PINNACLECARE

Medical Intelligence Report

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Topic: COVID-19 in Children and Young Adults

Overview

The contribution of children and young adults to the growth of the COVID-19 pandemic has been of great interest in recent weeks. The reopening of schools and other childcare facilities is an important step in allowing parents to effectively return to work. The role of young adults in the transmission of the virus and whether secondary schools and colleges can reopen have also been part of the debate.

Some of the confusion stems from early descriptions of people at risk for infection. In order to communicate the increased risk for older individuals and possibly to prevent anxiety over the outbreak, early descriptions of COVID-19 downplayed the risk to younger individuals and children. **While the risk of death from SARS-CoV-2 infection continues to be low for younger individuals, the risk of infection of younger people and subsequent transmission to their contacts of all ages has been found to be largely similar to that of adults**. This raises the question of whether restarting in person schooling would increase the rate of transmission in the whole community. With the number of specific details about SARS-CoV-2 that still remain, it is not possible to predict with any good accuracy what would happen upon resumption of classroom-based teaching. Instead it is necessary to make assumptions based on limited data and allow officials the flexibility to quickly adjust as the situation warrants.

> **It is also necessary to understand that it is possible to enact policies that reduce the risk of transmission and allow for quick isolation to prevent further spread, but it is not possible to completely prevent transmission.**

The only way to prevent all transmission from occurring at this time is to enact strict isolation rules because there are no treatments or vaccines that can reduce the effects and transmission of the virus.

Transmission of SARS-CoV-2 from Younger Individuals

There have been a number of studies investigating the transmission rate of SARS-CoV-2 in children, and there are still not definitive results on the role of children in the current COVID-19 pandemic. However, a recent study from South Korea investigated the contact tracing of a large

number of people with a wide range of ages that gives the first glimpse of how transmission from outside the home occurs (Park et al., 2020).

The data from the study was collected between January 20 and May 13 and includes all the reported COVID-19 cases in South Korea during that time. There were 10,962 cases reported, and each was tested using PCR-based testing. In the study an **index case** was defined as "the first documented case in an epidemiologic investigation within a cluster", or for instance, the first case observed in a household. People who had a high risk of infection were routinely tested regardless of symptoms. Those designated at high risk were healthcare personnel and people living in the same household with someone who tested positive. People living within the same household are referred to as **household contacts**. People who were not in one of these high-risk groups were tested only if they had symptoms.

59,073 contacts of index cases were monitored during the study. Of the total group of contacts, 10,592 were in the household of the index case. **The overall percentage of people who had a positive test after exposure to an index patient through household contacts was 11.8%.** As listed in Table 1, index patients between the age of 20 and 29 had the highest overall number of contacts. Out of the 10,592 total contacts identified from the total group, 3,417 (or 32.3%) were exposed by a person between the ages of 20 and 29. The number of people exposed by children was much lower, but the rate of infection stemming from exposure to a child was higher than the rate with adults. Children between the ages of 10 and 19 exposed 231 of the 10,592 total contacts (corresponding to 2.1%), but 18.6% of their contacts tested positive.

> **Children aged 10 to 19 had fewer contacts than adults (e.g. 231 versus 3,417 for 20 to 29-year-olds), but they were as likely to transmit SARS-CoV-2 to their contacts with 18.6% testing positive, and in fact had the highest rate of positive contacts in this study.**

Table 1. Household contacts and infections by age.

Age in years	Proportion and Number of Household Contacts by Age of the Index Patient	Rate of positive testing in a household based on the age of index patient
0-9	0.5% (57)	5.3%
10-19	2.1% (231)	**18.6%**
20-29	**32.3% (3,417)**	7.0%
30-39	11.6% (1,229)	11.6%
40-49	16.5% (1,749)	11.8%
50-59	19.3% (2,045)	14.7%
60-69	9.8% (1,039)	17.0%
70-79	4.5% (477)	18.0%
Over 80	3.2% (348)	14.4%

Younger children, under 10 years of age, were less likely to transfer the virus to their household contacts with 5.3% testing positive**.** There is a statistically significant smaller number of people infected by young children compared to other age groups, **but the rate at which young children under the age of ten transmit SARS-Cov-2 is still nearly as high as people between the ages of 20 and 29 (5.3% versus 7.0%).** As young children begin to interact with larger numbers of people again at school, they could spread SARS-CoV-2 at a similar rate to

those who are 20 to 29 years of age and contribute to an increase in community spread of COVID-19.

The transmission rates between non-household contacts was lower, presumably because of fewer close interactions. There were 48,481 non-household contacts investigated, and 1.9% tested positive for SARS-CoV-2 compared to the rate of household contacts of 11.8%. Index patients over the age of 40 were more likely to cause an infection in non-household contacts as illustrated in Table 2.

Table 2. Non-household contacts and infections by age.

Age in years	Proportion and Number of Non-Household Contacts by Age of the Index Patient	Rate of positive testing in contacts outside of a household based on the age of index patient
0-9	0.02% (180)	1.1%
10-19	0.46% (226)	0.9%
20-29	**25.5% (12,393)**	1.1%
30-39	15.2% (7,407)	0.9%
40-49	16.4% (7960)	**2.0%**
50-59	19.2% (9,308)	**1.8%**
60-69	15.4% (7,451)	**2.9%**
70-79	3.9% (1,912)	**4.8%**
Over 80	3.4% (1,644)	**4.6%**

When assessing the limitations of the study and its similarity to previous data, the authors mention that the data for this study was collected while social distancing was in effect so people may have had more contact than usual within their household. In a previous study of transmission in the United States, the level of household transmission was found to be 10.5% and higher than in non-household contacts, which is similar to this report. The potential for asymptomatic spread of the virus could lead to undercounting of those who were infected, but the overall number of people tested during the start of the outbreak in South Korea was very high and this would lead to a fairly accurate representation of the population with COVID-19 at the time.

