COVID-19 Transmission during Transportation of 1st to 12th Grade Students: Experience of an Independent School in Virginia

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ABSTRACT

BACKGROUND: In-school transmission of COVID-19 among K-12 students is low when mitigation layers are used, but the risk of acquiring COVID-19 during school bus transportation is not well defined. Given the operational limitations of many school districts, more data is needed to determine what mitigation is required to keep COVID-19 transmission low during bus transport.

METHODS: An independent school in Virginia monitored 1154 students in grades 1 to 12 with asymptomatic PCR testing every 2 weeks from August 24, 2020 to March 19, 2021, during the highest community transmission. Fifteen buses served 462 students while operating at near capacity of 2 students in every seat, using a physical distancing minimum of 2.5 ft, universal masking, and simple ventilation techniques.

RESULTS: A total of 39 individuals were present on buses during their COVID-19 infectious period, which resulted in the quarantine of 52 students. Universal testing and contact tracing revealed no transmission linked to bus transportation.

CONCLUSIONS: This study demonstrates a model for the safe operation of school buses while near capacity. COVID-19 transmission can be low during student transport when employing mitigation including simple ventilation, and universal masking, at minimal physical distances and during the highest community transmission.

Keywords: school bus; COVID-19; school transport; disease transmission; disease mitigation.

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SARS-CoV-2 is a novel infectious coronavirus, spread primarily through respiratory droplets, that has caused a worldwide pandemic. In March of 2020, this growing pandemic led to widespread implementation of largely untested mitigation measures that were deployed in attempts to abate the spread of the virus. One measure used to try to slow disease spread included the closing of schools throughout most of the United States.

Children are known to contribute to seasonal influenza spread, so school closures were justified by mathematical models assuming that COVID-19 spread similarly. However, it has become increasingly clear that children are not drivers of community spread and in-school transmission contributes relatively little to the incidence of COVID-19 throughout communities, especially when other aspects of societal life are open.
While government officials and leaders have called for school reopenings, basic operational tasks have proven challenging, including the transport of students. Prior to the onset of the pandemic, there were 26 million children utilizing 480,000 buses each day, traveling almost 6 billion cumulative miles per year. School buses are the largest mass transit program, providing approximately 10 billion student trips each year. In fact, each bus replaces approximately 36 cars that would each travel 3600 miles per year transporting children to and from school. Buses typically transport 36 to 64 students each way depending on size of the bus and age of the students. Physical distancing policy recommendations have forced many districts to limit numbers of bus passengers drastically while CDC guidance stresses the need for 3 to 6 ft distancing and placing non-related students alone in every other seat.

Policymakers and school officials have continued to discuss how to bus children safely, but data is lacking. At the onset of the pandemic in March 2020, public buses were identified as a source of COVID-19 spread in Wuhan, China and subsequently, public transportation became a health concern throughout the world. Airborne transmission of COVID-19 within a bus with recycled air, among unmasked passengers, was believed to have contributed to a COVID-19 outbreak in eastern China, and bus riders were noted to have become infected even if seated far away from the infected person.

Particle studies on metro and school transit have indicated that opening windows and using existing fans can reduce exhaled airborne particles by up to 84%, theoretically lowering the risk of COVID-19 exposure, but these studies were done without passengers present. Some guidance suggests that school buses can operate safely with masking and ventilation such as cracked windows, and some experts recommend structured loading and unloading methods.

Yet what schools require most is empirical data regarding the risks of passenger transmission of SARS-CoV-2 on school buses. School districts need this information in order to determine what is required to keep COVID-19 transmission low during bus transport and to properly weigh risks and benefits in decision making.

We report on the transport experience of an independent 1 to 12-grade school in Virginia. When returning their students to in-person learning in September 2020, the school utilized private busing for those students requiring communal transport, with simple mitigation in place. To monitor for the possibility of disease spread during transport, the school made use of semi-weekly SARS-CoV-2 testing to detect cases even in those remaining asymptomatic.

**Methods**

**Participants**

Beginning August 31, 2020, an independent school in Virginia with 1190 students and approximately 270 staff offered in-person instruction for grades 1 to 12. Of these, 1154 students selected in-person instruction with 36% or 3% of students choosing virtual learning. Students were brought back to school over 4 weeks, 3 grades per week, starting with the youngest learners. There were 15 school buses, each with a driver, and 7 buses that were operating at larger capacities had one aide each. In total, there were 462 students who consistently utilized transportation including 235 in grades 1 to 6, 164 in grades 7 to 9, and 63 in grades 10 to 12.

