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.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Utilisation of SARS-CoV-2 rapid antigen assays in screening asymptomatic hospital visitors: mitigating the risk in low-incidence settings

Liang En Wee 1,∗, Edwin Philip Conceicao 2, Jean Xiang-Ying Sim 1,2, Indumathi Venkatachalam 1,2, Limin Wijaya 1

1 Department of Infectious Diseases, Singapore General Hospital, Singapore
2 Department of Infection Prevention and Epidemiology, Singapore General Hospital, Singapore

ABSTRACT

Retrospective contact tracing, enabled by the use of automated visitor-management systems and digital contact tracing, together with rapid antigen detection (RAD) for SARS-CoV-2 among visitors staying ≥ 30 minutes, identified COVID-19 cases in < 0.01% (6/76 605) of hospital visitors to a large hospital campus over an 8-week study period. The potential for nosocomial transmission of SARS-CoV-2 from hospital visitors was thus very low, and could be further mitigated by universal mask-wearing among staff and visitors.

© 2021 The Authors. Published by Elsevier Ltd on behalf of International Society for Infectious Diseases. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

Introduction

During the COVID-19 pandemic, while mandatory point-of-entry screening of hospital visitors for respiratory symptoms/fever has been widely implemented (Wee et al., 2021a), asymptomatic visitors may escape detection and have been implicated in nosocomial clusters (Passarelli et al., 2021). However, screening for COVID-19 among hospital visitors poses significant challenges. Polymerase chain reaction (PCR) is unsuitable for testing visitors, with long turnarounds preventing real-time processing of results (Passarelli et al., 2021). Faced with these challenges, hospitals have adopted no-visitor policies; however, this poses risks of social isolation and psychological distress (Weiner et al., 2021). Rapid antigen detection (RAD) offers the potential for point-of-care testing; however, RAD testing in low-incidence scenarios, such as asymptomatic individuals, may result in low detection rates and a high number of false-positives (Kanji et al., 2021). Our study evaluated the utility of RAD testing for SARS-CoV-2 among visitors to a large hospital campus over an 8-week period in a low-incidence setting.

Methods

At our institution, a multi-pronged infection-prevention strategy was utilized for hospital visitors during the COVID-19 pandemic. This included symptomatic screening and automated thermal screening, with entry denied to visitors with fever/respiratory symptoms or significant travel/epidemiological history, as well as compulsory masking for all visitors (Wee et al., 2021b). Our campus comprised the largest tertiary hospital in Singapore (1735 beds), a 545-bed community hospital, and four subspecialty centers. A second wave of community transmission in May 2021 prompted tightening of visitor-management strategies. Usage of the national digital contact-tracing tool (Huang et al., 2021) to register entry/exit to/from hospital premises was made compulsory for all visitors. Linkage to the national test registry allowed retrospective contact-tracing of potential exposures arising from visitors who entered during their infectious period, and who subsequently tested positive for COVID-19 elsewhere.

Over an 8-week period from June 22 to August 17, 2021, all visitors intending to visit for ≥ 30 minutes had to first present a negative RAD test on the day of visit, as stipulated by our local Ministry-of-Health (MOH). RAD testing had to be performed by an MOH-approved provider or by our institution. PCR confirmation was required for all positive RAD results. Our institution used the
BD Veritor antigen rapid test-kit, with a positive-percent agreement of $\geq 80\%$ and negative-percent agreement of 99.5\% compared with PCR (Young et al., 2020). Over the same period, our epidemiology team was updated by our local MOH of COVID-19 cases who had visited our hospital campus during their infectious period, based on records of the national digital contact-tracing tool. Retrospective contact-tracing and post-exposure surveillance of exposed staff/patients was subsequently conducted. Our institution maintained surveillance through fortnightly rostered-routine PCR testing of all staff, and weekly testing of all inpatients (Wee et al., 2021c); this expanded surveillance allowed us to assess if any COVID-19 cases could be epidemiologically linked back to positive visitors.