Other experts have commented on this study from South Korea and stated that it was well done. Previous studies have been small and difficult to interpret, but Dr. Ashish Jha, director of the Harvard Global Health Institute told the *New York Times* that this study in South Korea was "very carefully done, it's systematic, and looks at a very large population…It's one of the best studies we've had to date on this issue" (Mandavilli, 2020). Other experts commented that the study was completed while interventions were in place to limit interaction in the community, which suggests that the levels observed for all groups would most likely increase as more interactions in the community occurred, including the opening of schools. One limitation of the study is that, the contact tracers only tested children who felt ill, and there is a high proportion of children who remain asymptomatic after infection with SARS-CoV-2. **Because it has not yet been determined, the experts stress that there still remains a question about the role of children without symptoms in transmission of SARS-CoV-2.**

Based on their results, the authors of the South Korean Study conclude that household transmission of SARS-CoV-2 was high if the index patient was between ten and 19 years of age.

Modeling Studies that Predict Transmission

Modeling studies can utilize known characteristics of an infectious agent to predict transmission dynamics (Esposito and Principi, 2020). This process was done early in the pandemic to determine the best methods to achieve control of the spread of SARS-CoV-2. The more that is known about a virus, the more accurate the prediction from the model will be. Modeling studies with influenza, where the virus is not easily transmitted (e.g. droplet driven) and attack rates are higher in children than in adults, indicate that school closure can be very effective for infection control of the flu. Based on current information, SARS-CoV-2 has different transmission dynamics than influenza with an increased level of transmission and higher attack rates for adults and elderly individuals. **These conditions suggest that there will be high rates of transmission outside of schools that is not diminished if schools are closed**. Therefore, school closures may not have the same effect when put into place for SARS-CoV-2 as with influenza. This hypothesis is supported by the outcomes observed in Taiwan where the transmission of COVID-19 was minimized without the closure of schools. However, it is difficult to convince people to act on a predictive model where there is incomplete knowledge of the characteristics of the virus. With influenza, reopening schools after a closure often leads to a resurgence of the outbreak, and this scenario has also been observed during the current COVID-19 pandemic in Israel and South Korea. With incomplete information, it is difficult to determine if Taiwan or Israel is closer to the real situation.

At this time, the true risk of transmission from children can only be approximated based on incomplete information and mostly small studies and any predictions are most likely inaccurate to some degree.

Effects of COVID-19 in Children

It has been determined that after infection, children are less likely to develop serious symptoms of COVID-19, and many remain asymptomatic during the entire infection.

During the initial outbreak of COVID-19 in Italy, it is estimated that there were 3,836 cases of COVID-19 in children under the age of 18 from February 23 up to May 8 (Bellino et al., 2020). **Out of the 216,305 total infections during this time period, pediatric cases accounted for 1.8% with children making up 16% of the population in the country**. The median age of children affected was 11 years, and 5.4% of the children had chronic medical conditions. The most common types of medical conditions were respiratory, cardiovascular, and oncologic diseases.

Number of pediatric cases for each age group:

- 40.1% of cases between the ages of 13 and 17
- 28.9% of cases between the ages of 7 and 12.
- 17.2% of cases between the ages of 2 and 6
- 13.8% were infants under the age of one

The symptoms of the disease were classified as mild in 32% of the children, and 13.3% were hospitalized for treatment. This is lower than the hospitalization rates observed during the same time period in Italy for adults (28.3%) and the elderly (49.9%). Younger children under the age of six were more likely to have severe symptoms, and 4.3% of the 3,836 children with COVID-19 had symptoms that were classified as severe. **The largest percentage of children who required hospitalization were under the age of one with 36.6% of hospital admission occurring in this group**. 12.8% of the hospitalized children were between the ages of two and six, and the older groups both had a rate of around 9%. Of the 511 children who were hospitalized, 3.5% were treated in the intensive care unit, and four deaths occurred. The children who died all had very complex medical conditions before they were diagnosed with COVID-19, and the addition of the viral infection was attributed to the deterioration of their health.

Based on the analysis of the data from the outbreak in Italy, the authors conclude that pediatric cases of COVID-19 are less severe than adults, but children under the age of one year old and those with chronic medical conditions have an increased risk of severe symptoms.

They also emphasize that children of all ages were diagnosed with COVID-19, and infection typically occurred after having contact with a sick adult in their household. Children were not allowed outside during the lockdown in Italy, so the low rate of infection may well be a result of a lack of exposure. The outcomes observed in Italy were found to be similar to the findings published for pediatric cases of COVID-19 in the United States and China, and there was no evidence of a change in disease course or severity as the outbreak spread around the world.

