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Concise Communication

Risk of SARS-CoV-2 infection in hospitalized patients following SARS-CoV-2 exposures before and during hospitalization

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Abstract

Little is known regarding SARS-CoV-2 infection risk following SARS-CoV-2 exposures in hospitalized patients. Amongst 11,997 patients in 14 hospitals exposed 2020–2023, 6.5% tested positive (median 3d after exposure). Positivity rates were 6.7% vs 5.8% for Omicron vs pre-Omicron exposures ($P = 0.07$) and 7.6% vs 4.6% for exposures before vs after admission ($P < 0.001$).

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Introduction

SARS-CoV-2 exposures in hospitals are common and consequential for both patients and hospital operations yet little is known about the probability of infection following SARS-CoV-2 exposures in hospitalized patients. Potential sources of exposure include visitors, healthcare staff, and fellow patients.[1] Exposures typically prompt isolation of patients in single rooms. This increases pressure on hospitals with limited bed capacity and may increase risk for adverse outcomes in patients. Moreover, exposure can lead to SARS-CoV-2 infection which can disrupt patients' subsequent care, prolong hospitalization, complicate discharge, and increase mortality.[2,3]

Prior studies have reported infection rates of 14%–39% amongst hospitalized patients exposed to SARS-CoV-2 but these estimates mostly come from small, single-center studies conducted early in the pandemic and/or focused on roommate exposures alone.[4–7] We therefore analyzed longitudinal data from 14 hospitals to characterize the risk of SARS-CoV-2 infection amongst hospitalized patients exposed to SARS-CoV-2, to determine whether risk has changed over time, and to measure how risk varies between patients exposed before vs after admission.

Methods

We retrospectively analyzed electronic clinical data from 14 hospitals affiliated with the Mass General Brigham system to identify patients with SARS-CoV-2 exposures identified between March 1, 2020, and December 31, 2023. The Mass General Brigham system includes two tertiary referral centers (Massachusetts General Hospital, Brigham and Women's Hospital), 8 community hospitals, 3 rehabilitation hospitals, and one psychiatric hospital.

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Exposures were identified using a flag in the hospital system's shared electronic health record (EHR) system (Epic Systems, Madison, WI). Exposure flags were manually placed by infection preventionists upon learning about an exposure or reflexively placed by the EHR system if clinicians ordering SARS-CoV-2 tests specified recent SARS-CoV-2 exposure as the indication. Exposure was defined as ≥15 minutes within 6-feet of someone with confirmed SARS-CoV-2 infection with one or both parties unmasked. Clinicians and infection preventionists were asked to indicate the date of last exposure if known. Sources of exposure were considered potentially contagious from 2 days before until 10 days after symptom onset (or until testing negative). Testing practices following an exposure varied throughout the pandemic but typically included testing on the day the exposure was identified and 3–5 days later.

Community-based exposures were cases where the specified date of exposure was 0–14 days before the date of admission. Hospital-based exposures were cases where the exposure date was hospital day 2 or later. If no exposure date was specified then patients were considered to have had a hospital-based exposure if the exposure flag was first added to the record on hospital day 5 or later. Specific sources of exposure (roommates, healthcare workers, visitors) were not available.

We assessed for positive SARS-CoV-2 tests up to 14 days following exposure, including tests obtained after discharge when available. We calculated infection rates overall, by year, by hospital type, and by community vs hospital exposures. All study hospital testing was PCR-based.

We did a time-series analysis looking for changes in monthly postexposure positive test rates before vs after the Omicron variant arrived (12/2020–12/2021 vs 1/2022–12/2023). We used December 2020 as the starting point for this analysis because of limited test availability before then. The Mann-Whitney test was used for postexposure positivity rates and the Kruskal-Wallis test to compare median tests per encounter. We use R-Studio for all statistical analyses (Version 4.2.2). The study was granted a waiver of informed consent by the Mass General Brigham Institutional Review Board.

Table 1. Overview of the percentage of patients testing positive after exposure to SARS-CoV-2 stratified by form of exposure (community vs. hospital) and type of hospital (tertiary vs. community)

Year	Overall Post Exposure Infection Rate	Community Exposures (Before Admission)	Hospital Exposures (After Admission)	Tertiary Hospitals	Community Hospitals
Overall	6.5% (774/11,997)	7.6% (303/3,962)	4.9% (349/7,182)	6% (363/6,027)	6.9% (411/5,970)
2020	8.5% (46/544)	11.9% (36/302)	2.7% (6/225)	7% (19/272)	9.9% (27/272)
2021	5.3% (159/2,995)	6.7% (77/1,149)	3.5% (59/1,692)	4.5% (76/1,681)	6.3% (83/1314)
2022	6.3% (359/5,729)	7.2% (132/1,829)	4.7% (167/3,563)	5.9% (183/3,078)	6.6% (176/2,651)
2023	7.7% (210/2,729)	8.5% (58/682)	6.9% (117/1,702)	8.5% (85/996)	7.2% (125/1,733)

Results

409,941 patients were admitted to study hospitals during the study period and 11,997 exposures were identified: 3,962 occurred before admission, 7,182 after admission, and 853 could not be classified (Table 1). Of these, 11,240/11,997 (93.7%) were tested for SARS-CoV-2 within 14 days following exposure. Patients were tested a median of 2 times (IQR 1-4) following exposure with no significant change across calendar years ($P = 0.39$).

