Canadian Journal of Public Health (2022) 113:898–903
https://doi.org/10.17269/s41997-022-00691-z

SPECIAL SECTION ON COVID-19: INNOVATIONS IN POLICY AND PRACTICE

SARS-CoV-2 rapid antigen screening of asymptomatic employees: a pilot project

Kevin L. Schwartz[1,2] · Isaac I. Bogoch[3,4] · Dwayne MacInTosh[5] · Jeffrey Barrow[5] · Dennis Sindrey[6] · Prabhat Jha[1,4] · Kevin A. Brown[2] · Brittany Maxwell[5] · Kath Hammond[5] · Michael Greenberg[7] · Eddie Wasser[5]

Received: 11 November 2021 / Accepted: 19 August 2022 / Published online: 12 September 2022

Abstract

Setting Rapid antigen screening can be effective in identifying infectious individuals in occupational settings to reduce transmission and outbreaks. We report results from a pilot project at the Greater Toronto Airports Authority (GTAA) and describe the operationalization. Toronto Pearson is a large international airport encompassing over 400 employers and, pre-pandemic, with approximately 50,000 employees.

Intervention An employee screening program was piloted between March 8 and May 28, 2021, to implement rapid antigen testing for asymptomatic employees. Recruitment targeted enrolment of 400 employees and yielded participation of 717 from 58 companies. Employees were recommended to book three times per week for nasal swabs on site, and were tested on the Abbot Panbio™ rapid antigen test. No action was taken from a negative result, and if positive, the employee was told to isolate at home and obtain a confirmatory polymerase chain reaction test.

Outcomes A total of 5117 tests were performed on 717 individuals over 12 weeks; 5091 tests were negative (99.5%), and 22 individuals tested positive (3.1% positivity rate). One hundred twenty-four (17%) completed the post-participation survey. All respondents reported that testing did not change their behaviour at work with respect to public health recommendations, and only 1 (1%) reported behaviour change outside of work (socializing with family) as a result of the program.

Implications This pilot program identified 22 (3.1%) potentially infectious employees. Onsite testing was feasible and highly accepted by this group of employees who completed the survey. Education resulted in reasonable uptake and no substantial change in behaviour, although the survey response rate may limit generalizability. Home-based testing may facilitate larger recruitment.

Résumé

Lieu Le dépistage antigénique rapide peut être efficace pour repérer les personnes infectieuses en milieu de travail afin de réduire la transmission et les éclosions. Nous rendons compte des résultats d'un projet pilote mené par l'Autorité aéroportuaire du Grand Toronto (GTAA) et nous en décrivons l'opérationnalisation. L'aéroport Toronto Pearson est un vaste aéroport international qui compte plus de 400 employeurs et, avant la pandémie, environ 50 000 employés.

Intervention Un programme de dépistage au travail a fait l'objet d'un projet pilote entre le 8 mars et le 28 mai 2021 pour mettre en œuvre le dépistage antigénique rapide chez les employés asymptomatiques. Le recrutement visait l'inscription de 400 employés et a donné lieu à une participation de 717 personnes dans 58 entreprises. Il était recommandé aux employés de s'inscrire à un prélèvement nasal sur place trois fois par semaine; le test antigénique rapide d'Abbot Panbio™ était utilisé pour

✉ Kevin L. Schwartz
Kevin.schwartz@unityhealth.to

[1] Unity Health Toronto, 30 The Queensway, Toronto, ON M6R 1B5, Canada

[2] Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada

[3] Toronto General Hospital, University Health Network, Toronto, Ontario, Canada

[4] Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada

[5] Greater Toronto Airports Authority, Toronto, Ontario, Canada

[6] National Research Council, Industrial Research Assistance Program, Ottawa, Ontario, Canada

[7] Fio Corporation, Toronto, Ontario, Canada

les prélèvements. Un résultat négatif ne donnait lieu à aucune mesure, mais si le résultat était positif, l'employé recevait l'instruction de s'isoler à la maison et d'obtenir un test de réaction de polymérisation en chaîne pour confirmer.

Résultats En tout, 5 117 tests ont été effectués sur 717 personnes sur une période de 12 semaines; 5 091 tests (99,5 %) ont été négatifs, et 22 ont été positifs (taux de positivité de 3,1 %). Cent vingt-quatre personnes (17 %) ont répondu au sondage après la participation. Tous les répondants ont déclaré que le dépistage n'avait pas changé leur comportement au travail en ce qui a trait aux recommandations sanitaires, et une seule personne (1 %) a déclaré avoir changé ses comportements en dehors du travail (sa socialisation en famille) en raison du programme.

