onset SARS-CoV-2 infections before the Omicron surge [5].

We defined hospital-onset SARS-CoV-2 as a positive PCR result on hospital day ≥5 following ≥2 negative tests (at admission and 72 hours later). We selected 5 days as the minimum interval for possible hospital-onset cases, given Omicron's short incubation period (median, 3 days; 75th percentile, 4 days) [4]. The validity of each case was adjudicated on the basis of history, symptoms, serologic findings when available, and serial cycle threshold values to eliminate false-positives (single positive test followed by 2 negative tests) and remote infections (serial cycle thresholds >33 and evidence of prior infection) [6].

We defined a SARS-CoV-2 cluster as ≥3 cases on a single unit within a 3-day period. Whenever clusters were identified, all patients in affected units were placed on enhanced precautions (requiring all healthcare workers to wear an N95 respirator, eye protection, gloves, and a gown whenever entering a patient room) regardless of SARS-CoV-2 status. All uninfected patients in cluster units were PCR tested daily. Room sharing was discouraged given the high risk of transmission between patients in shared rooms [7]. Healthcare workers exposed to patients who tested positive before enhanced precautions were initiated were notified and encouraged to get tested. New admissions to cluster units were permitted but also placed on enhanced precautions. Visitors were permitted but required to wear masks, gowns, gloves, and eye protection. Cluster response interventions were stopped after 7 days without new cases on the unit.

We describe the monthly incidence of new hospital-onset SARS-CoV-2 cases between 1 November 2021 and 15 January 2022, 2 unit-based clusters, and the impact of cluster responses on

Received 17 January 2022; editorial decision 1 February 2022; published online 7 February 2022.

Correspondence: M. Klompas Department of Population Medicine, 401 Park Dr, Ste 401 E, Boston, MA, 02215 (mklompas@bwh.harvard.edu).

Clinical Infectious Diseases® 2022;75(1):e296–9

https://doi.org/10.1093/cid/ciac113

the incidence of hospital-onset cases in cluster versus noncluster units. The regional frequency of Omicron rose from 0% in November 2021 to 19% the week ending 18 December 2021 and to 94% the week ending 8 January 2022 [8]. The study was approved by the Mass General Brigham Institutional Review Board.

RESULTS

Of 8798 patients admitted during the study period, 653 had SARS-CoV-2 infections. Of these infections, 45 of 653 (6.9%) were first detected on hospital day 5 or later (median [interquartile range], 11 [6–21] days; 49% female; mean age, 64 years; median cycle threshold [interquartile range], 24 [19–28]). Epidemic curves showing the timelines of hospital-onset cases are shown in Figure 1. The incidence of hospital-onset cases rose from 0 of 23 818 patients-days in November 2021 (0.0 per 1000 patient-days) to 12 of 24 174 patient-days in December 2021 (0.5 per 1000 patient-days), to 33 of 11 165 patient-days in 1–15 January 2022 (3.0 per 1000 patient-days). The rise in hospital-onset cases paralleled SARS-CoV-2 increases in the state (mean cases per day, 2301 in November 2021, 7450 in December 2021, and 20 908 1–15 January 2022). Of the 45 hospital-onset cases, 22 received care from healthcare workers with undiagnosed SARS-CoV-2, 5 were roomed with patients with undiagnosed SARS-CoV-2, and 1 had a visitor with undiagnosed SARS-CoV-2. No potential source was identified for the remaining 17 patients.

The first unit-based cluster was detected on 1 January 2022 in a medical unit, with 10 rooms and 15 patients where two cases were diagnosed after they developed symptoms consistent with COVID-19 on 1 January. This prompted unit-wide testing and the discovery of a third case on 3 January, leading to initiation of the cluster response protocol. Seven staff members tested positive in the week before 3 January and during testing in response to the cluster (3 with community SARS-CoV-2 contacts, 1 exposed to a positive patient before diagnosis, 3 with unknown sources). Of the 7 staff members, 1 worked while symptomatic. No additional patient or staff infections were attributable to the unit over the next 10 days.