774 of the 11,240 (6.9%) tested patients were positive and 6.5% of the 11,997 exposed patients. There was a trend toward more positive cases after exposure to the Omicron variant vs prior strains (6.7% vs 5.8%, $P = 0.07$). On time-series analysis (Figure 1), there was no significant level-change with the arrival of Omicron ($P = 0.19$) but a significant increase in slope in the Omicron period compared to the pre-Omicron period ($P = 0.05$). Median time to a positive test was 3 days (IQR 2-5) and consistent in each of 2021, 2022, and 2023.

Test positivity rates were similar in tertiary vs non-tertiary hospitals (6.0% vs 6.9%; $P = 1.0$) and consistent across time (2021: 4.5% vs 6.3%; 2022: 5.9% vs 6.6%; 2023: 8.5% vs 7.2%).

Patients exposed before hospitalization were more likely to test positive than patients exposed during hospitalization overall (7.6% vs 4.9%; $P < 0.001$) and by year (Table 1).

Discussion

Approximately 1 in 15 hospitalized patients with SARS-CoV-2 exposure subsequently tested positive for SARS-CoV-2. The conversion rate was higher for patients exposed in the community before hospitalization versus those exposed in the hospital following admission. There was a trend toward higher positivity rates following exposures during the Omicron versus pre-Omicron periods. Median time from exposure to testing positive was 3 days.

The higher attack rate associated with community vs hospital exposures is consistent with prior studies documenting that household and social exposures have very high transmission rates (presumably due to prolonged, close-range exposures without masks in close quarters with variable quality ventilation). Transmission in hospitals is less likely because exposures are shorter, ventilation better, and masking more common.[8,9]

Our study has important limitations. We were unable to characterize the precise conditions of exposures (duration, proximity, use of personal protective equipment, ventilation, procedures), differentiate between exposures from healthcare workers vs visitors vs roommates, or elucidate differences in infection risk according to patients' underlying conditions. We may have missed some exposures that contributed to the observed infection rates potentially inflating some of our estimates of the risk per exposure. Some postexposure infections may have been missed if patients were not tested or only tested positive after discharge using home tests or laboratories that did not export results into our EHR. Some exposures that were only documented on hospital day 5 or later may have occurred before admission leading to misclassification of in-hospital vs community exposures. We did not have access to phylogenetic analyses to confirm infections were linked to specific exposures. Testing practices following exposures varied throughout the pandemic. Clinicians were able to exercise some latitude in deciding whether and when to test after exposures; some of the increase in positivity in 2023 may reflect more selective testing.

Our study helps to establish a general rate of infection following SARS-CoV-2 exposure among hospitalized patients. The attack rate was low on a per-exposure basis. This provides useful data to inform patient and family counseling following exposures. Nonetheless, the cumulative number of patients infected following hospital exposures was high as the total number of exposures was high. In addition, if exposed patients are not identified and isolated, there is a risk of further transmissions and occasional clusters which can magnify the reach, disruption, and harm associated with nosocomial transmission. This suggests it still behooves hospitals to take measures to prevent nosocomial exposures. There is room, however, for hospital leaders and public health authorities to balance the complexity, disruption, and cost associated with preventing and managing exposures against the low probability of infection per exposure. A middle ground may be the use of targeted prevention strategies (eg, masking for clinical encounters) just during periods of increased SARS-CoV-2 burden.[10]