Conséquences Ce programme pilote a repéré 22 employés potentiellement infectieux (3,1 %). Le dépistage sur place était faisable et a été bien accepté par le groupe d'employés ayant répondu au sondage. La sensibilisation a donné lieu à une participation raisonnable sans modification sensible des comportements, mais le faible taux de réponse au sondage pourrait limiter la généralisabilité des résultats. Le dépistage à domicile pourrait favoriser un meilleur recrutement.

Keywords COVID-19 · Antigen testing · Workplace safety

Mots-clés COVID-19 · dépistage antigénique · sécurité en milieu de travail

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has resulted in devastating effects on the physical, social, and economic health of Canadian society. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus which causes COVID-19, is readily transmissible from presymptomatic (subsequently develop symptoms) and paucisymptomatic (mild symptoms) individuals (Schwartz et al., 2021). As a result, symptom screening and temperature checks as a method of eliminating infectious individuals from work are ineffective interventions (Talic et al., 2021). Many rapid antigen tests (RATs) approved for use in Canada have very high specificity and high sensitivity for detecting infectious levels of virus, which is the goal of screening programs (Peto et al., 2021).

There are multiple different strategies for use of RATs. For example, "test-to-stay" has been demonstrated to be non-inferior to quarantine of high-risk school contacts permitting children to return to school with a negative RAT daily (Young et al., 2021). Other strategies include "test-to-enable" which includes regular screening of asymptomatic individuals to permit safe return to work that minimizes the risk of an infectious person being present and transmitting infection (Crozier et al., 2021). Workplaces were provided with complementary RATs for employees required to be physically present on site (Government of Ontario, 2021). While there has been uptake across Ontario, and other jurisdictions for similar programs, few have reported on their experience. There are logistical, operational, and education challenges in order to successfully implement a screening program that facilitates in-person business operation without COVID-19 outbreaks and disruptions. We report on the experience at the Greater Toronto Airports Authority (GTAA) implementing a pilot program of RAT screening for employees including an employee survey.

Setting

Toronto Pearson International Airport is a large airport encompassing over 400 employers and pre-pandemic with approximately 50,000 employees.

Intervention

The GTAA has a strong, collaborative relationship with health and safety leaders of individual companies and unions, and worked together since the beginning of the pandemic to implement measures designed to mitigate the impacts of COVID-19 for employees. The GTAA received advisory services and funding support from the National Research Council's Industrial Research Assistance Program (NRC-IRAP) to set up and evaluate several diagnostic methods of onsite testing for patrons and employees. The objective of this phase of the study was to facilitate access to serial antigen testing for employees each week of the study. Rapid antigen tests used were the Abbott Panbio™ provided by Ontario's Ministry of Health as part of the employee screening program (Government of Ontario, 2021).

Recruitment efforts began 4 weeks in advance of the pilot launch. To recruit employees for the pilot project, the GTAA reached out to 18 companies at the airport identified as priority areas based on prior COVID-19 cases reported; these employers represented a cross section of operational functions including airlines, government agencies, security operations, ground handling, and retail/food and beverage operators. The employers provided program information through their own internal communications channels, including email distribution to company employees, posters placed in employee gathering areas, and raising the opportunity in team meetings. The GTAA provided further education and awareness of the program through airport Health and Safety forums at both

leadership and front-line levels. Additional communication through a monthly airport-wide newsletter, posters in employee areas (i.e. security screening, employee lounge), and signage on digital screens was provided.

Employees voluntarily signed up by 'pre-registering' through a SurveyMonkey form that enabled the pilot administrators access to the participants' email addresses in order to communicate pilot details such as additional information about the study, how study data would be used, details about testing, consent forms, and frequently asked questions. The initial confirmation of participation email included a link to an online appointment booking platform, developed by Fio Corp.