**Mitigation Strategies**

There were no symptom or temperature checks prior to entering the bus but families were emailed a checklist every school night to encourage self-reporting of any symptoms. Hand sanitizer was not used upon boarding but was available throughout the school day, and temperatures were checked as students entered the school building. Students, bus drivers, and aides were expected to remain masked at all times. Drivers were masked continually, although some reported problems with fog on their eyeglasses. In such occurrences, they were instructed to pull their masks below their noses while driving and place them back over their noses when they stopped the bus.

**Bus Layout**

Buses contained 11 to 13 rows, approximately 2.5 ft apart, with 22 to 26 double seats per bus. Students were distanced to the greatest extent possible, but 10 of the 15 bus routes were full and required students to be seated in almost every seat, with no more than 2 students per seat with the occasional exception of 3 to a seat with siblings (Figure 1). Buses were required to provide a one-inch window opening in the middle 2 windows and the 2 windows in the last row of seats on the bus. If additional windows were opened, this was at the discretion of the bus driver and was not tracked. Students were assigned to the same seats each day.

Buses were not loaded back to front, but older students were assigned to back rows while younger students were assigned to the front half of the bus. Students sat in the first row of the bus behind the bus driver which was spaced 4 ft from the driver, without any barrier between the students and the driver.

Bus routes each day ranged from 36 to 60 minutes in the morning, 44 to 74 minutes in the afternoon, and 42 to 62 minutes on evening routes at the completion of after school activities.
Mandatory surveillance testing was initiated on August 28, 2020. All students and staff at the school, including all present on bus transport, were tested initially every 2 weeks with pooled saliva-based testing using the SalivaDirect™ Yale protocol followed by a confirmatory PCR nasal swab test if a pooled saliva test resulted positive. Asymptomatic testing was changed to weekly starting February 4, 2021. Contact tracing was performed by school nurses and staff immediately upon receipt of a positive test using seating charts to trace exposures.

Students and staff who were deemed close contacts on a bus were quarantined for 14 days and tested by the school prior to being allowed to return to school. A close contact was defined as a student or staff member seated less than 6 ft for 15 minutes from someone who tested positive for COVID-19. Shortly after the CDC changed guidelines on October 21, 2020, quarantined students were allowed to test between day 5 and 10 by the school and allowed to return as early as day 10 post-exposure with a negative nasal swab PCR test collected at school.

RESULTS

From August 31, 2020 to March 19, 2021, 79 students and 21 staff members were identified with COVID-19, either through positive tests performed at school or conducted elsewhere and reported to the school. There were 37 student bus riders who were present on buses during their COVID-19 infectious period. All students with positive COVID-19 test results were sent home to isolate. An additional 52 fellow bus riders were quarantined due to exposure and were tested via PCR nasal swab 7 to 10 days from the date of exposure on the bus. All 52 students who were close contacts remained asymptomatic and tested negative for COVID-19. There were no drivers or aides who required quarantine due to close contact on the buses.

During the study period, 2 drivers and one aide tested positive for COVID-19. One driver tested positive over a holiday period and was not present on a bus during the infectious period; this case is excluded from this analysis. Another driver and one aide were on the same bus but were together in an unmitigated setting outside of work. Contact tracers found that the aide was most likely infected with COVID-19 while outside of school and infected the driver during another social gathering. No students exposed to the aide or driver tested positive.

There were 39 cases including 37 students, one driver, and one aide present on buses during their infectious period of COVID-19, but there was no student-to-student transmissions, no adult-to-student transmissions, and no student-to-adult transmissions. Subsequent routine testing the following week after return to school of all who were exposed as well as routine testing of all bus riders remained negative.

DISCUSSION

This study examined the experience of private school busing to and from a school that was utilizing mitigation measures to maintain in-person schooling throughout the fall and winter of 2020 to 2021. There was no evidence of COVID-19 transmission during bus transport, even at distances of 2.5 ft, with two-thirds of bus routes at full student capacity, and during the highest community incidence rates of COVID-19 which were 53.2 to 525.7 per 100,000 population for the study period. The school’s mitigation strategy employed a combination of masking, frequent testing, and ventilation on buses via spaced window openings.

CDC guidance recommends greater than 6-ft distancing for all public transportation including busing but does not distinguish between public transportation and school buses. As schools look for
ways to re-open safely, many school systems struggle with having adequate transportation capacity while maintaining 6 ft of spacing between passengers. The present study where students were seated as close as 2.5 ft from one another, indicates that 6 ft of distance may not be required to effectively limit transmission of COVID-19 on buses.

