Introduction

The COVID-19 pandemic has had a substantial impact on children and families; millions have been infected and far too many have lost loved ones to this disease. Widespread school closure resulted in learning loss, worsened mental health, and inadequate access to vital programs such as school-based health care and food distribution as well as disruption for children and families. When children returned to in-person classrooms, school communities and families undertook heroic efforts, attempting to ensure that schools remained open while not fueling the pandemic or contributing to illness and death in the community at large – even as other facets of society proceeded with their daily activities.

Despite the difficulties that school communities, children, and families have endured since March 2020, there is reason for optimism in 2022.

- We now have vaccines with proven safety and efficacy against COVID-19-related severe illness and death – the very reasons COVID-19 has been different than the common cold. The vaccines have been authorized for children 5 years of age and older and are fully approved for adults. We anticipate in spring or summer 2022 that vaccines will be authorized and available for every American 6 months and older.

- COVID-19 treatments (monoclonal antibodies and antiviral agents) are currently effective in preventing hospitalization and death and will soon have increased manufacturing that will result in wider availability for those 12 years and older. We also expect availability and dosing information for children younger than 12 within the next several months.

- We have learned a great deal over the course of the pandemic, including how to quantify risk and use data to successfully guide decisions about COVID-19 safety strategies within school settings.

In sum, these developments have enabled us to focus on the future and identify a pathway forward. As you read the recommendations and information below, please note that we have included a list of definitions at the bottom of this document for any terms that might be unfamiliar.

Planning the path forward in 2022

As school communities begin to plan the pathway forward, we anticipate that their paths will be based on local context. People making decisions about whether safety strategies, such as universal masking, are still needed should consider the following:

1. What are the potential, quantified implications of this decision on within-school transmission of SARS-CoV-2, the virus that causes COVID-19, and transmission from the school to the community at large?
2. Do all members of the school community (e.g., K-12th grade) have access to safe and effective vaccines?
3. Do vaccines and medications prevent severe disease from the current pathogen/variant (e.g., Omicron variant) such that illness and death are historically similar to influenza (i.e., years 2010-2019)?
4. Is the rate of community transmission and anticipated increase in community transmission such that critical institutions (hospitals and schools) can function with normal services and staffing?
5. It is important to recognize that regardless of how a child feels about changes in the safety strategies (excited, scared, uncertain), change is often unsettling for children and requires diligent and thoughtful
preparation, particularly in the context of the underlying mental health crisis in pediatrics. Has the school community been prepared for change and has the social emotional curriculum adapted to support children and families?

6. Is there a plan and ability to adapt and reinstate safety strategies to preserve in-person education if the pandemic changes again?

The ABC Science Collaborative has studied safety strategies in K-12 schools during different time periods of the COVID-19 pandemic, including during circulation of the ancestral (original), Alpha, Delta, and Omicron variants (view our available data below). We use these data as the basis for a hypothetical example of expected COVID-19 transmission under varying conditions of community transmission and with various safety strategies in place to help school communities address consideration No. 1.

**Universal masking with traditional quarantine**: Based on the data, we know that universal masking is extremely effective in preventing transmission of SARS-CoV-2. During moderate and high community transmission (e.g., Delta) universal masking is associated with an approximate 70-80% reduction in within-school transmission of COVID-19 when compared to school districts with voluntary masking policies.

The burden of quarantine can be substantial for schools, children, and families. Potential alternatives to quarantine are presented below, in order of increasing risk of COVID-19 transmission, from universal masking with quarantine to voluntary masking.

**Test-to-stay in universally-masked schools** during high community transmission (e.g., 200-500 cases/100,000/7 days), exposure to COVID-19 does not require quarantine, even for unmasked exposures, provided that the school district is universally masking. Testing in this scenario can help a school understand the burden of disease within buildings but requires resources and dedication to contact tracing.

**Mask-to-stay in a universally-masked environment** high community transmission (e.g., 200-500 cases/100,000/7 days) is a strategy that limits the burden of testing of exposed close contacts while minimizing the burden of quarantine on children and families.

**Test-to-stay in a voluntary masking environment** during high community transmission (e.g., 200-500 cases/100,000/7 days) is a strategy in which students and staff can stay in school even if they are exposed to other school attendees with COVID-19. This strategy results in a secondary infection rate that is higher than universal masking, or test-to-stay or mask-to-stay in universally masking districts. However, test-to-stay in a voluntary masking environment has a lower within-school transmission compared to districts that do not quarantine or test and mask close contacts after exposure.

