Return to School for Pediatric Solid Organ Transplant Recipients in the United States During the COVID-19 Pandemic: Expert Opinion on Key Considerations and Best Practices

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Abbreviations: AAP, American Academy of Pediatrics; CDC, Centers for Disease Control and Prevention; COVID-19, Coronavirus Disease 2019; ID, Infectious Diseases; IEP, Individualized Education Plan; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SOT, solid organ transplant; WHO, World Health Organization

ABSTRACT

The COVID-19 pandemic has created many challenges for pediatric solid organ transplant (SOT) recipients and their families. As the pandemic persists, patients and their families struggle to identify the best and safest practices for resuming activities as areas re-open. In particular, decisions about returning to school remain difficult. We assembled a team of pediatric infectious diseases, transplant infectious diseases, public health, transplant psychology, and infection prevention and control specialists to address the primary concerns about school re-entry for pediatric SOT recipients in the United States. Based on available literature and guidance from national organizations, we generated consensus statements pertaining to school re-entry specific to pediatric SOT recipients. Although data are limited, and the COVID-19 pandemic highly dynamic, our goal was to create a framework from which providers and caregivers can identify the most important considerations for each pediatric SOT recipient to promote a safe return to school this fall.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has created substantial hardships for children and their families. In early March 2020, areas across the United States (US) imposed strict measures to limit the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), including school closures, which have had deleterious impacts on the development, mental health, and socialization of children [1]. Months later, as the country re-opens, many caregivers struggle to weigh the risks and benefits of resuming activities of daily living amidst fluctuating SARS-CoV-2 community transmission. School re-entry decisions are especially difficult given incomplete knowledge of pediatric transmission dynamics, highly variable projections of community transmission rates during the upcoming academic year, and lack of clarity about which infection prevention measures will be implemented in school settings. While several other countries have been able to re-open schools without a spike in cases [2–5], how the US will fare when children return to schools, and how school return will impact higher risk pediatric patients, remains to be seen.

During this pandemic, pediatric solid organ transplant (SOT) recipients have generally been managed as a higher risk group due to use of immunosuppressive medications, the frequent presence of additional comorbidities, and knowledge that transplant recipients are at risk for more severe sequelae from other viral respiratory infections [6,7]. Although evidence thus far has not shown that pediatric SOT recipients fare worse from COVID-19 than other children, the transplant community has remained cautious when applying the general risks of COVID-19 in children to the pediatric SOT population. As a result, parents of transplant recipients are in need of clear guidance regarding return to school decisions and what

approaches, if any, they or their schools should take to protect their immunocompromised child. In addition to these health-related considerations, many are also weighing the notable academic, social, and emotional benefits of school attendance. Some school-based services and accommodations, which are common among pediatric SOT recipients [8], are not easily translated to the virtual learning environment. For others, continued home-based schooling is not a long-term option for a number of reasons.

The goal of this document is to address the most pressing questions related to return to school decisions in the US for pediatric SOT recipients. By reviewing the available literature, and potential strategies to be employed by school systems and local and state public health departments, we aimed to generate consensus statements regarding the key determinants of safe return to school for pediatric SOT recipients. How return to school decisions will impact the risk to teachers and adult staff is beyond the scope of this document. While focused on the US, we sought to a create recommendations that could potentially be applied in other countries with similar educational systems.

Although this document reflects the expert opinion of the authors, this is not a guideline or a systematic review and should not be interpreted as such. Additionally, decisions regarding whether or when schools should reopen, in general, are up to local health authorities and beyond the purview of our recommendations. We hope, instead, that this will serve as a framework to support providers and caregivers in identifying the most important considerations for each pediatric SOT recipient and family regarding returning to school when in-person education becomes an option. Finally, we recognize the dynamic nature of the pandemic and that our understanding of COVID-19 in pediatric SOT recipients will change over

time. These recommendations are based on current information and we anticipate that they will be updated as evidence evolves.

This work has been endorsed by the Pediatric Infectious Diseases Society (PIDS), the Society of Pediatric Liver Transplantation (SPLIT), the Starzl Network for Excellence in Pediatric Transplantation, the Pediatric Heart Transplant Society (PHTS), the Advanced Cardiac Therapies Improving Outcomes Network (ACTION), and the Improving Renal Outcomes Collaborative (IROC).

METHODS

A team of pediatric infectious diseases (ID) physicians was convened, consisting of specialists from across the United States with diverse academic and clinical expertise, including in transplant infectious diseases. Additional specialists were invited to participate to ensure representation from and expertise in infection prevention and control, public health, and transplant psychology. Team members met via webinar weekly beginning in June, 2020.

Clinical questions were drafted based on discussion of the most common issues faced asked by patients, families, primary and transplant providers, in relation to return to school decisions for pediatric SOT recipients. Questions were grouped according to 3 primary areas: 1) host-related risk factors, 2) community transmission and public health responses, and 3) school-related interventions. Only questions pertaining to school attendance in kindergarten through 12th grade in US schools were considered.

Team members were divided into sub-groups, based on areas of interest and expertise, and derived a final set of key questions per topic. A non-systematic review of the literature was

performed to collate data relating to each key question. This process consisted of PubMed and internet searches to identify pertinent published studies, preprint manuscripts, editorials, publicly available state policy documents, and planning considerations provided by the Centers for Disease Control & Prevention (CDC), American Academy of Pediatrics (AAP), World Health Organization (WHO), and the National Association of Independent Schools (NAIS) [9–12]. Based on the available literature, each sub-group drafted recommendations, which were then voted upon by the full group during webinars held June 30th and July 7th to ensure consensus. To be considered a consensus statement, each had to be approved by all 11 team members. The final version was sent to leadership from the following organizations for review and endorsement: the Pediatric Infectious Diseases Society (PIDS), the Society of Pediatric Liver Transplantation (SPLIT), the Starzl Network for Excellence in Pediatric Transplantation, the Pediatric Heart Transplant Society (PHTS), the Advanced Cardiac Therapies Improving Outcomes Network (ACTION), and the Improving Renal Outcomes Collaborative (IROC).