The second unit-based cluster was detected 2 January 2022 in a surgical unit with 10 rooms and 15 patients, after preprocedural

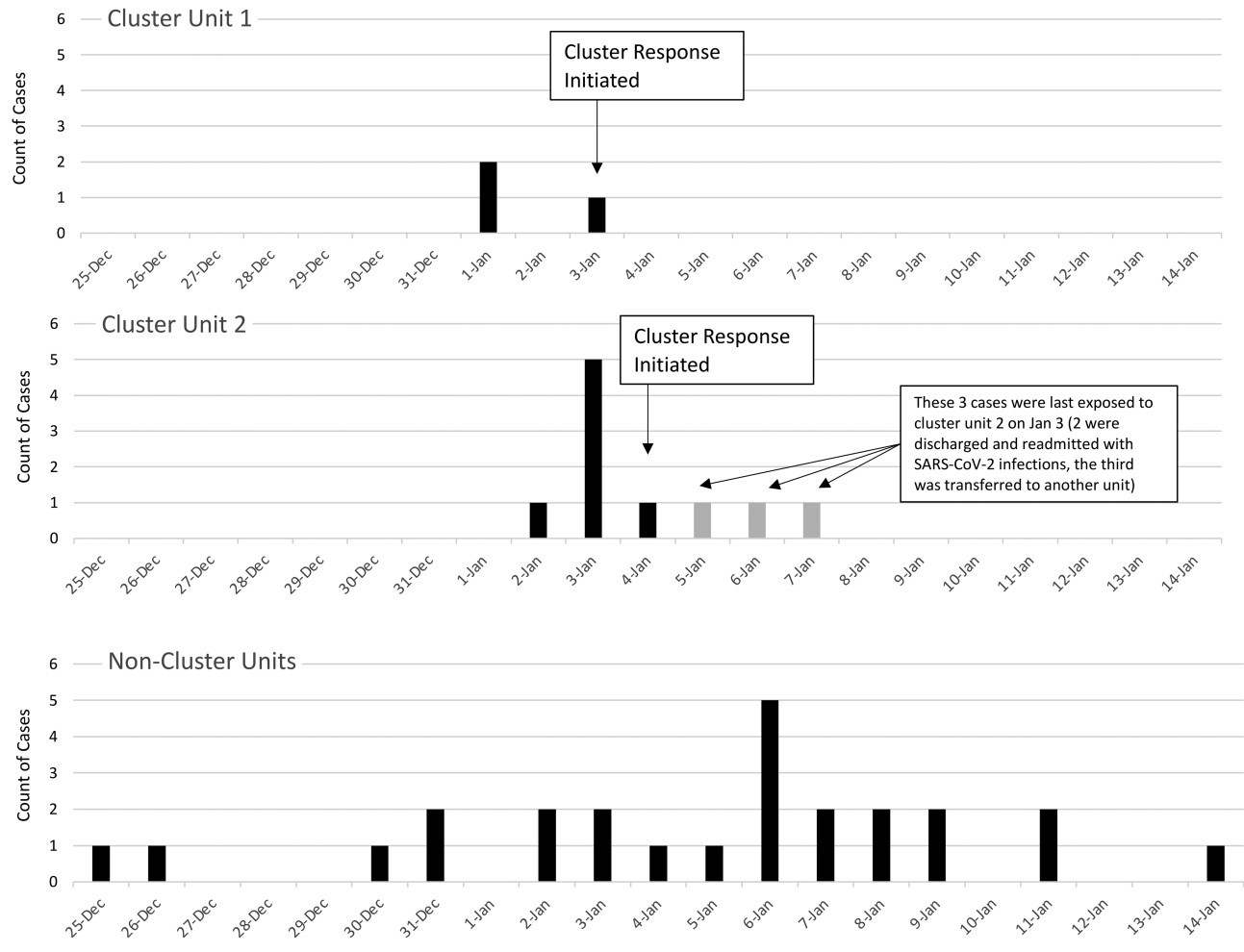

Figure 1. Epidemic curve of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) cases in the 2 cluster units versus the noncluster units.

testing identified an asymptomatic SARS-CoV-2 infection. Unit-based testing the next day revealed an additional 6 cases, leading to initiation of the response protocol on 4 January. Three additional cases were subsequently identified, but each was last on the implicated unit on 3 January (2 were discharged 3 January, readmitted 1–2 days later, and tested positive on readmission; the third was transferred to another floor on precautions and tested positive 3 days later). Fifteen unit staff members tested positive for SARS-CoV-2 in the week before 4 January and during testing in response to the cluster (4 with SARS-CoV-2 community contacts, 7 exposed to positive patients before diagnosis, and 4 with unknown sources). Of the 15 staff members, 2 worked while symptomatic. No additional patient or staff cases attributable to the unit were identified in the ensuing 10 days.