The online booking system was through the Fionet platform. Employees would create an account and book appointments through Fionet once they were registered for the program. Employees were asked to book 2–3 appointments per week. There was no exclusion based on the amount of participation and all data were utilized. Nasal swabs were performed in a dedicated entrance of the airport by a trained staff member from Wellpoint. Swabs were processed onsite in a provisional central laboratory, and employees received automated text messages and/or email notifications (depending on the communication method chosen at the time of registration) with their results once available. Employees who tested positive were advised to notify their employer, isolate immediately, and get a confirmatory PCR test through the public system or at the onsite clinic if available, and they were at the airport when they received their result. A variety of healthcare staff were provided to deliver the employee testing, including a nurse practitioner and registered practical nurse for swabbing, technicians for Panbio^{TM} antigen analysis, and a medical office administrator for employee registration and queuing.

For businesses considering rapid antigen screening programs of similar scope for 5 days a week, 8 h per day, the estimated human resource costs for nurse-performed swabs (three nurses) and medical technicians to analyze and interpret the results (three medical technicians) would equate to approximately $374,400 per year or $534 per employee undergoing screening per year (to test 700 employees). Human resource costs can be greatly reduced through self-testing; however, education and oversight for quality control are important to maintain testing integrity.

Data collection

Data were collected through Fionet. An anonymous identifier was created; date of test, test result, age, gender, and employer were also collected and descriptively analyzed. Surveys were created using SurveyMonkey and distributed to a participant email list collected during the pre-registration process. Throughout the pilot, weekly updates were provided to participants with reminders about participation terms (including encouragement to test at least twice weekly). Following the conclusion of the pilot, the post-pilot survey was emailed to the participant list with a deadline to respond within 2 weeks. Two reminder emails were sent post-pilot encouraging employees to complete the survey.

Outcomes

We enrolled 717 employees from 58 companies and performed 5117 tests during the 12-week study period from March 8 to May 28, 2021. For each employee, the number of tests ranged from 1 to 37 with an average of 7.4 (standard deviation 8.3) and a median of 3 (interquartile range 1 to 11) tests per employee. The median age was 45 years. Of the 717 employees, there were 22 positive during the study period (3.1% positivity). Of the 5117 tests performed, 3 were invalid, 23 (from 22 individuals) were positive, and 5091 were negative (Fig. 1). PCR confirmation was recommended and performed outside the airport during the study period and not routinely available to the study team.

Testing peaked the week of April 12, 2021, with a decline until study end in both the number of tests performed and number of positives (Fig. 2). This mirrored the peak of cases during the third wave of the pandemic in Ontario, largely driven by the Alpha (B.1.1.7) variant.

Survey

One hundred and twenty-four (17.3%) employees completed the post-pilot survey (Appendix). Of the respondents, 82% received one or more COVID-19 vaccinations and 20% received 2 doses during the study period. Of those vaccinated, 51 received Pfizer-BioNTech, 26 Moderna, 20 AstraZeneca, and 1 Janssen vaccine.

Five (4%) respondents reported a positive antigen test, and 4 of those 5 reported a confirmatory positive PCR test. Two respondents developed symptoms. One hundred twenty-three (99%) reported no change in their public health behaviours as a result of a negative test (7 reported higher adherence to public health recommendations as a result of testing). One employee reported visiting with parents as a result of testing but no change in work-related adherence to public health recommendations. There were no self-reported transmissions from respondents either at home or at work.

Implications

Transmission of SARS-CoV-2 occurs predominately from 2 days prior to symptom onset to 5 days after (Schwartz et al., 2021). Majority of transmission events likely occur from