RESULTS

Of the numerous questions and topic areas that were considered, 11 questions within the 3 primary domains were derived. These key questions and statements reflect the topics that were felt to be most frequently addressed by pediatric transplant ID providers.

HOST-RELATED QUESTIONS

1. **Are pediatric SOT recipients, in general, at higher risk of SARS-CoV-2 infection or at higher risk for severe COVID-19?**

- *While we do not have evidence that pediatric SOT recipients are at higher risk for more severe COVID-19, we would manage pediatric SOT recipients as a higher risk population, compared with other children, when it comes to school re-entry decisions.*

Pediatric SOT recipients are at increased risk for infections in general, including vaccine preventable diseases, compared with non-immunosuppressed children [7]. However, the limited reports of pediatric SOT recipients with COVID-19 thus far are insufficient to evaluate whether pediatric SOT are at increased risk for SARS-CoV-2 infection [13,14]. Several transplant-focused registries exist (e.g. Improving Renal Outcomes Collaborative, American Association for the Study of Liver Disease / Society of Pediatric Liver Transplantation, Pediatric Heart Transplant Study, Pediatric Infectious Diseases Transplant Network) but have not yet been fully populated nor analyzed data to address this question adequately [15]. Furthermore, in the absence of population-based, systematic evaluations with robust testing of both symptomatic and asymptomatic individuals, case reporting in such registries is unlikely to capture the true risk or spectrum of manifestations.

Studies show that adult SOT recipients experience the full spectrum of COVID-19 severity and outcomes from asymptomatic to critical [16,17]. Notably, adult SOT recipients in published cohort studies thus far have had high rates of comorbid conditions (ischemic heart disease, diabetes, obesity, older age), making it difficult to evaluate the independent effects of transplant immunosuppression [16,17]. No specific data currently confirm an elevated risk for

severe COVID-19 in pediatric SOT recipients. Based on the available adult data and the biologically plausible risk drawn from our understanding of immunosuppressive effects and experience with other respiratory viral infections in pediatric SOT recipients, a cautious approach is warranted when considering recommendations for school attendance, until more info is available [18]. This is also in keeping with the CDC, which has recently identified "people of any age" with a SOT to be at increased risk for severe illness from COVID-19 [19]. When evaluating options in the absence of complete information, given the priority to "first do no harm," a conservative approach is warranted when considering interventions, such as school attendance, that may increase exposure risk. The potential risk for disease exposure must, however, be balanced against both the known and potential benefits of school attendance to the SOT recipient.

2. **Are there certain risk factors in pediatric SOT recipients that may place them at higher risk for severe COVID-19?**

- *There are specific risk factors (**Table 1**), drawn from experience with other respiratory viral infections in pediatric SOT recipients and emerging COVID-19 risk factors in other populations, that may be used to guide decision-making.*
- *At this time, the available evidence is insufficient to distinguish which risk factors are specific for severe COVID-19 in pediatric SOT recipients.*

Potential risk factors for severe COVID-19 among pediatric SOT recipients can be hypothesized based on understanding of the pathogenesis and risk factors for other respiratory

viral infections in SOT recipients, as pediatric data specific to COVID-19 are limited. Patients undergoing enhanced immunosuppression greater than maintenance therapy, such as those patients within the first 3 months post-transplant, may be at increased risk for severe COVID-19 [20]. While at least one pediatric patient with peri-transplant SARS-CoV-2 infection ultimately did well, intensive care readmission was required during acute stages of illness [14,20]. In addition, the use of augmented immunosuppression for rejection, especially with lymphocyte depleting therapies such as thymoglobulin or rituximab, could potentially increase the risk for severe COVID-19. These risks, such as level of immunosuppression and time since lymphocyte depleting treatments for induction or rejection, lessen over time for an individual patient such that risk can be considered on a continuum and reassessed periodically. For example, a child may be considered relatively high risk early in the school year due to anti-rejection therapy, but with diminished risk later in the school year as their immunosuppression is tapered.

Another important consideration is the presence of medical comorbidities that may be seen in pediatric SOT recipients independent of the level of immunosuppression. Other comorbidities that may increase the risk for severe respiratory viral infection, and which are potentially applicable to COVID-19, include chronic lung disease, particularly with tracheostomy and/or ventilator-dependence, obesity, hyperlipidemia, diabetes mellitus, and heart disease [21,22]. These comorbidities are seen with greater prevalence in pediatric SOT recipients compared with other children because of the underlying etiology for transplant or post-transplant medical therapy [23–25]. Pending further data, a pediatric SOT recipient with one or more potentially high-risk comorbidities could be considered at elevated risk for severe COVID-19 when considering school attendance. Additionally, the relative clinical severity and stability

of each of these comorbidities could also be considered when weighing potential risk. **Table 1** provides a provisional framework for considering risk stratification of pediatric SOT recipients for the purposes of shared decision-making around school attendance. It is important to note that this is not a validated risk stratification system based on strong evidence, but reflects hypothesized risk and expert opinion.

3. **Are there higher risk pediatric SOT recipients that should not return to school this fall?**

- *The decision for any child who has had a SOT to return to school is a matter of shared decision-making between families, transplant professionals and educators, and depends on many factors including the child's clinical risk assessment (**Table 1**), level of circulating SARS-CoV-2 in the community, and preparedness of both the child and the school personnel to adhere to recommended precautions to prevent viral transmission (**Table 2**).*

As outlined in **Table 1**, pediatric SOT recipients can be provisionally considered in three major risk groups for the purposes of considering potential risk vs. benefit of return to school. It is important to note, however, that these risk groups must be taken into consideration along with community (Section 2) and school factors (Section 3). A recipient's potential risk is only one component of the decision-making process, and can change over the course of the school year; decision-making regarding return to school should thus be reassessed as the patient's clinical status changes.