During the 10-day period after initiation of the second cluster response protocol (4 January 2022), 16 new hospital-based infections were discovered in noncluster units but none in cluster units, despite daily testing. No other unit-based clusters were identified.

DISCUSSION

We document a large increase in hospital-onset SARS-CoV-2 infections coincident with the Omicron surge in Massachusetts. Two unit-based clusters rapidly abated after instituting universal use of N95 respirators and daily testing.

We hypothesize that the increase in hospital-onset SARS-CoV-2 infections was attributable to high SARS-CoV-2 incidence rates in the community, leading to a large increase in patients, healthcare workers, and visitors with occult SARS-CoV-2 infections who then infected patients. In addition, Omicron appears to be 2–3 times more contagious than prior SARS-CoV-2 strains, perhaps owing to its greater capacity to penetrate and reproduce in upper airway tissue [1, 9, 10]. In practice, this means that less viral exposure may lead to infection. Surgical masks decrease viral emissions and exposures by 40%–60%, but they do not eliminate them [11, 12]. If smaller amounts of viral exposure can lead to Omicron infections, this may explain the observed increase in patient transmissions despite universal masking. Inconsistent masking by patients likely increased their risk of infection.

N95 respirators have the potential to decrease transmission to and from patients because they provide better source control and respiratory protection. In contrast to surgical masks, the filtration efficiency of fit-tested N95 respirators is >95% [12]. This could prevent transmission to patients by better containing viral emissions from staff members with occult infections and thus decreasing patients' viral exposure [13, 14]. Preventing staff infections may further limit patient infections by stopping staff from serving as vectors to other patients and staff.

Daily testing may help abort hospital clusters by rapidly identifying newly infected patients so that precautions can be implemented expeditiously to minimize further spread. We identified several patients who tested positive with low cycle thresholds 1 day after a negative test result.

Limitations of our study include lack of whole-genome sequencing to demonstrate associations among cluster patients and staff. It is possible that some clusters reflected multiple viral introductions. Identifying nosocomial cases without sequencing is difficult: we may have misclassified some community-acquired cases with long incubation periods as hospital acquired and missed some hospital-acquired cases if they had incubation periods <5 days, were not tested, or were tested only after discharge. We were unable to disentangle the relative contribution of N95 respirators versus testing to controlling of clusters.

It is possible that the association we observed between universal N95 respirators plus daily testing and cluster control was spurious; however, the ongoing development of hospital-onset cases outside cluster units and the large numbers of infected staff in cluster units suggest that there was persistent high infection pressure and risk for hospital-based transmission. Our clusters abated rapidly compared with previous reports of hospital-based SARS-CoV-2 clusters [15, 16]. This may be owing to the short incubation period of Omicron as well as the control measures taken.

In summary, we report a large increase in nosocomial SARS-CoV-2 infections coincident with an Omicron surge and the potential benefits of universal N95 respirators and daily patient testing to prevent healthcare-associated SARS-CoV-2 infections. Universal use of N95 respirators and more serial testing in hospitals facing Omicron surges may help prevent nosocomial transmissions [17].

Note

Potential conflicts of interest. M. A. B., C. R., and M. K. have received grant funding from the Centers for Disease Control and Prevention within the past 3 years for research on prevention and transmission of severe acute respiratory syndrome coronavirus 2 and currently receive grant funding for research on unrelated topics. C. R. and M. K. also have grant funding from the Agency for Healthcare Research and Quality. M. A. B. reports a leadership or fiduciary role for the Society for Healthcare Epidemiology of America Guidelines Committee. C. R. reports receiving royalties from UpToDate and consulting fees from Pfizer. M. K. receives funding from the Massachusetts Department of Public Health to support public health surveillance and has received royalties from UpToDate for chapters on nosocomial pneumonia and other unrelated topics. 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.