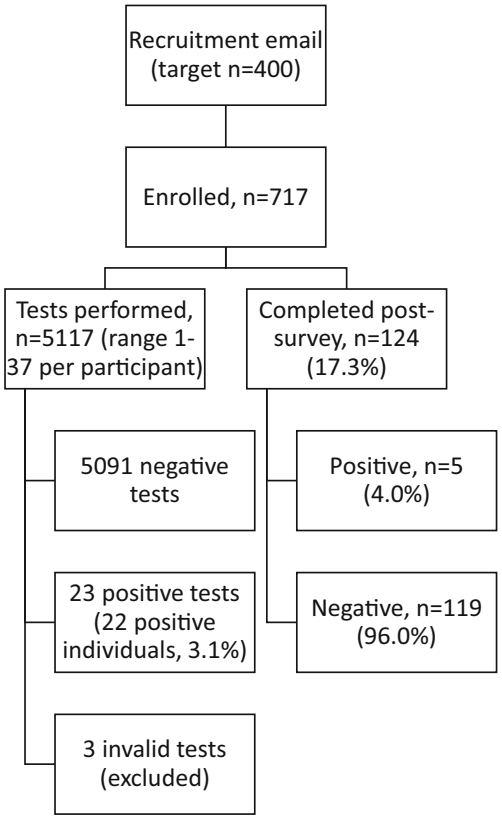

Fig. 1 Flow diagram of employee enrolment and testing

presymptomatic (prior to symptom development) or paucisymptomatic (mildly symptomatic) individuals creating challenges to reduce workplace transmission through symptomatic screening alone (Sun et al., 2021). Rapid antigen screening as a "test-to-enable" strategy can identify infectious individuals with mild or no symptoms who would not have otherwise been tested to reduce onward transmission. As an example of rapid antigen testing used for public health benefit, the city of Liverpool, England, evaluated their community rapid antigen screening program. They distributed rapid antigen tests with an estimated uptake by 45% of the population with an average of 5 tests per person over 5 months. Using synthetic control methods, they compared COVID-19 hospitalization admissions over 1 month to surrounding jurisdictions that were not using rapid antigen screening and identified a 32% (95% CI 22–39) reduction. They also estimated a 28% increase in case detection through the addition of rapid antigen testing. This observational analysis was not peer reviewed but provides supporting evidence to the public health benefits of rapid antigen screening (Green et al., 2022).

Rapid antigen testing has reduced sensitivity compared to PCR testing; however, direct comparisons are flawed as rapid antigen tests are best used for predicting the infectiousness of individuals and provide a result in a turnaround time that is actionable to interrupt chains of transmission. Furthermore, repeated antigen testing improves sensitivity to > 98% if used at least every 3 days (Smith et al., 2021). In a large-scale evaluation of over 900,000 rapid antigen screening tests in Canadian businesses, 462 (0.05% or specificity 99.95%) of tests were falsely positive and 60% of these were a result of a single defective batch of tests (Gans et al., 2022). Performance of rapid antigen tests for different variants of concern has so far been unchanged including for the Omicron (B.1.1.529) variant (Schrom et al., 2022). Ongoing evaluation will be required for changes in test performance on new or emerging variants.

In this pilot, we demonstrated the feasibility and challenges of implementing employee screening. This was conducted during Ontario's third wave when most of the population had not yet received a first COVID-19 vaccine dose. The airport provided screening to over 700 employees and performed over 5000 tests over 12 weeks. The program was facilitated by online appointments and notifications and was well received by employees. We also demonstrated from the survey results in this pilot that participation in the program did not adversely impact employee adherence to public health recommendations. However, the low survey response rate may limit the generalizability of its findings. A negative rapid

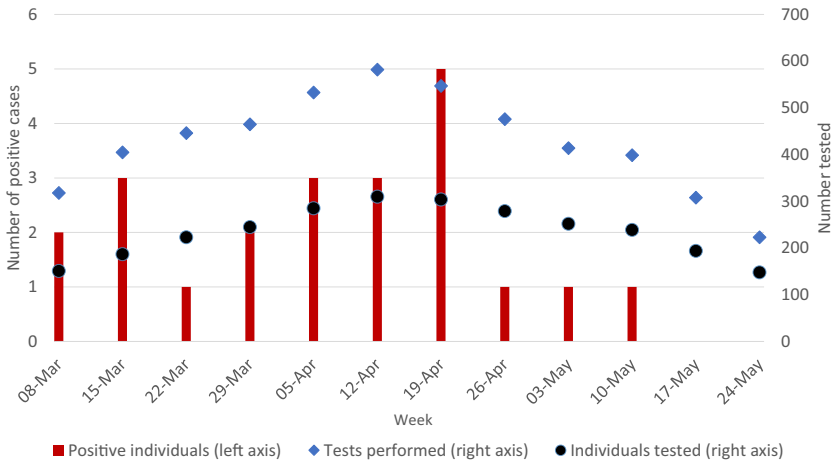

Fig. 2 Weekly results of tests performed, individuals tested, and positive results

antigen test is unlikely to result in increased infection risk through a change in behaviour as long as appropriate education is provided to employees on the purpose and implications of test results. A limitation of this pilot is that employees self-selected to participate and may not have been representative of the entire work force. In order to scale to thousands or tens of thousands of employees, companies should consider self- or home-based testing. A hospital in Singapore implemented self-testing twice per week of 8000 staff, identifying 20 true-positive staff (and 11 false-positive tests) over 8 weeks. The hospital reported no workplace transmissions during this time period and attributed this success in part to rapid antigen screening (Wu et al., 2022). Serial at-home testing is highly sensitive for detecting those infected with SARS-CoV-2 when they are most likely to be infectious (Harmon et al., 2021), as well as providing a scalable solution to test large numbers of employees without risk for transmission during testing or biosafety concerns with testing on site.