Within the “low potential risk” group are those children who are clinically stable and immune tolerant receiving minimal doses of maintenance immunosuppression. This group also includes patients who have been completely withdrawn from immunosuppression, which is possible in a subset of liver transplant recipients [26]. Children within this category are unlikely to be at increased risk for severe COVID-19 over the general pediatric population unless another concurrent risk factor is present. For individuals in this group, in-person school attendance is generally advisable. The risk-benefit assessment for school attendance and precautions taken in school to prevent transmission should mimic the approach for otherwise healthy children [10].

In contrast, children considered at “high potential risk” include those within the early months following transplantation, following intensified anti-rejection therapy, with unstable graft function, or if severe comorbidities exist. This group would also include individuals with complex comorbidities requiring frequent adjustment of medical management. Prior to COVID-19, most pediatric SOT recipients within this category would be counseled to remain home and pursue remote learning in the setting of significant community respiratory viral transmission. By extension, a cautious approach is advisable for COVID-19 until the specific risk is better understood. While not all children in this group need to remain home, careful consideration of local community transmission and available infection prevention measures in the school are imperative.

The majority of pediatric SOT recipients are likely to fall into the “moderate potential risk” category, such that their level of risk over the general pediatric population is not understood at this time but *may be* increased due to transplant immunosuppression. For these

individuals, return to in-person school attendance is generally advisable due to the compelling benefits of school attendance, yet should be considered on a case-by-case basis, weighing additional factors including the presence, degree of severity and stability of other comorbidities, as well as the level of community transmission (considerations in Section 2) and robustness of precautions in the school environment (considerations in Section 3). It is recommended that children in the "moderate potential risk" category follow precautions at school outlined in Section 3 (Question 1), which may, depending on the local requirements, be more stringent than those recommended for otherwise healthy children. Similar to decision-making for the "high potential risk" category, decision-making regarding school attendance should be re-evaluated if the child develops one or more factors that suggest an increase in potential risk for severe COVID-19.

Age has also been identified as an important risk factor for more severe manifestations of COVID-19 and an increased risk for adolescents compared to younger children [27,28]. However, teasing out the specific risk related to age for SOT recipients, who also are more likely to have comorbid conditions than other children, is difficult. An additional important individual consideration should be the pediatric SOT recipient's developmental and behavioral readiness to adhere to recommended precautions in the school setting. The child should be able to consistently demonstrate ability to practice appropriate hand hygiene, to wear a face covering consistently for the time period of school attendance, and to physically distance with appropriate prompts and support from school personnel. Adult caregivers should prepare the child for new norms within the school environment in a developmentally-appropriate manner. For a child who does not yet demonstrate readiness to follow hygiene, face covering, and

distancing precautions, school attendance may still be attainable. An Individualized Education Plan (IEP) or 504 Plan that includes school personnel support to aid a child in adhering to precautions or modified precautions that provide a comparable level of protection (e.g. cough/sneeze barriers, increased physical distancing) may help an individual child achieve recommended precautions. For those with sensitivities to or difficulties with wearing face coverings, behavioral therapy is likely to improve adherence with this recommendation.

4. Can a sibling of a high-risk pediatric SOT recipient return to school?

- *In general, siblings of pediatric SOT recipients should be encouraged to return to school.*
- *However, infection prevention measures for the sibling, both at school and within the home, should be emphasized to minimize transmission risk to the SOT recipient.*

The decision to send a pediatric SOT recipient's sibling(s) to school also requires thoughtful consideration. Siblings should be supported in a developmentally appropriate manner to adhere to recommended hygiene measures, face covering, and physical distancing that are recommended in the school setting. In general, in-home transmission of SARS-CoV-2 among children is uncommon [29]. However, a recent report found that rates of household transmission when an index case was 10-19 years of age were similar to rates when an index case was an older adult [30], although it's unknown how these transmission dynamics translate to school settings. At home, siblings should be encouraged to maintain frequent hand hygiene, appropriate toilet hygiene, and to avoid sharing utensils, food or drink with the pediatric SOT recipient. Additionally, if the sibling develops symptoms of illness, contact between the sibling

and pediatric SOT recipient should be minimized and the sibling should be supported to follow cough and sneeze etiquette (e.g. into the elbow, followed by hand hygiene). At school, siblings of high-risk SOT recipients should follow the same infection prevention measures outlined in the School-Related Questions section below.

COMMUNITY-RELATED QUESTIONS

1. **Should ongoing community transmission prompt a moderate- or high-risk pediatric SOT recipient (Table 1) to pursue virtual learning options, for a period of time, even if the school remains open?**

- *Spread of SARS-CoV-2 within local communities will continue to vary greatly in different parts of the US and over time. Public health responses to changing rates of infection and community acceptance of recommendations from local public health authorities, will also vary from one place to another.*
- *High and moderate risk pediatric SOT recipients (Table 1), their parents and caregivers, and local schools need to account for changing data on community-level and school-specific spread of infection in determining the level of risk of exposure to infection they are willing to accept.*
- *Increasing SARS-CoV-2 community transmission should prompt caregivers to reassess the most appropriate learning setting for their pediatric SOT recipient.*

Transmission of SARS-CoV-2 has not affected communities uniformly throughout the

pandemic. It is likely that in the future, outbreaks of infection will continue to occur at different times and places, and may be affected by mitigation strategies that have been adopted differently by states and communities. Current data suggest that school closures have not played a large role in affecting SARS-CoV-2 community-level transmission [2,4,31–35], though many regions quickly implemented school closures when local cases were identified [32], potentially limiting the burden of infection in children. It is likely that as schools open, cases of infection will occur in students, teachers and/or staff. This will result in the need for exclusion from school both for cases of infection and their close contacts.