**Modeling the path forward: An example from a hypothetical school district**

The potential real-world implications of these approaches during different community infection rates are displayed in the Table 1 below.

This model is presented for a school district with 10,000 attendees. The table has two sections: universally masking and voluntary masking districts with variable quarantine policies. Each section has 6 rows; each of the rows is a level of community transmission that ABC Science Collaborative has observed over the past 18 months.

We have highlighted a plausible community infection rate for Spring 2022 (similar to September 2021 in many parts of the United States). Of note, the data below are derived from districts where vaccination rates are typically <50% in children, which reflects the current national vaccination rates of children. When immunity from vaccination becomes more prevalent in a school system, the risk of infection and subsequent illness and death from COVID-19 are reduced.
In a universally masking district, with 500/100,000/week in the community, we expect 3 cases (secondary cases) acquired in school per week, and a total infection burden of approximately 4 cases per week, including potential infection of household contacts after in-school transmission.

In a voluntary masking district, with 500/100,000/week in the community, we expect 22 cases (secondary cases) acquired in school per week, and a total infection burden of approximately 29 cases per week.
The COVID-19 pandemic continues to cause stress for school districts and families of K-12 students. Because of the many short- and long-term benefits of continued in-person instruction, the shared goal of school districts, public health decision makers, and families should be to maintain a safe environment for in-person instruction with minimal disruptions for K-12 students. In working one-on-one with districts over the last 18+ months, we recognize the difficult local needs that must be weighed as the pandemic has evolved and safety strategies have been adapted. Our goal has always been, and remains, to provide school communities with data to inform decision-making around safe, in-person instruction. Moving forward, decisions around safety will look different for each school district and community. We have gathered – and summarized here – data and modelling that can inform strategies to mitigate risk and empower districts to make decisions that meet the needs of their unique communities.

Available data

<table>
<thead>
<tr>
<th>Publication</th>
<th>Approximate Time Frame &amp; location</th>
<th>Variant</th>
<th>Community rates (cases/100,000/7 days)</th>
<th>Setting and Mitigation strategies</th>
<th>Major Findings regarding COVID-19 and viral transmission in schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zimmerman et al</td>
<td>Fall 2020 (NC)</td>
<td>Ancestral</td>
<td>100</td>
<td>Hybrid education, universal masking</td>
<td>Secondary attack rate ~ 1%; For every 100 primary cases (community-derived) entering school buildings, we observed fewer than 5 within-school transmission events</td>
</tr>
<tr>
<td>Falk et al</td>
<td>Fall 2020 (NC)</td>
<td>Ancestral</td>
<td>100</td>
<td>Hybrid education, universal masking</td>
<td></td>
</tr>
<tr>
<td>Hershow et al</td>
<td>Fall/Winter 2020 (Utah)</td>
<td>Ancestral/Alpha</td>
<td>100</td>
<td>Full in-person; universal masking</td>
<td></td>
</tr>
<tr>
<td>Zimmerman et al</td>
<td>Winter 2020/21 (NC)</td>
<td>Alpha</td>
<td>100</td>
<td>Hybrid education or full in-person, universal masking</td>
<td></td>
</tr>
<tr>
<td>Boutzoukas et al</td>
<td>Spring 2021 (NC, WI)</td>
<td>Alpha</td>
<td>100</td>
<td>Full in-person or hybrid, universal masking</td>
<td></td>
</tr>
<tr>
<td>Boutzoukas et al</td>
<td>Summer 2021 (NC)</td>
<td>Delta</td>
<td>200-500</td>
<td>Full in-person, universal masking</td>
<td>Secondary attack rate ~ 2%; For every 100 primary cases entering school buildings, we observed 5-10 within-school transmission events</td>
</tr>
<tr>
<td>Boutzoukas et al. (manuscript)</td>
<td>Fall/Winter 2021 (national)</td>
<td>Delta</td>
<td>200-500</td>
<td>National cohort study evaluating universal</td>
<td>Secondary attack rate ~10% for the entire cohort;</td>
</tr>
<tr>
<td>Study</td>
<td>Time Period</td>
<td>Virus</td>
<td>Sample Size</td>
<td>Methodology</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>-------</td>
<td>-------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>Campbell et al. (accepted for publication, <em>Pediatrics</em> 2022)</td>
<td>Fall 2021 (NC)</td>
<td>Delta</td>
<td>200-500</td>
<td>For every 100 primary cases entering school buildings, we observe the following number of secondary cases for: Universal masking: 5 Variable masking: 12 Voluntary masking: 43</td>
<td></td>
</tr>
<tr>
<td>ABC (manuscript in preparation)</td>
<td>Spring, Summer, Fall 2021, Winter 2022 (NC)</td>
<td>Alpha, Delta, Omicron</td>
<td>100-2000</td>
<td>Secondary attack rate 2-4% focused test to stay strategy of unmasked exposures leads to reduction in quarantine by 99%;</td>
<td></td>
</tr>
<tr>
<td>ABC (manuscript in preparation)</td>
<td>Winter 2022 (NC)</td>
<td>Omicron</td>
<td>2000</td>
<td>&lt;1% positivity during alpha and delta waves. Slight uptick in screening positivity during Omicron, but no detectable impact of screening testing on secondary transmission</td>
<td></td>
</tr>
<tr>
<td>ABC (manuscript in preparation)</td>
<td>Winter 2022 (NC)</td>
<td>Omicron</td>
<td>2000</td>
<td>Secondary attack rate ~15%</td>
<td></td>
</tr>
<tr>
<td>ABC (manuscript in preparation)</td>
<td>Winter 2022 (NC)</td>
<td>Omicron</td>
<td>2000</td>
<td>Universal masking; household exposures Test-to-stay ~ 20-30% transmission among household contacts</td>
<td></td>
</tr>
</tbody>
</table>
Summary Data from the ABC National Cohort Study, currently under peer-review

