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RESEARCH ARTICLE

Evaluation of "Test to Return" after COVID-19 Diagnosis in a Massachusetts Public School District

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ABSTRACT

BACKGROUND: Per Centers for Disease Control and Prevention guidance, students with COVID-19 may end isolation after 5 days if symptoms are improving; some individuals may still be contagious. Rapid antigen testing identifies possibly infectious virus. We report on a test-to-return (TTR) program in a Massachusetts school district to inform policy decisions about return to school after COVID-19.

METHODS: During the 2021-2022 Omicron BA.1 surge, students with COVID-19 could return on day 6-10 if they met symptom criteria and had a negative rapid test; students with positive rapid tests and those who declined TTR remained isolated until day 11. TTR positivity rates were compared by grade level, vaccination status, symptom status, and day of infection.

RESULTS: 31.4% of students had a positive TTR rapid test; there were no differences by grade or vaccination status. Ever-symptomatic students were more likely to have a positive rapid test (75/174 [43.1%] vs 18/104 [17.3%]). For ever-symptomatic students, TTR positivity decreased by day of infection.

CONCLUSIONS: A substantial proportion of students may still be contagious 6 days after onset of COVID-19 infection. TTR programs may increase or reduce missed school days, depending on when return is otherwise allowed (day 6 or 11). The impact of TTR programs on school-associated transmission remains unknown.

Keywords: COVID-19; rapid antigen test; test-to-return.

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In December 2021, the US Centers for Disease Control and Prevention (CDC) updated guidance for people with SARS-CoV-2 infection, enabling end of isolation on day 6 after symptom onset (or positive test if asymptomatic) for those without fever, with symptom improvement, and with ability to mask through day 10.[1] However, some individuals still carry culturable virus beyond day 5 and may still be able to transmit infection.[2,3] Transmission risk may be reduced if those infected individuals who are still contagious can be identified, thereby delaying their end of isolation, while still allowing those who are not infectious to end isolation.

The ability to culture live virus is likely to be the best indicator of true SARS-CoV-2 infectiousness; however, viral culture is not commercially available (and relatively slow).[4] Rapid antigen tests detect the presence of viral antigens and are available as

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point-of-care tests, with the return of results in 15-30 minutes. While less sensitive than nucleic acid amplification tests (eg, polymerase chain reaction [PCR]) for detection of infection, rapid antigen test positivity in the early days of infection correlates with higher SARS-CoV-2 viral load and the ability to culture virus.[5,6] Positive rapid antigen test has therefore been considered a proxy for contagiousness.[7] Some have advocated for the use of rapid antigen test to facilitate safer return after COVID-19 infection, and in January 2022, CDC updated its guidance to allow rapid antigen test toward the end of the 5-day isolation. When used, a negative rapid antigen test permits cessation of isolation, while a positive result extends isolation through day 10 or the time of a negative repeat rapid antigen test, if before day 10.

Throughout the pandemic, school districts have been asked to adjust to rapidly changing guidance, considering both the safety of students and staff and the benefits of in-person learning for students. Understanding that current CDC guidance allows some individuals with COVID-19 infection to return to school while still contagious has led to renewed concerns about safety within school districts.[8] ''Test-to-return'' (TTR) programs, in which only those students or staff having negative rapid antigen tests are allowed to return between days 6 and 11, have been implemented in some settings,[9-11] although the impact of utilizing a TTR program in school districts is unknown. This study was conducted to assess the proportion and characteristics of students with COVID-19 infection with positive TTR tests and thus who might still be contagious despite having completed CDC-defined isolation, to inform policy-makers as new school-focused guidance is developed.

METHODS

Participants

In January 2022, a public school district in eastern Massachusetts initiated a TTR program for those returning from COVID-19 isolation. Some students had initially been diagnosed with COVID-19 through participation in a voluntary asymptomatic surveillance testing program; others were diagnosed when symptomatic or exposed (Table 1). Students isolating for COVID-19 infection could return on day 6-10 if they were afebrile without the use of antipyretics, had symptom improvement, and had a negative rapid antigen test conducted by school staff on the day prior to return. Participants with a positive rapid antigen test and those who declined TTR maintained isolation until day 11. Eligible individuals could undergo a school-administered test once on days 5-9.