References

1. UK Health Security Agency. SARS-CoV-2 variants of concern and variants under investigation in England. Technical briefing 33. London: UK Health Security Agency, **2021**. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1043807/technical-briefing-33.pdf
2. Klompas M, Karan A. Preventing SARS-CoV-2 transmission in health care settings in the context of the omicron variant. JAMA **2022**; 327:619–20.

3. NHS England. Covid-19 hospital activity. Daily admissions and beds from 1 October 2021 up to 4 January 2022. https://www.england.nhs.uk/statistics/statistical-work-areas/covid-19-hospital-activity/. Accessed 5 January 2022.
4. Brandal LT, MacDonald E, Veneti L, et al. Outbreak caused by the SARS-CoV-2 Omicron variant in Norway, November to December 2021. Euro Surveill **2021**; 26:2101147.
5. Rhee C, Baker M, Vaidya V, et al. Incidence of nosocomial COVID-19 in patients hospitalized at a large US academic medical center. JAMA Netw Open **2020**; 3:e2020498.
6. Rhee C, Baker MA, Kanjilal S, et al. Prospective clinical assessments of hospitalized patients with positive SARS-CoV-2 PCR tests for necessity of isolation. Open Forum Infect Dis **2021**; 8:ofab194.
7. Karan A, Klompas M, Tucker R, et al. The risk of SARS-CoV-2 transmission from patients with undiagnosed covid-19 to roommates in a large academic medical center. Clin Infect Dis **2021**. doi:10.1093/cid/ciab564
8. Centers for Disease Control and Prevention. Variant proportions. **2022**. https://covid.cdc.gov/covid-data-tracker/#variant-proportionsc. Accessed 12 January 2022.
9. Chan MCW, Hui KPY, Ho J, et al. SARS-CoV-2 Omicron variant replication in human respiratory tract ex vivo. Research Square **2021**. doi:10.21203/rs.3.rs-1189219/v1
10. Peacock TP, Brown JC, Zhou J, et al. The SARS-CoV-2 variant, Omicron, shows rapid replication in human primary nasal epithelial cultures and efficiently uses the endosomal route of entry. bioRxiv [Preprint: not peer reviewed]. 3 January **2022**. Available from: https://www.biorxiv.org/content/10.1101/2021.12.31.474653v1.
11. Adenaiye OO, Lai J, de Mesquita PJB, et al. Infectious SARS-CoV-2 in exhaled aerosols and efficacy of masks during early mild infection. Clin Infect Dis **2022**; 75:e241–8.
12. Sickbert-Bennett EE, Samet JM, Clapp PW, et al. Filtration efficiency of hospital face mask alternatives available for use during the COVID-19 pandemic. JAMA Intern Med **2020**; 180:1607–12.
13. Lindsley WG, Blachere FM, Law BF, Beezhold DH, Noti JD. Efficacy of face masks, neck gaiters and face shields for reducing the expulsion of simulated cough-generated aerosols. Aerosol Sci Technol **2021**; 55:449–57.
14. Kim MC, Bae S, Kim JY, et al. Effectiveness of surgical, KF94, and N95 respirator masks in blocking SARS-CoV-2: a controlled comparison in 7 patients. Infect Dis (Lond) **2020**; 52:908–12.
15. Hetemaki I, Kaariainen S, Alho P, et al. An outbreak caused by the SARS-CoV-2 Delta variant (B.1.617.2) in a secondary care hospital in Finland, May 2021. Euro Surveill **2021**; 26:2100636.
16. Shitrit P, Zuckerman NS, Mor O, Gottesman BS, Chowers M. Nosocomial outbreak caused by the SARS-CoV-2 Delta variant in a highly vaccinated population, Israel, July 2021. Euro Surveill **2021**; 26:2100822.
17. Klompas M, Rhee C, Baker M. Universal use of N95s in healthcare settings when community Covid-19 rates are high. Clin Infect Dis **2022**; 74:529–31.