Inflammatory Multisystem Syndrome in Children

The inflammatory syndrome associated with COVID-19 in children that has similarities to the previously defined Kawasaki syndrome has been named multisystem inflammatory syndrome in children, or MIS-C, in the United States and paediatric inflammatory multisystem syndrome temporally associated with SARS-CoV-2, or PIMS-TS, in the United Kingdom. There is a slight difference in the technical definitions of the two syndromes, but in this report, the syndrome will be referred to as MIS-C for clarity.

In an editorial in STAT News, Sharon Ostfeld-Johns, a physician, assistant professor of clinical pediatrics, and instructor in internal medicine at Yale University School of Medicine, **suggests that rather than a specific ailment associated with children, MIS-C is the same inflammatory phase of COVID-19 observed in adults** (Ostfeld-Johns, 2020). The pattern described by Dr. Ostfed-Johns has been mentioned by other physicians treating COVID-19 in adults and involves an initial viral phase during which some people develop symptoms several

days after exposure to the virus and a later inflammatory phase that starts days to weeks after initial respiratory symptoms appear that involves more severe symptoms resulting from an overreaction of the immune response and over production of cytokines. As with adults, there is a highly variable set of symptoms in young individuals, but children more often have prominent gastrointestinal symptoms and difficulty in maintaining a stable blood pressure with few respiratory symptoms. There have also been reports of cardiac symptoms and a high rate of coronary artery aneurysm (Vergnano et al., 2020). Dr. Ostfeld-Johns theorizes that physiological differences between children and adults lead to the difference in symptoms observed. She further suggests that the second phase of COVID-19 be called multisystem inflammatory disease in both cases.

Cases in the United Kingdom

Researchers in the United Kingdom have described the clinical characteristics, course, management, and outcomes of children admitted to pediatric intensive care units with MIS-C. In the first report, **78 cases of MIS-C were identified between April 1 and May 10 in 21 of the 23 pediatric intensive care units in the United Kingdom** (Davies et al., 2020). This corresponded to an average of 14 admissions per week with a peak number of 32 admissions in one of the weeks in the study period. This is compared to a mean admission of one case a week with similar symptoms of septic-type shock prior to the COVID-19 pandemic. **This rate leads to eleven times more admissions during the same time frame**. The large increase in the hospitalization rate suggests that the cases have a novel cause rather than increased awareness due to the current health environment.

The characteristics of the children admitted to the pediatric intensive care unit include

- median age of 11 years
- 67% male
- **78% from ethnic minority groups**
- 100% had fever, 87% had symptoms of shock, 62% had abdominal pain, 63% were vomiting, and 64% had diarrhea

Some of the children (35 of 78) were evaluated for SARS-CoV-2 antibodies, and 33 were positive for a previous infection. One of the individuals who tested negative for antibodies had a positive PCR-based test, meaning there was still an active infection.

Initial evaluations indicated there was elevated C-reactive protein (a marker for the presence of an inflammatory response), D-dimer (a component of the molecular pathway involved in clot formation), and ferritin (another marker for inflammatory responses), troponin (an indicator of damage to the heart muscle), and lymphopenia (lower-than-normal number of a white blood cells called lymphocytes) in the blood. During the first four days the children were hospitalized, there was a reduction of C-reactive protein as well as reductions in D-dimer and ferritin. The levels of the lymphocytes were found to increase, which normally indicates that the immune system is fighting an infection or there are high levels of inflammation. There were also increases in troponin levels during the hospital stay.

During the time in the intensive care unit, 46% required mechanical ventilation, 83% required medications to moderate their blood pressure, 73% received steroid treatments, 76% received treatment with intravenous immunoglobulin, 22% received biologic therapies (anakinra, infliximab, tocilizumab, or rituximab), and 4% required extracorporeal membrane oxygenation. **Additionally, 36% of the children had coronary artery abnormalities with 18 aneurysms and ten children with changes in ultrasound examinations of the coronary artery, suggesting a structural change occurred**. Three patients (or 4%) had significant blood clots, with no pulmonary emboli, and seven (or 9%) received anticoagulation medications to treat existing clots or due to concerns about small, diffuse clots. By the end of the study period, two of the children had died.

A description of children treated in the United Kingdom for MIS-C describes the neurological manifestations that occurred in 14.8% of the children treated for MIS-C at Great Ormond Street Hospital for Children in London, UK, between March 1 and May 8 (Abdel-Mannan et al., 2020). The children had all been previously healthy, but required treatment in the intensive care unit. The neurological symptoms observed included encephalopathy, headaches, brainstem and cerebellar signs, muscle weakness, and reduced reflexes, but they did not exhibit respiratory symptoms. There was evidence of changes in the brain tissue using MRI scans, but there was no evidence of direct infection within the cerebrospinal fluid from SARS-CoV-2 based on PCR-based testing. During treatment, there were improvements in neurological symptoms, and by the end of the study period, two of the four children had made a full recovery, suggesting that the **neurological dysfunctions were not permanent.**

Another report from the United Kingdom suggests that there may be increased severity in symptoms in infants with MIS-C syndrome (Vergnano et al., 2020). The report describes the outcome of seven infants younger than a year who were diagnosed with a Kawasaki-like disease between February and March. The association of the cases to SARS-CoV-2 infection is currently unclear because five of the seven infants did not have antibodies present to the virus upon testing. The physicians have reported the cases because they were abnormally severe and required higher than normal levels of treatment. **Six of the seven developed coronary artery aneurysms with one child dying due to ruptured aneurysm**. In historical cases of Kawasaki disease, 10 to 20% of infants develop aneurysms while 86% of this group did. The child that died was found to have markedly abnormal coronary arteries with multiple massive aneurysms but no inflammation in the upper or lower respiratory tracts that suggested ongoing respiratory infection. Significant changes in scans of the coronary arteries were also observed in studies that included older children in the United Kingdom and the United States, and severe cardiac symptoms appear to be common with MIS-C.