Figure 1

- >13,800 school districts contacted
- 143 districts express interest
- 85 districts complete initial survey on policies
- 73 districts submit at least one week of infection and quarantine data
- 61 districts included in regression analyses
- 6 districts reported all infection data as combined (primary + secondary cases)
- 6 additional districts did not consistently differentiate infections by primary and secondary cases
- 46 consistently universally mask
- 9 have varying masking policies
- 6 consistently voluntarily mask

Figure 2. Impact of masking strategies on secondary cases, adjusted analysis
Definitions

- **Primary cases**: A school attendee infected with COVID-19 and that infection was acquired outside of the school environment.
- **Secondary cases**: A school attendee who is infected with COVID-19 on school property (it is acknowledged that this is estimated via contact tracing and testing, and that some of these cases are “tertiary cases.”)
- **Tertiary cases**: School attendees infected as a result of exposure to another attendee who was infected at school. Typically, these are linked as a “cluster” of multiple cases.
- **Total infectious burden**: Total subsequent infections plus any infections that occur in the community in people who are in contact with school attendees (typically household members of students and staff).
- **Test-to-stay**: Student 1 comes to school infected and exposes student 2. Student 1 goes home (they’re infected), but student 2 can regularly test for COVID-19 while staying at school. As long as student 2 does not develop symptoms, keeps a mask on while at school, AND tests negative, then student 2 can stay at school. Requires contact tracing, use of masks following exposure, and rapid testing.
- **Mask-to-stay**: Student 1 comes to school infected and exposes student 2. Student 1 goes home (they’re infected), but student 2 can stay in school as long as he/she does not develop symptoms AND keeps a mask on while at school. This strategy requires contact tracing and masking following exposure.
- **Appropriately masked**: A mask over nose mouth and chin. This may be accomplished with any type of mask with loops around the ears or head: a multilayer cloth, procedural (“surgical”), KN95 mask, or N95 mask.
- **Universal masking**: This is a school or district policy in which all school attendees are required to mask at all times indoors on school property except while eating or drinking. In North Carolina, the fraction of school attendees appropriately masked in the universal masking environment is ~90%.
- **Voluntary masking**: This is a policy in which children and adults decide for themselves whether to mask. The fraction of school attendees appropriately masked in the voluntary masking environment varies from community to community and over time.
- **Contact tracing**: The process of identifying all the possible contacts of an infected person for purposes of quarantine, testing, and/or required masking for the duration of possible infectivity.
- **Testing burden to districts**: Testing burden to districts may result from screening testing, testing after exposure, or symptomatic testing. In a universally-masked district, testing burden can be decreased with a strategy of mask-to-stay or focused testing of close contacts after unmasked exposures.
- **Secondary attack rate**: The proportion of cases out of those quarantined or tested (during the test-to-stay study program).

References

1) Boutzoukas AE, et al, submitted to Pediatrics for publication February, 2022; see data from the submission above.
7) Campbell et al, accepted to Pediatrics for publication February 2022 (Test-to-Stay in universal masking and Delta variant).
9) The data in this document comparing Test-to-Stay in universal masking districts to voluntary masking districts includes enrollment from January 2022 and thus the Omicron variant.