As the transmission rate increases in a local community, so does the chance that students or staff at the school may become infected at home or from a community source. This, in turn, increases the likelihood that a pediatric SOT recipient may encounter a case at school. In its guidance considerations for schools, the CDC [9] uses low, medium, and high transmission levels to inform school mitigation strategies, but does not define specific threshold rates of community infections for each level. Instead, transmission dynamics that indicate rebound SARS-CoV-2 activity will differ among states and be determined at a statewide or community population level. An interactive map (https://globalepidemics.org/key-metrics-for-covid-suppression/) provides county level transmission data in cases per 100,000 and could be used as a resource. Additionally, local factors such as increased absenteeism or an increased percentage of positive cases in the student's school may also be informative about local risk to the individual SOT recipient.

Ultimately, there is no specific level of community transmission that should prompt pediatric SOT recipients to stay home when schools otherwise remain open. Instead, decisions

may need to change as local virus transmission rates fluctuate. For instance, the family of a high-risk SOT recipient may determine that return to in-person education is preferred when community transmission rates are low, but virtual learning options are best if local transmission increases. The capacity of a local health department to perform testing of symptomatic individuals, as well as contact tracing, may also influence decisions for a high-risk recipient to return to school. In lower resource communities, fewer testing opportunities may impede early identification of infected students and change the threshold of community transmission at which return to school is deemed safe. Families should maintain an open dialogue with the child's school so that this information can be shared and initiate discussion between the family and the transplant provider about when to pursue virtual learning options.

2. Should a pediatric SOT recipient stay home if there is a case of COVID-19 in their school or in their classroom?

- *Individual risk of infection will depend on the degree of contact that a pediatric SOT recipient had with a presumed or confirmed case. In the absence of close contact, it will likely be permissible for a pediatric SOT recipient to continue attending school in person.*
- *Schools and local public health authorities will initiate specific responses and provide recommendations when cases are suspected or identified in a school or classroom.*

Local health departments, in accordance with CDC guidance [9], may recommend dismissing students and staff for several days after identification of an infected student, staff member, or school visitor who attended the school prior to knowing they had COVID-19. The

purpose of this short-term closure is to allow time for the school to clean and disinfect the affected facilities, and for local health officials to investigate the specific situation at the school and implement contact tracing activity. Local health officials will determine appropriate next steps, including whether an extended dismissal duration is needed to stop or slow further spread of infection.

Schools can assist the local public health process by working to limit contacts among students, to the extent that it is possible. Additionally, having information on specific student placement, such as seating charts, can help to identify close contacts. Students, including SOT recipients, who are not considered close contacts to an infected individual will not need to be excluded from school. However, it is possible that if schools are unable to reliably determine the nature of contacts within a class or school, that wider school dismissals may be necessary.

3. Is there value in serologic testing for pediatric SOT recipients prior to return to school?

- *There are currently knowledge gaps regarding the degree of protection from infection that is indicated by a positive antibody test, and if there is protection, how long it will last.*
- *As a result, there is no current role for serologic testing in assessing the individual risk of returning to school.*

Antibody testing to assess prior infection with SARS-CoV-2 is becoming more widely available; however, there are several caveats to the application of this testing in general and specific to pediatric SOT recipients. A variety of different manufacturers have developed tests

to assess SARS-CoV-2 antibody levels, but the performance characteristics are not well-described for many of them. One potential performance issue is cross-reactivity with seasonal coronaviruses, which could result in false positive testing. The relative diminishment in immune response of SOT recipients may also affect testing reliability. While a recent case series of adult transplant recipients demonstrated a positive serologic response in the seven patients tested [36], there has been at least one report of a renal transplant recipient with PCR-confirmed COVID-19 who failed to mount an antibody response after recovering from infection [37].

It is also not known whether demonstration of a serologic response against SARS-CoV-2 correlates with protection against disease after subsequent exposure, and if it does, how long such protection lasts. Memory T cell responses induced by other betacoronaviruses may also mitigate susceptibility to SARS-Cov-2 infection [38]. Although animal models of SARS-CoV-2 infection support the development of short term resistance to re-challenge [39], the degree to which such protection is mediated by antibodies alone, or whether adaptive cellular responses are important, is not known. In a study of 149 individuals recovered from COVID-19, titers of neutralizing antibody were variable although IgG memory B cells that produce neutralizing antibodies could be detected [40]. The duration of protection is also uncertain, and it is known that immune protection against infection with seasonal coronaviruses diminishes over time [41]. Antibodies may wane over time, though it remains possible that memory cellular immunity may provide some protection. How all of these arms of the immune system are affected by the immunosuppressive regimens of a pediatric SOT recipient has not been studied.

For the above reasons, current recommendations from the AAP and CDC are that serologic testing cannot provide significant information on protection from disease. Thus,

serologic testing should not be used to guide decisions on whether a pediatric SOT recipient should return to school.