Data Analysis

Data from all SARS-CoV-2 cases reported to the district with onset between December 27, 2021 and January 24, 2022 were included; this coincided with the Omicron BA.1 surge in Massachusetts. Student grade level, presence of symptoms at any time during illness, date of symptom onset, date and type of initial positive test, vaccination status, and date/result of school-administered rapid antigen test for TTR participants were recorded. Day 0 of infection was considered the date of symptom onset if symptomatic or date of initial positive test, whichever came first. Eligibility for TTR and return to school was calculated forward from day 0.

Positivity rates were calculated for the entire cohort and compared by grade level, type of initial test, vaccination status, presence of symptoms during illness, and day of infection on which TTR was conducted (chi-square tests, R software).[12]

RESULTS

Cases were reported among 636 students (Table 1); 67.8% with known symptom status were symptomatic. Of these, 408 students (64%) elected to participate in TTR; the rationale for non-participation among the remaining 228 is not known. Of 408 TTR participants (64.2% of total), 128 (31.4%) had a positive rapid antigen test. There were no differences in TTR positivity by grade level, type of initial test, or vaccination status. Compared to always-asymptomatic students, ever-symptomatic students were more likely to have a positive TTR rapid test (75/174 [43.1%] vs 18/104 [17.3%]). For ever-symptomatic students, TTR positivity decreased by day of infection, declining from 55% on day 6% to 21% on day 9 ($p = .02$; Figure 1).

DISCUSSION

In a public school district during the Omicron BA.1 surge, 31% of students with SARS-CoV-2 infection had a positive rapid antigen test 5-9 days after symptom onset or positive test, despite symptom improvement. This proportion is similar to model predictions,[13] although lower than observed results among health care workers[10,11] and among residents of a southwestern Alaska province.[9] Similar to findings in other studies analyzing TTR impact,[9,11] ever-symptomatic students were more likely to have a positive TTR than students who remained asymptomatic (43% vs 17%).

IMPLICATIONS FOR SCHOOL HEALTH POLICY, PRACTICE, AND EQUITY

School districts have been asked to adjust to rapidly evolving science around COVID-19 transmission along with changing CDC guidance as they develop policy

Table 1. **Demographic and Clinical Characteristics of Students With COVID-19 Infection Eligible for School-Based TTR in an Eastern Massachusetts School District**[†]

	Total, n (%)	Positive TTR	Negative TTR	Did not TTR	Percent Positive on TTR	p value[‡]
Overall	636 (100)	128	280	228	31.4	—
Grade level[§]						
Elementary	321 (50.5)	52	137	132	27.5	.2892
Middle	175 (27.5)	43	83	49	34.1	
High school	140 (22.0)	33	60	47	35.5	
Mode of initial positive test[‖]						.173
Individual PCR test	14 (2.2)	5	6	3	45.5	
Rapid antigen test	412 (64.8)	87	167	158	34.3	
School pooled testing program	181 (28.5)	34	97	50	26.0	
Unknown	29 (4.6)	2	10	17	16.7	
Vaccination status[¶]						.255
Fully Vaccinated	408 (64.2)	89	176	143	33.6	
Partially Vaccinated	12 (1.9)	2	9	1	18.2	
Unvaccinated	133 (20.9)	26	54	53	32.5	
Unknown	83 (13.1)	11	41	31	21.2	
Symptoms at any time during illness						<.0001
Asymptomatic	147 (23.1)	18	86	43	17.3	
Symptomatic	309 (48.6)	75	99	135	43.1	
Unknown	180 (28.3)	35	95	50	26.9	
Day of TTR[#]						.0194
5	63 (15.4)	25	38	0	39.7	
6	117 (28.7)	41	76	0	35.0	
7	108 (26.5)	30	78	0	27.8	
8	74 (18.1)	24	50	0	32.4	
9	46 (11.3)	8	38	0	17.4	

[†] The public school district in Eastern Massachusetts has an enrollment of 5866 students in 11 schools (1 preschool, 7 elementary schools, 2 middle schools, and 1 high school); 3.4% of students identify as African American, 12.9% as Asian, 6.5% as Hispanic, 69.6% as white, and 7.6% as multi-race, non-Hispanic; 4.2% of students are English-language learners, 15.9% have disabilities, and 11.5% are low-income.

[‡] Chi-square test for categorical variables (grade, location, vaccination status, and symptoms); chi-square test of trend used for time-dependent variables (TTR day from first positive test or first symptoms).