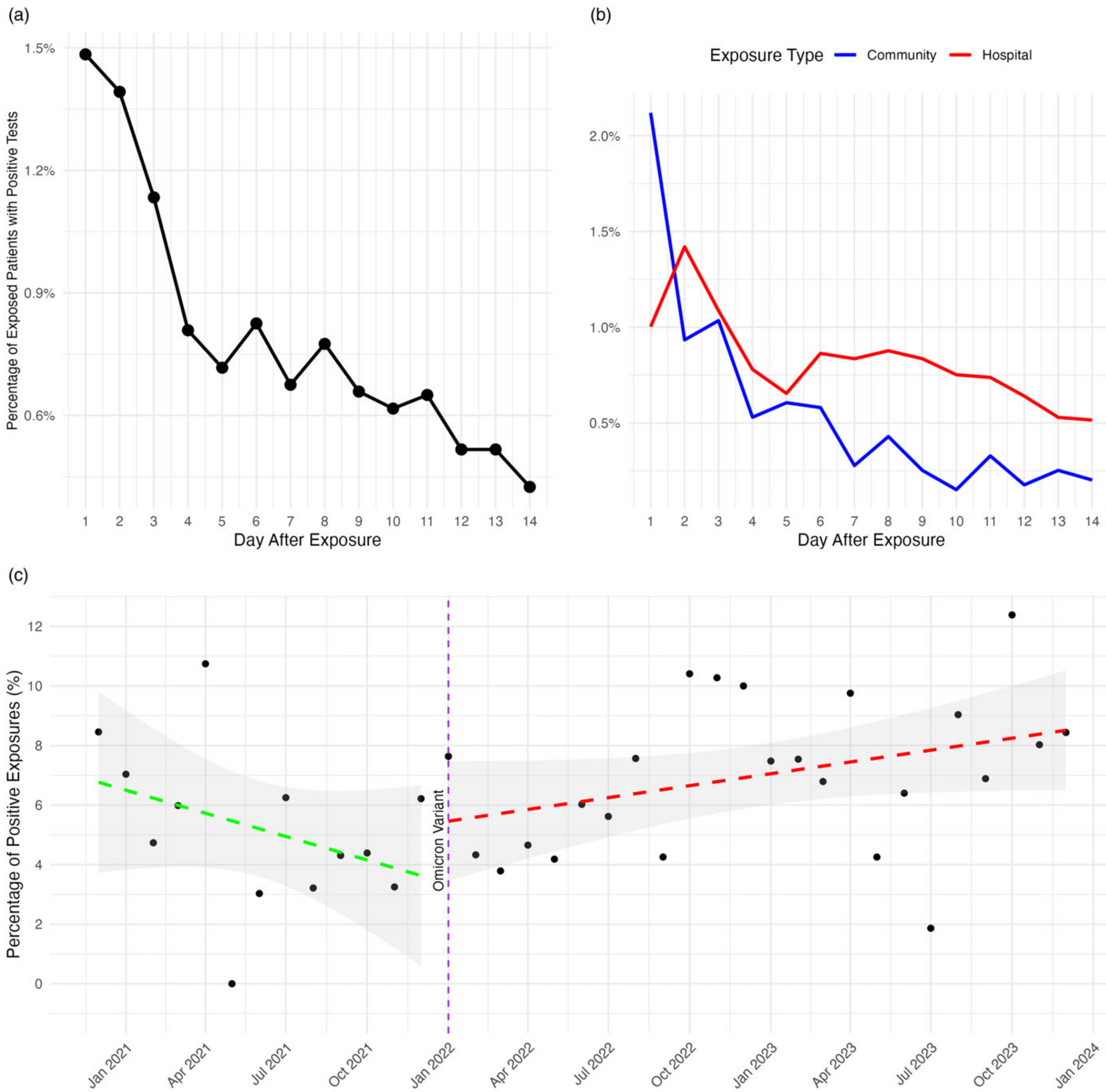

Figure 1. Percentage of exposed patients testing positive using all exposed patients as a fixed denominator for days 1–14 after exposure. A) Overall, B) Stratified by exposure type: pre-hospital (community) vs. in-hospital, C) Monthly percentages of patients testing positive after SARS-CoV-2 exposure before vs after the arrival of the Omicron variant in January 2022.

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References

1. Cooper BS, Evans S, Jafari Y, *et al.* The burden and dynamics of hospital-acquired SARS-CoV-2 in England. *Nature* 2023;623(7985):132–138.
2. Dave N, Sjöholm D, Hedberg P, *et al.* Nosocomial SARS-CoV-2 infections and mortality during unique COVID-19 epidemic waves. *JAMA Netw Open* 2023;6(11):e2341936.
3. Klompas M MC, Kanjilal S, Pak T, Rhee C, Chen T. Morbidity and mortality of hospital-onset SARS-CoV-2 infections due to Omicron versus prior variants: a propensity-matched analysis. *Ann Intern Med* 2024 (in press).
4. Wolfensberger A, Kufner V, Zaheri M, *et al.* Nosocomial COVID-19 incidence and secondary attack rates among patients of tertiary care center, Zurich, Switzerland. *Emerg Infect Dis* 2022;28(10):2087–2090.

5. Bhattacharya A, Collin SM, Stimson J, *et al.* Healthcare-associated COVID-19 in England: A national data linkage study. *J Infect* 2021;83(5):565–572.
6. Ponsford MJ, Jefferies R, Davies C, *et al.* Burden of nosocomial COVID-19 in Wales: results from a multicentre retrospective observational study of 2508 hospitalised adults. *Thorax* 2021;76(12):1246–1249.
7. 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(6):1097–1100.
8. Shah VP, Breeher LE, Alleckson JM, *et al.* Occupational exposure to severe acute respiratory coronavirus virus 2 (SARS-CoV-2) and risk of infection among healthcare personnel. *Infect Control Hosp Epidemiol* 2022;43(12):1785–1789.
9. Farah W, Breeher L, Shah V, Wang Z, Hainy C, Swift M. Coworkers are more likely than patients to transmit SARS-CoV-2 infection to healthcare personnel. *Occup Environ Med* 2022;79(10):713–716.
10. Klompas M, Baker MA, Rhee C, Baden LR. Strategic Masking to Protect Patients from All Respiratory Viral Infections. *New England J Med* 2023;389(1):4–6.