SCHOOL-RELATED QUESTIONS

1. **What are the minimum infection prevention measures that should be in place for all pediatric SOT recipients to return to school?**

- *Physical distancing: pediatric SOT recipients should adhere to physical distancing (optimal: >6 feet, minimum: >3 feet) in all settings in which they would have prolonged contact (>15 minutes) with another student, teacher, or staff.*
- *Masking: In situations when physical distancing of at least 6 feet will not be possible and contact will be prolonged, a face covering should be worn by the pediatric SOT recipient. If all students and staff are wearing cloth face coverings, then a cloth covering will be sufficient for the SOT recipient, otherwise the SOT recipient should wear a surgical mask.*
- *Hand hygiene: Frequent hand hygiene should be openly encouraged for all students including, but not limited to, upon classroom entry, before and after eating and use of bathrooms, and before and after touching shared objects.*
- *Cleaning and disinfection: Schools should have policies in place to ensure that cleaning and disinfection practices adhere to local health department and CDC guidance.*
- *Exclusion of ill students and staff: Schools should implement policies to identify sick students and staff, as well as those who have been exposed to a known COVID-19 case, prior to school entry on a daily basis.*

The CDC and AAP have released guidance that outlines important considerations for those developing policies to mitigate the spread of COVID-19 within schools [9,10,42]. Of the numerous potential interventions that could be implemented (**Table 2**), five areas will likely be of greatest importance to minimize risk to all children, including SOT recipients: physical distancing, face covering/masks, hand hygiene, cleaning and disinfection, and exclusion of ill students/staff. These measures, which have been the cornerstone of public health re-opening recommendations, are imperative for the safe return of higher risk students to in-person education. When schools reopen, there will undoubtedly be substantial variability in how schools adhere to guidance from the CDC and AAP, but we feel that the above represent the minimum measures to ensure a safe learning environment for SOT recipients.

A meta-analysis including 38 studies and more than 10,000 participants found a significant reduction in transmission of coronaviruses (SARS-CoV, SARS-CoV-2, MERS-CoV) when physical distancing exceeded 1 meter and that protection increased based on distance (2.02-fold change in relative risk per meter) [43]. In an ideal scenario, physical distancing of at least 2 meters (6 feet) will be in place in all classrooms. But, this is an area of debate and the ability for schools to arrange classrooms to adhere to these physical distancing recommendations will vary. The AAP states, “Evidence suggests that spacing as close as 3 feet may approach the benefits of 6 feet of space, particularly if students are wearing face coverings and are asymptomatic [10].” We believe these physical distancing measures to be imperative for SOT recipients and should be followed in conjunction with other infection prevention measures, as below. Physical barriers (i.e. plastic desk separators) may also be an option when adequate spacing is a concern.

SARS-CoV-2 is spread primarily via respiratory droplets, which are generated during coughing and sneezing, but also during normal speech [44,45]. The meta-analysis by Chu et al. included 6 studies comparing using a surgical face mask (or similar) to no face mask and demonstrated that use of a surgical face mask was associated with significant protection against viral infection compared with no mask [43]. The use of eye protection was also associated with protection from infection, though none of the included studies evaluated use of a face shield in non-healthcare settings. Cloth face coverings, when worn by all individuals, effectively prevent the spread of respiratory droplets from one individual to another but are less effective to prevent acquisition of viral particles when worn by one individual alone [46]. Given these data, we believe that SOT recipients would benefit from wearing a surgical mask (i.e. medical mask, or a 3-ply disposable mask) when face coverings are not universally worn and physical distancing is not possible. This may be more difficult in younger children, and this recommendation should be followed only if masks can be worn properly without increasing hand-to-face activities. If cloth face coverings are worn by all students and staff, use of a cloth face covering will also suffice for the transplant recipient. Clear face shields could be considered in lieu of a surgical mask or cloth face covering if education is impaired when wearing a mask that obscures the SOT recipient's mouth (e.g. impedes enunciation or another student's ability to understand the SOT recipient's speech) or in younger students who cannot tolerate a mask, recognizing that the effectiveness of a face shield without a mask has not been studied in younger school-aged children. When surgical masks are not available, wearing a face shield with a cloth face covering is a reasonable alternative, again noting that efficacy data in children are absent.

Person-to-person transmission of SARS-CoV-2 is also possible when hands become soiled or after touching a contaminated surface [47]. Thus, protocols should be in place to ensure that adequate cleaning and disinfection takes place within schools. Protocols should specify routine measures to be taken, as well as specific practices that will be followed should a COVID-19 positive student or staff member attend school. Frequent hand hygiene should be encouraged for and accessible by all students and staff, particularly upon entry into classrooms, after use of bathrooms, after eating, and following use of any shared objects.

Early identification of cases and removal of infected individuals from schools may prevent transmission within classrooms. Comprehensive investigation following two separate events where students with SARS-CoV-2 infections attended schools identified no evidence of transmission [34]. In these two instances, including a 5-year-old and a 12-year-old who both attended school on their first day of symptoms before being isolated, 42 symptomatic contacts were followed and none tested positive for SARS-CoV-2. Daily symptom and exposure screening would be optimal to identify and exclude potentially contagious students and staff from school grounds. However, the extent to which this will be possible for all schools is unclear. Nevertheless, for pediatric SOT recipients to return to in-person learning, schools should have a policy that requires that families keep a sick child at home and outlines what signs and symptoms will qualify for exclusion from school. Schools should also detail how contact tracing will occur and what will be done if a student or staff member becomes sick while at school, as well as outline what requirements must be met to return to school. Schools should also implement flexible leave policies for staff to discourage coming to work sick.

2. **Are there additional infection prevention measures that should be in place for high-risk pediatric SOT recipients to return to school?**

- *<u>Masking:</u> Surgical masks should be worn by high-risk pediatric SOT recipients at all times when physical distancing (at least 6 feet) will not be possible, even if close contact is not prolonged and/or other students are wearing cloth face coverings.*

Based on meta-analysis from Chu et al, protection against viral infection is increased with increased physical distancing and with use of surgical masks, specifically [43]. Although younger children may transmit SARS-CoV-2 less efficiently, data are insufficient to make age-specific recommendations regarding physical distancing requirements for higher risk individuals [34]. Thus, we believe that all high-risk SOT recipients should adhere to 6-foot (2-meter) physical distancing requirements when prolonged contact with another individual will occur. Although schools may not have space to arrange all desks >6 feet apart, schools may consider modified classroom arrangements such that some desks are >6 feet apart, enabling high risk students to maintain this preferred physical distance. We would also recommend that surgical masks be worn by high risk SOT recipients in all settings in which physical distancing cannot be maintained, even if contact will not be prolonged and regardless of whether other students are wearing cloth face coverings. This would include high risk SOT recipients wearing masks at all times if they or their classmates cannot reliably adhere to distancing and/or masking recommendations.