### Results

During the study period, 72 605 visitors visited our hospital campus, with an average of 12738 visitors/day ($SD = 426.8$). Less than one-fifth (17.6\%, 12 763/72 605) of visitors remained on hospital premises for $\geq 30$ minutes, based on automated visitor-management system data; the majority (82.4\%, 10 521/12 763) underwent RAD testing. Five visitors (0.05\%, 5/10 521) tested positive on RAD; of those, four were false-positives, with a single true-positive confirmed by PCR. Separately, based on records from the national digital contact-tracing tool, five other asymptomatic visitors with PCR-confirmed COVID-19 infection entered our campus during their infectious period; the majority (4/5) stayed $< 30$ minutes and hence did not undergo RAD testing. The epidemiological details are listed in Table 1. In total, 77 patient and staff close-contacts were identified on contact-tracing; none tested positive on subsequent 14-day surveillance. The majority of staff (88.4\%, 46/52) did not require furlough. No nosocomial COVID-19 clusters were detected over the study period, despite intensive surveillance of staff and patients. Over the same period, 0.3\% (31/9679) of admitted inpatients tested positive for COVID-19.

### Discussion

Antigen testing for SARS-CoV-2 among asymptomatic visitors in a low-incidence setting is resource intensive and low yielding. Close to 200 asymptomatic visitors were tested daily over an 8-week period, with detection of a single PCR-confirmed case. Retrospective contact tracing enabled by the use of automated visitor-management systems and digital contact-tracing, together with RAD testing for visitors staying $\geq 30$ minutes, identified COVID-19 cases among $< 0.01\%$ (6/72 605) of hospital visitors. In the same period, RAD testing of all admissions via our hospital’s emergency department yielded a positive rate of 0.6\% (40/6665), of which the majority (29/40) were true positives (Wee et al., 2021d). However, antigen testing may remain relevant during high ongoing community transmission; increases in rates of antigen positivity among asymptomatic visitors were noted during subsequent pandemic waves (Tischer et al., 2021).

Antigen testing remains logistically challenging for large healthcare facilities. During our study, $\geq 1200$ visitors entered our campus daily; RAD-testing was thus only feasible if restricted to visitors staying for $\geq 30$ minutes. The risk of transmission from asymptomatic visitors was further mitigated by universal masking among visitors and usage of appropriate personal protective equipment among staff.

---

**Table 1**

Epidemiological details of asymptomatic visitors at a large hospital campus in Singapore who subsequently tested positive for COVID-19, over a 6-week period.

| Case number | Visit reason     | Duration of potential exposure during infective period | SARS-CoV-2 RAD done? | Number of HCW who came into significant contact with cases\(^\text{i}\) | Number of HCW deemed to have significant unprotected contact requiring quarantine\(^\text{i}\) | Number of patients who came into significant contact with cases\(^\text{i}\) | Number of patients deemed to have significant unprotected contact requiring quarantine\(^\text{i}\) |
|-------------|------------------|--------------------------------------------------------|----------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| Case 1      | Family member of patient | 0.5 hours                                               | Not done (visit duration $< 30$ minutes) | 5                                                             | 5                                                               | 2                                                             | 2                                                             |
| Case 2      | Family member of patient | 4 hours; (2-hour visits on two consecutive days) | Not done (self-declared short visit duration) | 4                                                             | 0                                                               | 5                                                             | 5                                                             |
| Case 3      | Family member of patient | 1 hour; (0.5-hour visits on two consecutive days) | Not done (visit duration $< 30$ minutes) | 20                                                            | 1                                                               | 9                                                             | 9                                                             |
| Case 4      | Family member of patient | 0.5 hour; (single visit) | Not done (visit duration $< 30$ minutes) | 4                                                             | 0                                                               | 5                                                             | 5                                                             |
| Case 5      | Family member of patient | 0.5 hour; (single visit) | Not done (visit duration $< 30$ minutes) | 12                                                            | 0                                                               | 4                                                             | 4                                                             |
| Case 6      | Caregiver of patient | 2 hours; (1-hour visits on two consecutive days) | SARS-CoV-2 RAD positive on 3rd visit | 7                                                             | 0                                                               | 0                                                             | 0                                                             |

\(^{\text{i}}\) Risk stratification was conducted based on the duration of contact, nature of activity, and personal protective equipment (PPE) utilized at the time of contact. Significant contact was defined as having had contact within 2 m of the index case for a cumulative time of $\geq 15$ minutes.