Cases in the United States

Two papers were also published describing the effects of MIS-C in New York state and throughout the United States. Together, the groups observed around 300 cases of MIS-C in previously healthy children who had had COVID-19 in the previous four weeks (Branswell, 2020). Based on an editorial from Michael Levin of the Imperial College London, it is estimated that there have been around 1,000 cases of MIS-C worldwide as of June 29. He also voiced a concern that there may be additional cases that were not officially recognized. Cases may be missed due to milder symptoms that did not require hospitalization, underreporting due to lack

of recognition of an emerging syndrome, differences in the tests taken during treatment that kept some children from being identified based on the accepted diagnostic criteria, and those who had both MIS-C in combination with severe acute COVID-19, which may not have been reported as MIS-C but only as COVID-19. Also, Dr. Levin points out that the diagnostic criteria were developed based on symptoms of severely ill patients, which may lead to the exclusion of milder cases. Proof of previous exposure to SARS-CoV-2 may also be difficult to determine as many cases in children remain asymptomatic and the accuracy of antibody testing remains quite variable.

After the physicians in London raised concern about MIS-C, the New York State Department of Health established active, statewide surveillance of potential cases of the syndrome to learn more about the incidence and characteristics of children who were affected (Dufort et al., 2020). The paper covers the cases reported between March 1 and May 10. In total, 191 potential cases were reported, and 95 were confirmed as MIS-C based on diagnostic criteria. The Health Department reported that about half were boys, suggesting there was no difference based on sex. There was a much higher number of ethnic minorities affected, however, and 40% of the children diagnosed with MIS-C were Black, while 36% were Hispanic. The age ranges of those affected were 31% from birth to five years, 42% were from six to twelve years, and 26% were 13 to 20 years of age.

Symptoms associated with the syndrome included

- 100% of participants with fever or chills
- 97% of participants with tachycardia
- 80% of participants had gastrointestinal symptoms
- 60% of participants had rash
- 56% of participants had redness in the eyes
- 27% of participants had mucosal changes
- 100% of participants had elevated levels of C-reactive protein
- 91% of participants had elevated D-dimer
- 71% of participants had elevated troponin

While in the hospital, 93 of the children had at least one echocardiogram, which indicated that **52% had some degree of ventricular dysfunction, 32% had pericardial effusion, and 9% had a documented coronary-artery aneurysm.** There was also a high rate of abnormal findings from CT and ultrasound scans of the abdomen that encompassed a wide range of internal organs. Of the 95 children, 80% required treatment in the intensive care unit, and 62% required treatment to normalize blood pressure. As mentioned in the report by Abdel-Mannan and colleagues, there were only mild respiratory symptoms observed, and only occasional need for supplemental oxygen, suggesting differing effects from COVID-19 in adults and children. The median length of the children's hospital stays was six days, and two children died during the study period.

All but one child was tested for SARS-CoV-2 by PCR-based testing and 77 children (or 81%) were also tested for antibodies to the virus. Twenty percent of the group had a positive PCR-based test without the presence of antibodies, 47% had evidence of SARS-CoV-2 infection based on the presence of antibodies but were no longer positive by PCR-testing, and 33% had

positive results on both PCR-based testing and antibody testing. Two of the children were not tested, but reported symptoms that are consistent with COVID-19 in the preceding weeks. **When the cases of MIS-C were investigated in relation to the overall SARS-CoV-2 outbreak in New York state, it was found that the peak in the number of MIS-C cases followed the peak in the number of cases of laboratory-confirmed SARS-CoV-2 infection by 31 days.** Importantly, the preceding infection with SARS-CoV-2 was not necessarily accompanied by severe symptoms or, in many cases, even any symptoms.

Public health surveillance of the United States between March 15 and May 20 identified 186 cases from 26 states (Feldstein et al., 2020). The report excluded children identified in the New York state assessment in order to avoid duplicating the information. It was found that a substantial proportion of the children included in the second report were infected with SARS-CoV-2 at least one to two weeks before the onset of MIS-C. The median age for affected individuals was 8.3 years, and 73% had previously been healthy.

The median length of hospitalization of the children in the study was seven days with a range between four days and ten days. The systems affected by the syndrome were similar to those reported previously, and the gastrointestinal system was affected in 92% of children, the cardiovascular system in 80%, hematologic (blood) systems in 76%, mucous membranes or skin in 74%, and respiratory system in 70%. While hospitalized, 80% were treated in the intensive care unit, 20% received mechanical ventilation, 48% received treatment to normalize blood pressure, and 2%, or four children, died. At the time of the report, 28% of the children remained in the hospital.