3. **What should parents/caregivers of a pediatric SOT recipient discuss with their school regarding learning and health accommodations for their child?**

- *Communication: Disclosing a child's transplant status with the school is recommended for pediatric SOT recipients to promote open communication between the school and family specific to the presence of school-based cases and the potential need for any changes in a SOT recipient's learning plans or accommodations.*
- *Individualized Education Plans (IEP) and 504 Plans: Although not necessary for all pediatric SOT recipients, IEPs and 504 plans may be helpful to identify specific supports/accommodations that will benefit the student's education in the setting of the ongoing pandemic.*

Open communication between families of SOT recipients and schools is important to facilitate transitions back to school, set expectations for attendance and performance during the school year, and identify periods where local transmission of communicable diseases poses significant risk to the student. All parents should anticipate challenges to establishing a routine for a high-risk individual since the health of the student and the safety of the school environment may fluctuate over the academic year. Although not necessary for all pediatric SOT recipients, IEPs and 504 plans, which provide children with health impairments or other disabilities specialized instruction, services, and accommodations to ensure academic success, may be helpful. Some specific supports/accommodations to consider include: excused absences, flexible learning instruction (i.e., transitioning to/from in-person to virtual learning), school personnel support for adhering to recommended precautions, permission to bring own

cleaning/disinfecting supplies if not available, opportunities to make-up missed work, and access to learning materials (e.g., textbooks) for at-home learning.

4. **Are there other preventative measures that a pediatric SOT recipient should take in advance of returning to school?**

- *SOT recipients and their household contacts should receive all eligible immunizations, including inactivated influenza vaccination.*
- *Families should discuss immunosuppression with transplant providers with the goal of maintaining the minimal amount of immunosuppression necessary to prevent rejection while minimizing infection risks.*

Administration of routine childhood vaccinations has substantially declined in the U.S. during the COVID-19 pandemic [48]. This may lead to community outbreaks of vaccine-preventable infections, which could pose substantial risks for high-risk children upon school re-entry this fall. All children should receive recommended immunizations prior to school re-entry, especially those at higher risk for more severe sequelae of infections, such as SOT recipients. Influenza vaccination will be particularly important this academic year to reduce the risk of concurrent circulation of influenza and SARS-CoV-2.

All pediatric SOT recipients should have a discussion with their transplant providers prior to school re-entry regarding immunosuppression and sick day plans. There are no data to support that immunosuppression should be empirically lowered during the COVID-19 pandemic or that specific immunosuppressive agents should be avoided. We instead support the

continued goal of use of adequate amounts of immunosuppressive medications to prevent rejection, while minimizing infection risks.

DISCUSSION

The COVID-19 pandemic has created unprecedented circumstances and unique challenges for vulnerable children around the world. While caregivers are grappling with difficult decisions regarding returning to schools, public health officials, local health departments, and school administrators are working hard to make returning to school as safe as possible. We fully support efforts to allow all children to safely return to in-person education this academic year. Schools often provide robust learning and socioemotional supports, helping to mitigate achievement gaps for children and adolescents with various risk factors, including chronic illness. These in-person school-based supports can be particularly valuable for pediatric SOT recipients given the higher rates of executive functioning and academic impairments, as well as educational service needs [8]. Many young people also receive critically important mental health services through their school system [49], which is an important consideration given the impact of the pandemic on emotional wellbeing in children and adolescents. For many families facing financial stressors, schools help to address food insecurities, as well as other barriers to home-based schooling, such as technology/internet access and caregiver availability [1]. Thus, we recognize that parents and caregivers are considering many factors, some competing, when making decisions about returning to school. We also know that data are limited, evidence is evolving, and capacity to implement specific interventions will vary across the country. Therefore, we have developed these recommendations in hopes that they can be

useful for parents and providers of pediatric SOT recipients who are weighing the risks and benefits of various learning options on an individual level.

Our understanding of SARS-CoV-2 continues to evolve during the COVID-19 pandemic. It remains difficult to provide strong recommendations given the paucity of robust data to inform guidance, but there are some reassurances. Emerging data have shown that children are disproportionately less affected compared with their adult counterparts [50,51]. Children who become infected also have milder disease and some remain asymptomatic. The minority develop severe disease; in those requiring admission to the intensive care unit, approximately half have a pre-existing comorbidity [22]. Obesity and asthma are more frequently reported comorbidities than underlying immunosuppression in children with COVID-19 laboratory-confirmed hospitalizations in the US [28,52,53]. The reasons why children are less affected and have milder clinical manifestations, have not been fully elucidated. It also appears that children may contribute less to COVID-19 transmission than adults and are less likely to be the index case in household transmissions [27,35,54–58]. Specific data from pediatric SOT recipients remain limited; however, there continues to be a lack of evidence that COVID-19 is more frequent or severe in this population.