Current federal mandates require masking during bus transportation; however, ventilation with open windows is recommended but not mandated. While there is little data on how ventilation on buses affects transmission of COVID-19, the opening of doors or windows on a bus can reduce the number of aerosol droplets by half. In the present study, the consistent spaced window openings on each school bus, regardless of weather, may have significantly contributed to the lack of transmission of SARS-CoV-2. Ventilation via window openings is a simple intervention to lower transmission risk that can be applied universally on all school buses. Recent data indicate that a significant area of concern among school staff is specifically directed at the safety of transportation of students to and from school. While this study is a small sample size of 462 students over a 7-month period, there were no identified cases of spread among passengers which suggests that universal masking and open ventilation alone may be sufficient to limit COVID-19 transmission for school busing. There were no cases of even asymptomatic transmission linked to school buses, thus, calling into question whether quarantining exposures on buses is necessary so long as masking and ventilation is being enforced. Interestingly, some states have already stopped quarantines for children who were masked while exposed at school, citing low in-school spread; although, the CDC still recommends quarantines in mitigated school settings.

Limitations

The first limitation of the study is the small size in that it involved a private school setting of 1154 students and only 15 buses. However, while there were only 39 infectious COVID-19 cases who were present on buses during the study period, there was the implementation of SARS-CoV-2 PCR testing for all close contacts, as well as the asymptomatic screening of all school personnel and students, increasing the likelihood of detection of any transmission. Another limitation is that it was not recorded how long or where each positive case was present on the bus, or if that person was symptomatic or asymptomatic when detected.

Although screening for asymptomatic SARS-CoV-2 PCR testing may have increased the likelihood of finding transmission in our study, its utilization by this school may limit the generalizability of the observed safety in school busing in this study. We recognize that most public school systems do not have the current operational ability to implement such widespread screening, which may have expedited quarantines, decreasing infectious exposures. Without asymptomatic screening and early identification of infections, a larger outbreak may have occurred.

Conclusions

In this study of 15 buses involving 462 student passengers, no cases of COVID-19 were linked to transmission during transit, despite biweekly and later weekly asymptomatic screening in the first 7 months of the 2020 to 2021 school year during the highest levels of community transmission. Findings support the use of simple mitigation on buses, including ventilation with open windows and mandated masking, and allowing children to sit in every row if needed due to space limitations.

IMPLICATIONS FOR SCHOOL HEALTH AND EQUITY

Public schools face crippling shortages of student transportation when faced with guidelines that recommend 3 to 6 ft of distance and/or skipping bus seats between students. A large number of students from underserved regions rely on bus transportation as their only means of travel to school. If schools are unable to offer transport during the COVID-19 pandemic due to distancing requirements on buses, a secondary consequence will be an unequal distribution of students able to attend in-person learning. As schools re-open for in-person learning, safe bus transport is vital to maximizing student and staff health, but buses must operate at close to maximum capacity in order to provide transportation equitably to all students. The model offered may assist school administrators in planning transportation operations. We propose the following considerations:

- Utilize every row on a bus but with students assigned to seats to allow cohorting thus limiting potential disease transmission. Seat siblings together rather than mixing students from different households.
- Optimize ventilation by strategically placed cracked windows regardless of the weather.
- Create a culture that keeps children and staff from coming to school sick. A checklist of symptoms performed each day before school can assist with the identification of symptoms that would indicate a student and/or educator should remain home. Engaging parents as partners with school staff can assist with promoting school health and with preventing the spread of COVID-19 on the bus as well as in school.
- Require continuous universal masking by school bus passengers and drivers at all times. When available,
a school bus aide can help audit and correct improper mask use.

- Layer the described mitigation strategies to keep the transmission of COVID-19 on school buses low, so that normal bus operations can continue even during times of highest community transmission. Taking these simple steps that are operationally possible can protect the health of staff, families, and students so that bus transportation is not a limitation for offering in-person instruction.

Human Subjects Approval Statement
Our study is not human subject research. There is no identifiable private information. The Institutional Review Board (IRB) of the Eastern Virginia Medical School determined that IRB review is not required for this study. IRB#21-03-NH-0072.

Conflict of Interest
Dana W.E. Ramirez, MD and Leah C. Rowland, MD disclose the following nonfinancial conflicts of interest. Drs. Ramirez and Rowland are members of the Virginia American Academy of Pediatrics school re-opening task force and assist with advising schools on school re-opening during the COVID-19 pandemic. Drs. Ramirez and Rowland declare they have no additional nonfinancial conflicts of interest. Martin Klinkhammer, MD, MPH declares no nonfinancial conflicts of interest. All authors of this article declare they have no financial conflicts of interest.

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