> **Due to the timing of symptoms after the resolution of the initial SARS-CoV-2 infection, the authors suggest that MIS-C is a consequence of an abnormal reaction of the immune system triggered by SARS-CoV-2 infection rather than a direct result of viral infection of the involved tissues.**

MIS-C versus Kawasaki Disease

The reports showed that there are important differences between MIS-C and Kawasaki disease (Branswell, 2020). The individuals typically affected by Kawasaki disease are under the age of 5 years while the average age of children with MIS-C was eight years. In the New York state study, 42% of the group were between the ages of 6 and 12 years. Kawasaki disease is also normally apparent in children of Asian descent, and the background of most of those treated in the New York Study was African (40%) or Hispanic (36%) descent. It was also found that treatment to normalize blood pressure was more often required in children with MIS-C than in previous reports of Kawasaki disease with 50% of the United State cases versus 5% of historical Kawasaki disease cases.

Prevalence of MIS-C

> **The occurrence of MIS-C continues to be an uncommon complication of SARS-CoV-2 infection, but there is not yet sufficient evidence to determine if there is a subgroup of children more likely to be affected.**

The number of individuals under the age of 21 who developed MIS-C was two in 100,000 while the number of individuals in that group who were diagnosed with SARS-CoV-2 is 322 in 100,000. Based on the accumulated information, physicians suggest that parents and care providers be aware of cases of fever or rash in children who live in areas where SARS-CoV-2 infections are, or were, common. Additionally, children with Kawasaki disease have a higher risk of later cardiac complications, and the physicians in the above studies suggest continued surveillance to identify potential risks in those who have recovered from MIS-C. Other long-term effects may also become apparent due to the severity of symptoms associated with the syndrome. While the symptoms of MIS-C are severe, the syndrome itself occurs only rarely (Portman and Cimaz, 2020 and Couzin-Frankel et al., 2020).

Physicians and other public health experts have stated that because of the low incidence, MIS-C should not be a direct consideration in deciding whether to open schools.

Opening Schools and Childcare

There has been an intense debate over whether or not it is safe and/or necessary to proceed to reopening schools and childcare facilities in the United States. This debate encompasses both the opening of schools for younger children as well as college-age individuals and also involves the balancing of physical health with mental health and financial concerns. As might be expected, a large number of people have weighed in on the debate, and the following mainly describes the physical and health related questions as other subjects are outside the bounds of this report.

Main Themes from the Discussion

The benefits of reopening schools are many, and the American Academy of Pediatrics (AAP) released a statement where they describe school as

“fundamental to child and adolescent development and well-being and provide our children and adolescents with academic instruction, social and emotional skills, safety, reliable nutrition, physical/speech and mental health therapy, and opportunities for physical activity, among other benefits” (AAP, 2020).

On the other side of the discussion, it is not known how allowing schools to reopen will affect transmission of SARS-CoV-2 in the community. There have been conflicting reports on the extent to which children are susceptible to infection and whether they can facilitate transmission to vulnerable individuals even though they themselves are minimally affected by COVID-19. The study described above from South Korea suggests that elementary aged children as less likely to infect people in their household, but infections will still occur, and older children had a high rate of transmission within their household.

Dr. Susan Enfield, the superintendent of Highline Public Schools, which serves more than 17,000 students in suburban Seattle, told reporters from *JAMA* that “there are no good options

for next year. There is no scenario in the fall that doesn't break your heart." Dr. Nathaniel Beers, a general and behavioral developmental pediatrician who is now the president of the HSC Health Care System and was previously the chief operating officer of the District of Columbia Public Schools, mentioned that officials are aware of the situation where those already in a disadvantaged situation who may be struggling academically may have a lack the technology needed to learn remotely, have parents that must work outside of the home, and are dependent on other siblings or older relatives, who are more susceptible to the virus, for supervision. In some areas, students attending city public schools receive food support, access to health care, dental care, and vision screenings through their schools and being out of school stops their access to these programs (Rubin, 2020).

If schools are to reopen, there are both community-based thresholds and in-school criteria that are important components of the discussion. In the community, a low level of transmission reduces the risk of transmission within a school-setting as well. Within the school, there are steps that allow for a reduction of the risk of transmission. The AAP advocates that the discussion of opening schools should start with a goal of having students physically present in school in the fall (AAP, 2020). **They stress that COVID-19 policies can mitigate, but not eliminate, all risk of transmission of the virus**. They state that "no single action or set of actions will completely eliminate the risk of SARS-CoV-2 transmission, but implementation of several coordinated interventions can greatly reduce that risk."

Community Thresholds for Reopening Schools

The generally accepted criteria for beginning the process of reopening schools are similar to those suggested for reopening other segments of the community, and a number of expert groups have released recommendations, which are also included in the White House's guidelines and the CDC recommendations for relaxing restrictions (White House, 2020 and CDC, 2020).

Before removing restrictions on movement of members of a community, the following criteria should be met to keep the outbreak under control:

- A sustained reduction in new cases for one incubation period, or 14 days for SARS-CoV-2.
- Local hospitals are safely able to treat all patients requiring hospitalization (stemming from COVID-19 or everyday health issues) without resorting to crisis standards of care.
- The area has the capacity to test for COVID-19 and actively monitor confirmed cases and their contacts.

There have also been recommendations made for conditions that trigger a return to a higher level of restrictions, including a substantial number of cases that cannot be traced back to a point of exposure, a sustained rise in new cases for five days, and if hospitals are no longer able to safely treat all patients requiring hospitalization.