[§] Elementary school: Kindergarten through grade 5; Middle school: grades 6 through 8; high school: grades 9 through 12.

[‖] Initial positive test refers to the test at COVID-19 diagnosis, not TTR. The district participates in a voluntary pooled testing program in which asymptomatic students are screened through pooling multiple samples together, with positive cases identified through deconvolution of the positive pool. The indication for testing for those diagnosed outside of surveillance testing was not reported.

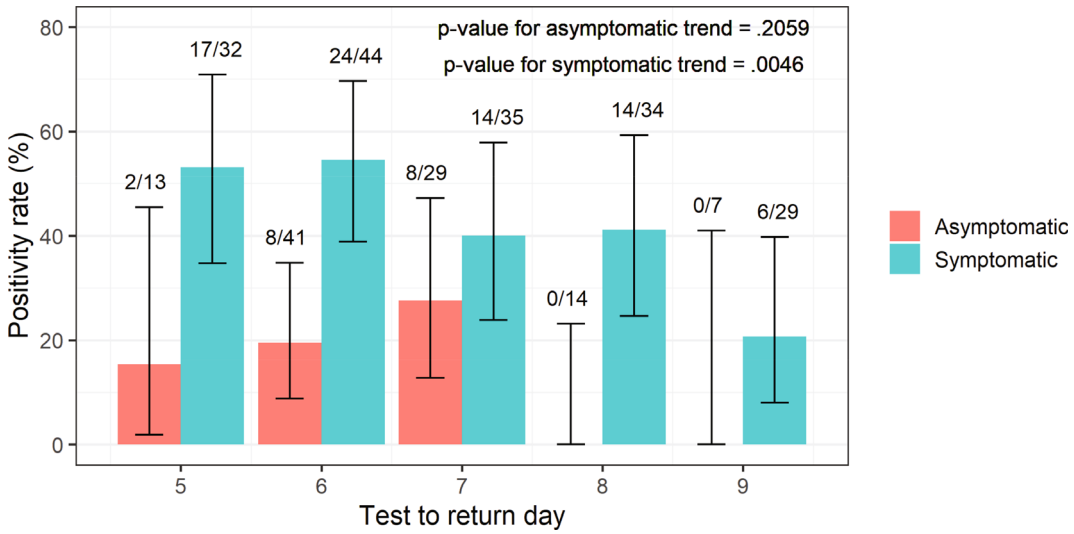
[¶] Fully vaccinated defined as 2 doses of an mRNA vaccine or one dose of the J&J vaccine.

[#] Day of TTR is calculated forward from day 0, defined as the date of positive test or date of symptom onset, whichever came first.

around COVID-19 mitigation in schools. Current CDC guidance allows an end of isolation after infection on day 6 after symptom onset or positive test, a time when some individuals may still be contagious.[10,14,15] While a change from requiring all students to remain isolated for 10 days to 5 days would reduce lost-learning days for those infected, it might also lead to increased potential for transmission within schools. Some districts have therefore sought ways to identify those students who are still contagious to reduce the potential for in-school transmission, while still minimizing lost in-person learning among all students. TTR programs may address this need; they have been widely implemented in settings such as hospitals for employees returning after COVID-19, but implementation and evaluation of TTR programs have not previously been reported in school settings. In this study, 31.4% of students had a positive rapid antigen test after day 6, despite having met symptom-based criteria to exit isolation.

If adopted, implementation of TTR programs in schools would have both advantages and costs. Compared to schools that allow return on day 6 without TTR, schools with TTR programs may have fewer school-associated transmissions, but more missed school days. However, as an alternative to isolation through day 10, TTR programs will reduce the number of missed school days. While the number of missed school days with each approach can be easily estimated, the impact of each approach on in-school SARS-CoV-2 transmission is more difficult to quantify. It is likely that TTR programs will identify and exclude most individuals who still carry replication-competent (infectious) virus. However, if students with positive rapid tests on days 6-10 (whether this status is known or unknown) return to school and wear a well-fitting mask, the risk that they will transmit to others at school is not well known. It is well-documented that SARS-CoV-2 transmission risk in schools is low when masks are worn consistently by both people with