Vaccination became mandatory at the GTAA on October 31, 2021, aligning with the government of Canada's vaccination mandate for all federal employees and federally regulated employees. The GTAA has continued antigen test screening for unvaccinated employees who are exempt under the Canadian Human Rights Act. Unvaccinated exempt employees self-administer their antigen tests before coming to work and submit results to the GTAA through a custom reporting program.

Rapid antigen screening is an important public health tool to identify infectious individuals and mitigate transmission within the workplace. In the context of circulating variants of concern (i.e. Omicron) with substantial immune escape, this is an increasingly important tool to mitigate work disruptions from outbreaks. The approach to public health measures designed to mitigate transmission of SARS-CoV-2 changes between jurisdictions and over time. Decisions regarding asymptomatic screening should be based on the workplace (i.e. are employees required to have close interaction?) and community transmission risk, as higher community risk is associated with less impact from false-positive screening results. Asymptomatic screening may be less broadly applicable in future pandemic phases in certain settings. However, this approach may continue to be utilized in defined populations to protect those at higher risk for severe infections where mitigating transmission will be important, such as long-term care and other congregate settings. Further evaluation is needed on the optimal frequency of screening with new variants and in vaccinated populations. Screening programs require effective education for employees, scalability facilitated by using home-based testing, information technology resources to facilitate reporting of results, and targeting use of tests based on employee risk and community infection incidence. Taking this approach provides an important infection prevention mitigation layer to support economic stability and public health.

Appendix

Survey questions

1. How many weeks did you participate in the study for?
2. During your participation time, did you test two times or more each week?
3. During your participation time, did you receive a vaccination?
    a. Date of first dose if applicable
    b. Date of second dose if applicable
    c. Which vaccine did you receive?
4. Did any of your antigen tests give a positive result?
    a. If *no* to positive antigen test
        i. Have you changed your behaviour with respect to COVID-19 public health recommendations as a result of your negative tests?
        ii. If you answered *yes* that your behaviour changed, please explain.
    b. If *yes* to positive antigen test
        i. Was your positive test confirmed by PCR?
        ii. Date of symptom onset if applicable
        iii. Symptoms—check all that apply (cough, fever, runny nose, sore throat, vomiting, diarrhea, loss of taste, loss of smell, shortness of breath, other (please specify))
        iv. To the best of your knowledge, did anyone you had contact with get diagnosed with COVID-19 after you?
            1. How many people total? (0, 1, 2,…)
                a. How many household members do you think you transmitted to?
                b. How many work colleagues do you think you transmitted to?
5. Any feedback about the program overall?

Implications for policy and practice

What are the innovations in this policy or program?

- The operationalization of rapid antigen screening programs has not been well described in the literature; therefore, we describe an in-person pilot implementation of such a program with defined costs

and resources for other workplaces interested in developing their own program.
- We present results of an employee survey demonstrating high acceptance and no substantial behaviour change from a negative test supporting antigen test screening as an effective public health tool that can help mitigate transmission of SARS-CoV-2 in the workplace.

What are the burning research questions for this innovation?

- In future phases of the pandemic, we are likely to see more targeted use of rapid antigen screening.
- Research priorities should include:
  - Evaluating home-based self-swabbing;
  - Describing the virological trajectory in vaccinated individuals and the impact this has on rapid antigen testing; and
  - Well-designed large-scale evaluations to quantify the public health impact of antigen screening with new circulating variants.

Author contributions The project was conceived by KLS, IIB, DM, JB, DM, BS, and EW. All of the authors contributed to the study protocol and design. Program implementation was conducted by DM, JB, DS, BM, KH, MG, and EW. KLS drafted the manuscript and performed the data analysis. All of the authors provided critical edits and feedback on the manuscript and approved the submission.

Funding This pilot project was supported in part by funding from the National Research Council of Canada, Industrial Research Assistance Program (NRC-IRAP).