Applying these criteria to cities across the United States, there are few areas that have met the threshold for reopening schools. In many places, there are rising, rather than falling, numbers of new cases, and Florida has recently set several records for most number of cases per day since the beginning of the pandemic (Calfas and Prang, 2020). The health systems in Texas, Arizona, California, Louisiana, and Florida are being strained with Texas suspending non-essential procedures and Florida reaching full capacity in at least 45 of the adult intensive-care units in the state as of July 9 with continuing reports of others becoming full. There are re-emerging outbreaks in several areas that had previously been able to contain the transmission of SARS-CoV-2, including Illinois, Louisiana, and California. Shortages of testing supplies are occurring again, and wait-times for test results are currently between several days and a week, which is twice as long as the turn-around time observed in June.

School-Based Recommendations to Reduce the Transmission Risk

Separating individuals is currently the best way to prevent the spread of SARS-CoV-2. However, in a school environment appropriate distancing to prevent all types of transmission would negate the benefits from attending school and be logistically impossible for most schools.

The AAP has provided general guidelines for the different age groups of school children that allow for setting up initial steps to organize the school day. These recommendations are based on the spread of SARS-CoV-2 occurring through droplet transmission, however, and as more information becomes available on aerosol transmission the recommendations on spacing may need to be updated. More specific recommendations from the AAP and other public health experts on ways to reduce the risk of transmission inside a school are discussed below.

The AAP suggestions on in school procedures based on the age of the students.

- **Pre-K**- focus on hand hygiene, infection prevention education for staff and families, adult physical distancing, adults wearing face coverings, keeping groups separated, and spending time outdoors. Face coverings for children would be difficult to implement, and reducing interaction between children is not expected to greatly reduce the risk of transmission.
- **Elementary Schools**- Children should wear face coverings if they have the restraint to do so. Desks should be placed 3 to 6 feet apart. Reduce interactions between different classes and teachers, and use outdoor spaces when possible. As with younger children, reducing physical interactions between children may not lead to a large enough reduction in the risk of transmission to overcome the difficulty in enforcement. Similarly, reducing class size may also require more challenges when compared to the magnitude of the reduction in risk achieved.
- **Middle and High School**- As the age of the children increases, so does the risk of transmission. Along with the increase in individual levels of restraint that is attained with age, use of social distancing for older students becomes important and feasible. All students and adults should wear face coverings when not able to maintain a 6-foot distance, and desks should be placed 3 to 6 feet apart. Increased distance, or placement outdoors, should be used during activities such as singing or exercising where increased exhalation occurs. Changes in scheduling and physical areas, like lockers, should be made so that small groups can remain together with limited interaction with other groups or teachers.

Physical Distancing and Classroom Changes

Physical distancing limits the spread of contagion between individuals. Initial reports suggested that SARS-CoV-2 is spread mainly through infectious droplets, but there is mounting evidence of aerosol transmission from smaller, airborne particles that remain suspended in poorly ventilated areas for over an hour (Prather et al., 2020). While droplets are typically formed when people sneeze or cough due to symptoms of an illness, aerosol particles are produced by simply breathing or speaking and can be produced by those without symptoms. Droplets can be transmitted by contact with people or contaminated surfaces while aerosols allow for inhalation of infectious particles that are suspended in the air and can be transported by air currents. The protocols used to control droplet and aerosol transmission of an infectious agent in the community differ due to how the contagion behaves.

The current recommendations for maintaining good hand hygiene and maintaining a distance of six feet from others are based on a compilation of studies on the droplet transmission of a variety of respiratory diseases and not SARS-CoV-2 specifically. The studies indicate that a **droplet will settle to the ground in 4.6 seconds while an aerosol particle takes 12.4 hours**. The potential for aerosol spread of SARS-CoV-2 suggests that spacing of six feet without the use of masks may not be sufficient to reduce transmission for indoor conditions where aerosols can remain airborne for hours, accumulate over time, and follow airflows over distances further

than six feet. Experts describe the movement of airborne virus particles as similar to the particles observed when a smoker exhales cigarette smoke, and they mention that “the distance from a smoker at which one smells cigarette smoke indicates the distance in those surroundings at which one could inhale infectious aerosols.”

In their recommendations for businesses, **the CDC suggested increasing the ventilation in rooms and using outside air if possible to reduce transmission indoors**. This could be accomplished using fans in open windows or by increasing the rate at which HVAC systems circulate air. Similar steps would be necessary in schools as classrooms resemble office spaces.

Other areas where physical distancing is difficult may also need to be addressed depending on the school. In districts that use bussing for transportation to school, the close proximity in a small space in not ideal. Assigned seating on the bus to limit contact with different people and use of masks are one possible change. Separation of the driver from the children by a Plexiglas barrier can also help to reduce transmission. Opening windows to increase ventilation would also be expected to reduce the risk.

Use of Masks

The general recommendations from the CDC state that separation of six feet is typically sufficient to stop droplet transmission. The AAP states that there is evidence that spacing of three feet “may approach the benefits of six feet” if students are wearing face coverings and are asymptomatic. Use of cloth masks can contain infectious particles that are produced by sick individuals and keep them from reaching other people in close contact. Cloth masks may also prevent transfer of infectious material by preventing people from touching their nose and mouth with their hands. Use of masks is not recommended by children under the age of two because they may not be able to communicate if the mask impedes their breathing. Some older children may also not be good candidates for using masks if they are prone to touching it or if the mask is ill-fitting. The use of “mask breaks” during time when distancing is possible could help students deal with having a mask on all day, and children who do not tolerate masks well may be able to utilize clear face shields instead (Reddy, 2020).