Figure 1. **Test to Return Positivity Rate According to Day of Infection on Which TTR Was Conducted, Stratified by Presence or Absence of Symptoms at Any Time During Infection, Among Those With Available Symptom Status Chi-square tests of trend were performed for each group. Error bars show 95% exact binomial confidence intervals. When we excluded the 9th day from the chi-square test, neither group showed a significant trend.**



COVID and those in contact with them.[16-19] These data about transmission in schools were primarily reported at the time when circulating variants were less transmissible than current variants and before the Omicron surges increased population immunity, suggesting that our understanding of school-based transmission may continue to evolve. In addition, as mask requirements are lifted across the country, most students and teachers exposed to students returning from isolation will be unmasked. Districts that lift mask requirements earlier may see increased transmission in schools;[20] importantly, however, the risk of school-associated transmission during days 6-10 when only the returning student is masked is not known, especially if masks are worn inconsistently and removed for eating.

At this time, the data to inform decisions around the utilization of TTR in school settings are incomplete, including the risk of infectiousness among people with a positive rapid test with ''real-world'' adherence to masking on days 6-10 and the impact of a TTR program on missed school days for students returning from COVID-19 and for those to whom they might transmit infection. These additional data are needed before a concrete recommendation about the role of TTR in schools can be made. In the interim, this study demonstrates a high rate of antigen test positivity, thus possible infectiousness, on days 6-10 and can inform decisions being made currently about TTR. In selecting strategies for safe in-person education, those districts choosing to incorporate TTR programs and those choosing isolation longer than 5 days without TTR should work to ensure learning loss is minimized; those allowing return to school without rapid antigen testing should prioritize masking for those returning from isolation and for those higher-risk students and staff, understanding that there may still be contagious persons within the school community. When a TTR program is implemented, given that rapid test positivity declines over time for symptomatic students, allowing those who test positive early after day 5 to test again prior to day 10 may facilitate an earlier return and reduce loss of in-person time.

Limitations

This study is subject to several limitations. First, the proportion of infected persons with a positive rapid antigen test may be lower in this study because students had only 1 opportunity to participate in TTR. Some may have pre-tested and/or delayed TTR to ensure a negative school-administered test. If all persons meeting time and symptom criteria had tested on day 5 or 6, the positivity rate would likely have been higher. Second, this study was conducted when the Omicron BA.1 variant was predominant. Test performance and viral kinetics have changed over time, and the impact of a TTR program may be different with different prevalent variants. Third, the correlation between rapid antigen test and culture-positivity is not yet well understood for the Omicron variant. Preliminary data suggests that rapid antigen test is more likely to be positive when viral load is high by RT-PCR, and that high viral load itself is correlated with culture-positivity and thus a higher

likelihood of infectiousness.[21] Further, most of the data about changing sensitivity of rapid tests focus on the onset of infection, rather than at the time of infection resolution. While a negative rapid antigen test on days 6-10 of illness is well correlated with a lack of ability to culture live virus and thus is reassuring that people are no longer infectious, a positive rapid antigen test on days 6-10 of illness may include some people who are no longer infectious. Several small studies with the Delta and Omicron BA.1 variants have documented that rapid antigen tests may remain positive for 1-2 days after viral culture becomes negative, and that approximately 50% of people with positive rapid antigen tests on days 6-10 may have negative viral culture, but more work is needed to confirm these findings.[2,6,14,15]

Conclusions

In a Massachusetts public school district during the Omicron BA.1 surge, 31.4% of students participating in a TTR program had a positive rapid antigen test, suggesting the potential for contagiousness, after meeting time- and symptom-based criteria for return to school. Students who were ever symptomatic and those testing earlier in the disease course were more likely to have a positive TTR rapid antigen test. The role of TTR programs in reducing school-associated transmission remains unknown. When return occurs prior to day 11 without TTR, districts and families should assume that some students could still be infectious. For students on days 6-10, strict adherence to masking in all settings (consistent with CDC guidance) and safe distance during unmasked periods both in and out of school, are essential.

Human Subject Approval Statement

This study was approved by the Mass General Brigham Institutional Review Board.

Conflict of Interest

Dr. Nelson is a scientific advisor for the Massachusetts Department of Elementary and Secondary Education. Dr. Pollock is a subject matter expert for the Massachusetts Department of Public Health, advising on testing for COVID-19. The other authors have no relevant conflicts to disclose.

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