Data availability Data are not publicly available.

Code availability Not applicable

Declarations

Ethics approval This study was approved by the National Research Council of Canada Ethics Review Board.

Consent to participate Participants provided informed consent.

Consent for publication Not applicable

Conflict of interest KLS and IIB received consulting fees from GTAA. IIB has consulted to BlueDot, a social benefit corporation that tracks emerging infectious diseases, and the NHL Players' Association. DM, JB, BM, KH, and EW are employees of GTAA. DS is employed by the NRC-IRAP. MG is CEO of Fio Corp.

References

Crozier, A., Rajan, S., Buchan, I., & McKee, M. (2021). Put to the test: Use of rapid testing technologies for covid-19. *BMJ, 372*, n208.

Gans, J. S., Goldfarb, A., Agrawal, A. K., Sennik, S., Stein, J., & Rosella, L. (2022). False-positive results in rapid antigen tests for SARS-CoV-2. *JAMA*. https://doi.org/10.1001/jama.2021.24355

Government of Ontario. (2021). Provincial antigen screening program. Available online at: https://covid-19.ontario.ca/provincial-antigen-screening-program. Accessed 14 December 2021.

Green, M., Hughes, D., & Charalampopoulos, D. (2022). Covid-SMART asymptomatic testing pilot in Liverpool City region: Quantitative evaluation. Available online at: https://www.liverpool.ac.uk/coronavirus/research-and-analysis/covid-smart-pilot/ Accessed 20 January 2022.

Harmon, A., Chang, C., Salcedo, N., Sena, B., Herrera, B. B., Bosch, I., et al. (2021). Validation of an at-home direct antigen rapid test for COVID-19. *JAMA Network Open, 4*(8), e2126931–e2126931.

Peto, T., Affron, D., Afrough, B., Agasu, A., Ainsworth, M., Allanson, A., et al. (2021). COVID-19: Rapid antigen detection for SARS-CoV-2 by lateral flow assay: A national systematic evaluation of sensitivity and specificity for mass-testing. *EClinicalMedicine, 36*, 100924.

Schrom, J., Marquez, C., Pilarowski, G., Wang, G., Mitchell, A., Puccinelli, R., et al. (2022). Direct comparison of SARS-CoV-2 nasal RT-PCR and rapid antigen test (BinaxNOW(TM)) at a community testing site during an Omicron surge. *medRxiv*, 2022.2001.2008.22268954. https://doi.org/10.1101/2022.01.08.22268954

Schwartz, K. L., McGeer, A. J., & Bogoch, I. I. (2021). Screening asymptomatic people with rapid antigen tests: a public health tool in the fight against COVID-19. CMA-CANADIAN MEDICAL ASSOC 1867 ALTA VISTA DR, OTTAWA, ONTARIO K1G 5W8, CANADA.

Smith, R. L., Gibson, L. L., Martinez, P. P., Ke, R., Mirza, A., Conte, M., et al. (2021). Longitudinal assessment of diagnostic test performance over the course of acute SARS-CoV-2 infection. *The Journal of Infectious Diseases, 224*(6), 976–982. https://doi.org/10.1093/infdis/jiab337

Sun, K., Wang, W., Gao, L., Wang, Y., Luo, K., Ren, L., et al. (2021). Transmission heterogeneities, kinetics, and controllability of SARS-CoV-2. *Science, 371*(6526), eabe2424.

Talic, S., Shah, S., Wild, H., Gasevic, D., Maharaj, A., Ademi, Z., et al. (2021). Effectiveness of public health measures in reducing the incidence of covid-19, SARS-CoV-2 transmission, and covid-19 mortality: Systematic review and meta-analysis. *BMJ, 375*, e068302.

Wu, S., Archuleta, S., Ming, L. S., Somani, J., Chye, Q. S., & Fisher, D. (2022). Serial antigen rapid testing in staff of a large acute hospital. *The Lancet Infectious Diseases, 22*(1), 14–15.

Young, B. C., Eyre, D. W., Kendrick, S., White, C., Smith, S., Beveridge, G., et al. (2021). Daily testing for contacts of individuals with SARS-CoV-2 infection and attendance and SARS-CoV-2 transmission in English secondary schools and colleges: An open-label, cluster-randomised trial. *The Lancet, 398*(10307), 1217–1229.