While cloth masks are not able to stop all small, infectious particles there is an increasing amount of data the shows that using masks in public spaces reduces the transmission of COVID-19. An analysis from the *Morbidity and Mortality Weekly Report* (MMWR) of the CDC shows that face mask use was able to prevent infections of SARS-CoV-2 spreading from two stylists and 139 clients at a hair salon in Missouri (Hendrix et al., 2020). The incident occurred in May in Springfield-Green County in Missouri where stay-at-home orders had just been lifted. At the hair salon, two of the stylists tested positive for COVID-19 after having served 139 customers over the course of eight days. **In accordance with local recommendations, both the stylists and their clients wore masks, and based on testing and symptom tracking, none of the exposed customers were infected.** Additionally, none of the other stylists at the salon became ill. After reviewing the timing of the symptoms of the two infected stylists, it was determined that one most likely infected the other as they had several encounters when they had removed their masks to talk. The first stylist had attributed her symptoms to allergies that she normally experienced at that time of year rather than COVID-19 (Wu, 2020).

Contact tracing was performed by the local county health department for all 139 clients seen after the date when the stylists developed symptoms. None of the clients reported any symptoms in response to daily phone or text messages. All of the clients were offered testing, and 48.2% of clients volunteered to be tested while the remaining refused testing. All of those who were tested had negative PCR-based test results. The testing occurred at least five days after exposure at the salon, suggesting that viral infections would have been detectable at the time of the test. Close contacts to the stylists from outside of the salon were also followed for contact tracing, and all of the people who were in contact with the first stylist outside of the salon developed symptoms and tested positive for COVID-19. None of those in contact with the other stylist developed symptoms.

The customers ranged in age from 21 to 93 years, and the length of appointments ranged from 15 minutes to 45 minutes. When clients were asked what type of mask they had worn, it was found that 47.1% wore cloth face coverings, 46.1% wore surgical masks, 4.8% wore N95 respirators, and 1.9% did not know what kind of face covering they wore. One of the stylists wore a double-layered cotton face covering, and the other wore either a double-layered cotton face covering or a surgical mask.

Based on the outcome of the situation, the authors from the CDC concluded that adherence to the community's and company's face-covering policy mitigated spread of SARS-CoV-2, and broader implementation of face covering policies could mitigate the spread of infection in the general population.

Implementing Cohorts in the School

Scientists often refer to a specific, defined group of people as a cohort, and this concept is being used in the planning for reopening schools. **Separating children into small groups, or cohorts, that do not interact with each other or with other adults within the school will reduce the risk of transmission of SARS-CoV-2.** For example, a class of 10 to 15 children and their teacher would interact only within their own group during the day without sharing space or intermingling with other classes. This would keep infections from one group from spreading to another group and allow for smaller groups to quarantine if infection does occur so that the entire school may not need to close (AAP, 2020).

Congregation in hallways between classes can also increase the risk of viral transmission. Using one-way hallways, staggering class periods, and rotating teachers rather than students may reduce contact in these situations. In secondary school, cohorts could stay together for the day in a single classroom and different teachers could come in for instruction in different subjects as needed. This would avoid the crowded halls and intermingling of students between class periods. Use of lockers should also be grouped by cohort or discontinued to prevent mixing of large groups of people.

Outdoor play, such as recess, should be staggered so that only one group of students interacts. Being outdoors reduces the risk of transmission generally, and efforts to separate individuals in a group would not be expected to lead to a large enough benefit based on the effort required.

Lunch time may also require adjustments to reduce interactions between large numbers of people. Serving food in the classrooms to continue separation of different groups, use of other spaces for eating, use of outdoor spaces, and adherence to hand hygiene before and after eating can be used to reduce transmission risk.

Adults in the School

As adults have the highest risk associated with COVID-19, their movements should be the most restricted. **Adult staff should practice strict social distancing around other adults in the school with meetings occurring on virtual platforms**. Interactions with parents and caregivers should also be redesigned to limit contact between adults. Limiting access of adults who are not part of the staff would also reduce the number of contacts that could facilitate transmission. This includes pickup and drop-off of children, which could be staggered to reduce the number of people present at one time. Having these activities occur outside would further reduce the risk of transmission. In areas where interactions with adults who are not school staff need to occur, such as in school offices, physical barriers should be used to separate adults. Staff lounges should be used in a way that promotes physical distancing and to prevent congregation of groups.

Testing and Assessment of Symptoms

PCR-based testing for viral infections is recommended by the AAP in accordance with CDC guidelines. This means that **staff and students who have close contact with someone with a confirmed case of COVID-19 and those who have symptoms associated with the illness should not come to school until they are tested**. Surveillance testing, where non-symptomatic individuals are tested on a regular basis, would be difficult to coordinate at the school and may not be economically feasible. This sort of testing is currently suggested for college-type environments where people are in close living quarters, but may not help reduce the risk with non-residential, daily school programs. Antibody testing is not recommended because of the variability of the results and unknowns regarding immunity.

Temperature checks may be useful in identifying individuals who are sick with a number of illnesses, but a lack of a fever does not mean someone is not sick (Begley, 2020). There has also been concern over the accuracy of some of the devices being used to monitor temperature of individuals. If used incorrectly, or if less expensive devices are used, the measured temperature can vary widely.