\(^{\text{i}}\) Risk stratification was conducted based on the duration of contact, nature of activity, and personal protective equipment (PPE) utilized at the time of contact. Significant unprotected contact was defined as not having utilized N95 respirators during a significant contact episode and/or not having donned disposable gowns/gloves during episodes of physical contact with the index case.
Declaration of Competing Interest

The authors report no conflicts of interest.

Funding source

This research was not grant-funded.

Ethical approval

As this study was conducted as part of outbreak investigation, ethical approval was not required under our institutional review board guidelines.

References

Huang Z, Guo H, Lim HY, Chow A. Awareness, acceptance, and adoption of the national digital contact tracing tool post COVID-19 lockdown among visitors to a public hospital in Singapore. Clin Microbiol Infect 2021;27(7):1046–8. doi:10.1016/j.cmi.2021.01.007.

Kanji JN, Proctor DT, Stokes WC, Berenger BM, Silvius J, Tipples G, Joffe AM, Vennaer AA. Multicentre post-implementation assessment of the positive-predictive value of SARS-CoV-2 antigen-based point-of-care tests used for asymptomatic screening of continuing care staff. J Clin Microbiol 2021 JCM014121. doi:10.1128/JCM.014121-21.

Passarelli VC, Faico-Filho K, Moreira LVL, Cunha AP, Carvalho JMA, Barbosa GR, Camargo C, Conte DD, Perosa AH, Bellei N. Asymptomatic SARS-CoV-19 in hospital visitors: the underestimated potential of viral shedding. Int J Infect Dis 2021;102:412–14. doi:10.1016/j.ijid.2020.10.067.

Tscher C, Supp C, Janson P, Willeke K, Hung CW, Floter J, Kirchner A, Zink K, Eder L, Hackl C. Evaluation of screening tests in Bavarian healthcare facilities during the second wave of the SARS-CoV-2 pandemic. Int J Environ Res Public Health 2021;18.7371. doi:10.3390/ijerph18147371.

Wee LE, Conceicao EF, Sim JX, Aung MK, Venkatachalam I. The impact of visitor restrictions on health care-associated respiratory viral infections during the COVID-19 pandemic: experience of a tertiary hospital in Singapore. Am J Infect Control 2021a;49(1):134–5. doi:10.1016/j.ajic.2020.09.007.

Wee LE, Venkatachalam I, Sim JX, Tan KB, Wen R, Tham CK, Gan WH, Ko KKK, Ho WQ, Kwek GTC, Conceicao EP, Sng CYE, Ng XHJ, Ong JY, Chiang JL, Chuah YL, Ling ML, Tan TT, Wijaya L. Containment of COVID-19 and reduction in healthcare-associated respiratory viral infections through a multi-tiered infection control strategy. Infect Dis Health 2021b;26(2):123–31. doi:10.1016/j.idh.2021.10.004.

Wee LE, Conceicao EF, Aung MK, Oo AM, Yong Y, Venkatachalam I, Sim JX. Ros- tered 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 2021c;6:1–9 Epub ahead of print. doi:10.1017/ice.2021.366.

Wee LE, Conceicao EF, Sim JX, Venkatachalam I, Tan BKK, Wan PW, Zakariah ND, Wijaya L. 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 2021d Epub ahead of print.

Weiner HS, Firn JL, Hoghikian ND, Jagis R, Laventhal N, Marks A, Smith L, Spector-Bagdady K, Vercler CJ, Shuman AG. Hospital Visitation Policies During the SARS-CoV-2 Pandemic. Am J Infect Control 2021;49(4):516–20. doi:10.1016/j.ajic.2020.09.007.

Young S, Taylor SN, Cammarata CL, Varnado KG, Roger-Dalbert C, Montano A, Grego-Fullbright C, Burgard C, Fernandez C, Eckert K, Andrews JC, Ren H, Allen J, Ackerman R, Cooper CK. Clinical evaluation of BD Veritor SARS-CoV-2 point-of-care test performance compared to PCR-based testing and versus the Sofia 2 SARS antigen point-of-care test. J Clin Microbiol 2020;58(1):e02338–20. doi:10.1128/JCM.02338-20.

134