Rapid control of hospital-based SARS-CoV-2 Omicron clusters through daily testing and universal use of N95 respirators

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Abstract

The highly contagious SARS-CoV-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.

Key words: SARS-CoV-2, nosocomial infection, Omicron variant

Background

The 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 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.[2,4]

We describe an increase in hospital-onset SARS-CoV-2 cases in a large academic hospital coincident with an Omicron surge, two 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 one patient whenever possible.

Methods

Brigham and Women's Hospital is an 803-bed tertiary referral hospital in Boston. The hospital's pre-existing SARS-CoV-2 control program included PCR testing all patients on admission, retesting all inpatients 72 hours later (to identify infections incubating on arrival), universal use of surgical masks (employees, patients, and visitors), eye protection, restricting visitors to 2/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 if positive. These policies were associated with very low rates of hospital-onset SARS-CoV-2 infections prior to the Omicron surge.[5]

We defined hospital-onset SARS-CoV-2 as a positive PCR on hospital day ≥5 following ≥2 negative tests (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 prior history, symptoms, serology 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 Covid cluster as ≥3 cases on a single unit within a 3-day period. Whenever clusters were identified, all patients on affected units were placed on enhanced precautions (N95 respirator, eye protection, gloves, and gowns) regardless of SARS-CoV-2 status. All uninfected patients on 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 positive patients 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 November 1, 2021 and January 15, 2022, two unit-based clusters, and the impact of cluster responses on the incidence of hospital-onset cases on cluster versus non-cluster units. The regional frequency of Omicron rose from 0% in November, to 19% the week ending December 18, to 94% the week ending January 8.[8] The study was approved by the Mass General Brigham Institutional Review Board.

Results

There were 8,798 admissions during the study period of which 653 had SARS-CoV-2 infections. Of these, 45/653 (6.9%) were first detected on hospital day 5 or later (median 11 days, IQR 6-21 days; 49% female; mean age 64; median cycle threshold 24, IQR 19-28). An timeline of hospital-onset cases is shown in Figure 1. The incidence of hospital-onset cases rose from 0/23,818 patients-days in November(0.0 per 1000 patient-days), to 12/24,174 patient-days in December(0.5 per 1000 patient-days), to 33/11,165 patient-days January 1-15(3.0 per 1000 patient-days). The rise in hospital-onset cases paralleled SARS-CoV-2 increases in the community (mean 2,301 cases/day in November, 7,450/day in December, 20,908/day January 1-15). 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 January 1 in a medical unit with 10 rooms and 15 patients. Two cases were detected after they developed symptoms consistent with COVID-19 on January 1. This prompted unit-wide testing and the discovery of a third case on January 3 leading to initiation of the cluster response protocol. 7 staff members tested positive in the week before January 3 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. There were no additional patient or staff infections attributable to the unit over the next 10 days.

The second unit-based cluster began January 2 in a surgical unit with 10 rooms and 15 patients after pre-procedural testing identified an asymptomatic SARS-CoV-2 infection. Unit-based testing the next day uncovered an additional 6 cases leading to initiation of the response protocol on January 4. Three additional cases were subsequently identified but each was last on the implicated unit on January 3 (two were discharged January 3, 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). 15 unit staff members tested positive for SARS-CoV-2 in the week before January 4 and during testing in response to the cluster (4 with SARS-CoV-2 community contacts, 7 exposed to positive patients before diagnosis, 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 following initiation of the second cluster response protocol (January 4), 16 new hospital-based infections were discovered on non-cluster units but none on 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 compared to prior SARS-CoV-2 strains, perhaps due to its greater capacity to penetrate and reproduce in upper airway tissue.[1,9,10] In practice, this means 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 prevent transmission from patients to staff by decreasing their 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 to minimize further spread. We identified several patients who tested positive with low cycle thresholds one day after a negative test.

Limitations of our study include lack of whole genome sequencing to demonstrate associations amongst 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, weren't tested, or were only tested after discharge. We were unable to disentangle the relative contribution of N95s versus testing to controlling clusters.

It is possible the association we observed between universal N95s 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 on cluster units suggest there was persistent high infection pressure and risk for hospital-based transmission. Our clusters abated rapidly compared to previous reports of hospital-based SARS-CoV-2 clusters.[15,16] This may be due 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 N95s and more serial testing in hospitals facing Omicron surges may help prevent nosocomial transmissions.[17]

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Figure. Epidemic curve of cases on the two cluster units versus non-cluster units.