At the start of the COVID-19 pandemic, many nations confronted with high rates of SARS-CoV-2 community transmission, implemented country-wide school closures, impacting 60% of the world's student population [59]. Limited historical experience with school closures during the SARS epidemic in 2003 and theoretical modelling studies estimate that SARS-CoV-2 transmission in classroom settings is low and that school closures alone would have minimal impact on modifying the COVID-19 pandemic [32,60,61]. Emerging reports from countries that

kept schools open during the present COVID-19 pandemic additionally demonstrate encouraging results [62,63]. In Stockholm, investigators were able to monitor all hospitalizations for laboratory-proven SARS-CoV-2 and found a low incidence of pediatric hospitalizations for COVID-19, despite daycare centers and elementary schools remaining open and seeing an increase in hospitalizations in adults [4]. In Australia, 9 staff and 9 students with SARS-CoV-2 from 15 schools had close contact with another 735 students and 128 staff, yet only 2 secondary infections were identified, in one elementary and one high school student [5]. In France, a nine-year-old student with SARS-CoV-2 had exposed 80 contacts, yet no secondary COVID-19 cases were reported despite contact tracing investigation [35]. In Ireland, SARS-CoV-2 infections among 3 students and 3 staff resulted in 1,155 contacts investigated, with no confirmed secondary cases occurring in other children [2]. In the Netherlands, children ≤ 6 years of age were allowed to attend daycare and kindergarten even if they had mild upper respiratory infection symptoms, as long as they had no fever or known contact to a COVID-19 case; using this approach and testing 3,500 symptomatic children, 0.5% had detection of SARS-CoV-2 [64]. Finally, in Singapore, where schools remained open and multiple public health measures were implemented, 3 cases (2 students, 1 staff) in 3 distinct schools were identified using comprehensive nationwide public health surveillance and contact tracing [34]. All 3 had adults identified as the index case and even when nasopharyngeal viral screening was performed on asymptomatic classmates, no secondary cases were reported.

Although only an incomplete snapshot, these reports highlight that the risk of SARS-CoV-2 transmission among children in school appears to be low and that secondary cases in students are rare. But, there will undoubtedly be cases that occur as U.S. schools reopen and

steps must be taken to maximize the safety of all children, teachers, other staff members, and their families. We recognize that data on COVID-19 in pediatric SOT recipients are sparse and evidence about best practices to mitigate spread of SARS-CoV-2continues to evolve. We have developed this document to provide a constructive framework for how to think about risk, specifically for pediatric SOT recipients and aid in the decision-making process. While we hope that most pediatric SOT recipients who had previously attended in-person education prior to the COVID-19 pandemic can do so when schools reopen, we recognize that risk will vary substantially across communities and schools, and that decisions must ultimately be shared between patients, families, providers, and their schools.

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Table 1: Risk stratification for pediatric SOT recipients based on potential risk factors for severe respiratory viral infection			
Potential risk category	High potential risk	Moderate potential risk	Low potential risk
Definition	Pediatric SOT recipients at potentially increased risk for severe COVID-19 based on extrapolation of risk factors from other respiratory viruses, emerging pediatric risk factors for severe COVID-19, and adult risk factors for severe COVID-19 (meeting any of the following criteria)	Pediatric SOT recipients with possible elevated risk over the general pediatric population but without other specific risk factors apart from standard SOT immunosuppression	Pediatric SOT recipients unlikely to have substantially elevated risk for severe COVID-19 over general pediatric population (meeting all of the following criteria)
Level of immunosuppression	SOT recipients within early months post-transplant (i.e. first 3-6 months) SOT recipients undergoing augmented immunosuppression for rejection with high dose corticosteroids or lymphocyte depleting therapies (e.g. thymoglobulin, rituximab) SOT recipients who are escalating or not yet tapering immunosuppression	SOT recipients on stable maintenance immunosuppression SOT recipients beyond the first 3-6 months following transplant or anti-rejection therapy who are tapering immunosuppression	Immune tolerant SOT recipients on stable immunosuppressive monotherapy (e.g. tacrolimus) with low or undetectable trough levels or not receiving any immunosuppression

Stability of graft function and underlying disease indication for transplantation	Unstable graft function, increased likelihood of requiring augmented immunosuppression for rejection or other medical interventions to preserve graft function	Stable or improving graft function with low likelihood of requiring augmented immunosuppression for rejection or other medical interventions	Stable graft function
Potentially high-risk comorbidities	Presence of multiple medical comorbidities or single comorbidity that is severe or requiring frequent adjustment of medical management, including: ● Obesity ● Diabetes mellitus ● Chronic lung disease ● Tracheostomy and/or ventilator dependence ● Cardiac dysfunction ● Neurologic disease Presence of another concurrent condition leading to immunocompromise (e.g. cancer therapy for hepatoblastoma or for secondary malignancy, primary immunodeficiency)	Single medical comorbidity that is medically stable or improving and not requiring frequent adjustment of medical management	No potentially high-risk comorbidities
Developmental and behavioral readiness to adhere to precautions in school setting	SOT recipient who would otherwise be categorized as “moderate potential risk” but due to developmental readiness, does not consistently demonstrate	SOT recipient who would otherwise be categorized as “low potential risk” but due to developmental readiness, does not consistently demonstrate	SOT recipient demonstrates ability to adhere consistently to optimal hygiene, face covering and physical distancing practices

	ability to adhere to optimal hygiene, face covering and physical distancing practices AND Low likelihood that school personnel would be able to consistently support adherence to precautions.	ability to adhere to optimal hygiene, face covering and physical distancing practices AND Low likelihood that school personnel would be able to consistently support adherence to precautions.	OR SOT recipient has an individualized plan in place such that school personnel can consistently support adherence to optimal hygiene, face covering and physical distancing practices.

Table 2. School-related considerations for pediatric SOT recipients when assessing risks of return to school.			
General area	**Examples of school-based interventions**	**Why important**	**Pertinent questions for pediatric SOT recipients**
Readiness, preparedness and educational options			
Attendance modifications	● Distance learning options ● Staggered attendance ● Modified absenteeism policies	● Supports lower student density and physical distancing ● Provides support for students at home due to: ○ Personal choice or high-risk condition ○ Intercurrent illness ○ Exposure and need for quarantine	● Is online learning an option for higher risk students? ● Can higher risk students be offered more flexible attendance policies? ● Can I update my child's IEP or 504 plan with educational contingencies that promote continuity of learning?
Communication with students, families, and staff	● Use of a reliable communication tree for time-sensitive events ● Regular updates from schools and/or local health	● Schools must maintain student confidentiality and cannot disclose individual student's health status to families ● Clear and timely	● How will students/families be notified of important information? ● Should a SOT recipient inform classmates, families, and

	departments to parents and community stakeholders using written and virtual modalities ● Accessible resources for families	communication between schools, local health departments, and families will be critical to ensure the safety of all students, teachers and staff	teachers that he/she may be at higher risk?
Individual and environmental infection prevention practices while in school			
Face coverings and masks	● Use of face masks in children ≥ 2 years of age and those students who can remove masks without assistance ● Use of face masks or shields for teachers, staff, or adult learners	● Face coverings can limit person-to-person spread, but their routine use in children is challenging ● Surgical masks are more effective than cloth face coverings for preventing acquisition of viral infections ● Face shields may be preferred for teachers or others to allow students, particularly those that are hearing impaired, to	● Can the child wear a face mask for an extended period of time without touching his/her face? ● What type of face covering will other children be wearing?

		see the individual's face/mouth	
Hand hygiene and cough etiquette	● Routine or scheduled hand hygiene with access to soap and water or 60% ethanol ● Age-appropriate targeted education to promote and reinforce proper respiratory etiquette and hand hygiene	● Routine hand hygiene can reduce spread of respiratory infections	● Does the school have a plan for enhanced hand hygiene? ● How will the school ensure adequate supplies? ● Can students bring their own supplies?
Managing student flow to reduce congestion	● Reduced contact at drop-off and pick-up ● Staggered start/stop times for classes and meals ● One-way hallway traffic ● Assigned entrances	● Managing student movement in common areas will reduce contacts between students ● If student mixing is unavoidable, establishing entry/exit points and visual aids will direct flow and support social distancing measures	● Can higher risk students be offered more flexible schedules to avoid settings/situations where physical distancing is not possible?
Managing shared	● Cafeteria use in shifts	● Strategizing meal times will	● How will shared spaces be

spaces to reduce contacts	● Scheduled restroom use by class ● Playground use by single cohorts	ensure food safety by providing individual student meal services in non-cafeteria settings ● Rotating use of shared spaces will reduce the number of contacts between students	managed to reduce the number of contacts for students?
Optimizing physical distancing measures in classrooms	● Desk spacing to comply with 3-6 feet of separation and in same direction ● Limited sharing of school equipment or supplies ● Reduction in class size or alternating classroom use to larger, well ventilated spaces or outside areas (weather permitting) ● Assigned seating, cohorting of students	● Promoting physical distancing of 3-6 foot radius per student will reduce possible exposure to respiratory droplets and limit viral spread ● Schools will need to individualize measures based on the maximum number of participants allowable to comply with space and activity precautions	● What measures can our school put in place to comply with physical distancing measures?

Managing group gatherings, extracurricular activities, field trips	● Cancellation of extra-curricular activities, athletic events, and group gatherings that cannot comply with physical distancing recommendations ● Limited traveling within and outside of geographic regions	● Supplemental activities at school are important for social and emotional development. However, these activities may result in increased contact and may need to be cancelled when there is community transmission of SARS-CoV-2. ● Schools should engage in virtual group activities with students in lieu of in-person events, when possible	● How close will children be to one another, for how long, and will they be wearing a mask? ● What will trigger cancellation of an activity?
Enhanced cleaning procedures	● Scheduled cleaning and disinfecting of classrooms, bathrooms, and high touch surfaces ● Restricted activities involving shared objects (books, computers, instruments, etc.) to allow cleaning between	● Person-to-person transmission is the primary means of infection, but contaminated objects can serve as fomites ● Schools will need to have a plan for safe and consistent use of cleaners and disinfectants, which may vary	● How and how often will objects and classrooms be cleaned?

	uses, as possible ● Elimination of toys and nonessential high-touch objects from classrooms and playgrounds	based on age of students, resource availability, and physical space considerations	
Alternate transportation plans	● Single seating, seating by families, or back-to-front seating on buses	● Physical distancing on buses may be difficult. Policies should be in place to ensure that they are adequately cleaned and disinfected, and to promote physical distancing as much as possible	● What alternative transportation arrangements are available to students, such as walking, biking, or driving?
Screening procedures for students and staff and actions taken once ill/exposed student or staff member identified			
Establish school stay-at-home and closure policies	● Clearly defined and enforced stay-at-home policies, and return to school/work criteria. ● Temporary school closures if confirmed COVID-19 case within a school or classroom.	● Policies that prevent students and staff from coming to school while ill will reduce the spread of infection in schools ● Prompt reporting without penalizing illness-related	● How will these policies be enforced to mitigate risk of exposure to others? ● How will families be notified of sick students or staff? ● What will be the policy for

		absences for students and staff will facilitate compliance with these policies ● School closures may be necessary to adequately clean, disinfect, and perform contact tracing	return to school after a symptomatic illness?
Daily health screening of students and staff	● Temperature checks at school entry ● Screening based on symptoms and epidemiologic viral exposures ● Algorithm for referring students who screen positive for SARS-CoV-2 testing	● Screening students and staff for symptoms of or exposure to SARS-CoV-2 is important for preventing introduction of the virus into schools	● Will daily screening be required for school attendance? ● How will screening be performed (i.e. in-person, online, etc.)?