> **The AAP states that anyone with a fever of 100.4 or above, regardless of other symptoms, should not be present in the school**.

With SARS-CoV-2 infections, people are infectious before they develop symptoms, and some individuals do not ever have noticeable symptoms. Research currently suggests that people with SARS-CoV-2 are the most infectious in the two days **BEFORE** symptoms become evident, making containment of transmission more difficult. In general, it has been found that children may be less likely to have a fever with SARS-CoV-2 infections, and they may be less likely to present with fever as an initial symptom. However, while it may not catch all of those who are

sick, isolation of those with symptoms has been found to decrease the risk of transmission in the general population.

There are other symptoms associated with COVID-19 that can be used to screen for infected individuals. For example, gastrointestinal symptoms are more common in children than respiratory symptoms. A sudden onset of not being able to smell has also been found to be associated with COVID-19 early on in the infection. An analysis of 47 studies indicated that nearly 80% of people with COVID-19 lost their sense of smell, but only 50% list this symptom when asked to describe how they are feeling. Many people do not notice the sudden inability to smell things, and effective screening would require use of a scratch and sniff cards, or a similar test, rather than asking people to self-report.

The practicality of screening for symptoms at school may also be difficult due to the time required as well as the need to isolate sick individuals after they have already arrived at school. Parents and caregivers can aid with symptom screening by checking in with their children before they leave for school and keeping them home if they have potential symptoms (Strauss, 2020). A checklist of symptoms to look for and specific guidelines for parents, such as those used for other illnesses, would help to facilitate this process. For example, in the case of a stomach virus, most schools require that children be fever free, have not had diarrhea, and not vomited within 24 hours of returning to school. Having specific rules in place allows for better decision making than a general statement of keeping children home if they “don’t feel well.”

Avoidance of Other Illnesses

As flu is an annual problem that is easily spread in a school environment, lessening the impact of the flu this season will also help in control of COVID-19. The flu and COVID-19 have several overlapping symptoms, which could lead to an increased burden on testing for COVID-19.

> **Experts are recommending that everyone over six months of age get the flu vaccine in order to reduce the impact of flu season on COVID-19 this fall and winter.**

Flu shots normally become available in September and October based on the region of the country you are in. Keeping children up to date on their other vaccinations is also important so that overlapping symptoms are not attributed to possible SARS-CoV-2 infections and that preventable diseases do not cause a burden on the healthcare system (Strauss, 2020).

Hand Hygiene and Sanitation

Handwashing is likely to be more effective at reducing transmission than intensive cleaning of spaces. Frequent cleaning throughout the day of surfaces that are often touched, like door knobs, reduces the risk of transmission, but use of strong disinfectants on a regular basis may present a higher risk of injury due to toxic effects while not providing additional reductions in the risk for transmission. This is especially true for spaces for children as they are more prone to transferring substances from surfaces to their face and mouth.

Bathrooms should receive regular cleaning throughout the day due to the high frequency of use by a large number of people.

Use of UV light sources in open spaces is not recommended by the AAP in schools due to the potential harm to skin and eyes. Installation of UV light filters on HVAC systems could be helpful for reducing aerosol transmission, but the expense needed to implement this measure would be prohibitive in most school buildings.

Complications with Reopening Schools

Many working parents rely on school and childcare facilities to care for their children during their workday, and the lack of these resources has put strain on the ability of individuals to continue to work even without the contribution of layoffs. In New York City, there are 1.1 million students enrolled in the nation's largest school district, which means at least that many parents would be affected if supervision at school does not occur this fall (Shapiro and McGeehan, 2020). This would compound the already near-record level of unemployment of 20%, and the staggered attendance plans that are the center of many districts plans would not address the continued need for part-time care even if they do allow for much needed social interaction for the children.

Reopening schools contains many unknowns and considerations. It is widely accepted that the highest risk of transmission of SARS-CoV-2 occurs in enclosed and poorly ventilated areas where people are in close and prolonged contact with each other. The risk of transmission can therefore most likely be reduced by increasing ventilation inside buildings, conducting classes outside, and by increasing the distance between people. The logistics of implementing these changes, however, in aging and crowded school buildings is daunting for many areas when there is no promise of added funding to implement strategies. There has been little organized guidance to establish priorities or to help individual districts make plans. Additionally, the wait-and-see approach used by most areas has led to only a small amount of time to implement changes before the start of the new school year.

In some areas in the United States, childcare programs have started reopening, and the need for additional funding for both daycare arrangements and schools is becoming evident (Rampell, 2020). Both types of facilities need space, supplies, virus testing, and additional staff to meet the needed recommendations for safe operation. Because of the increases in operating costs, **40% of childcare providers who operated before the pandemic expect to close permanently if they do not get financial assistance based on responses to a survey conducted by the National Association for the Education of Young Children**. The difference between the amount of tuition and fees collected and operating expenses is very small for daycare facilities even under normal circumstances, and caring for younger children entails following strict regulations for safety and complying with teacher ratios that do not allow for much flexibility. The enrollment in childcare facilities is reported to be down by 67% with a major increase in costs for more cleaning supplies, personal protective equipment, thermometers, disposable plates, and extra sets of toys.

Another complicating factor will be whether schools will be able to find enough staff for in-person schooling (Rubin, 2020). If teachers and other staff members are not sure of their safety based on conditions at their school, they may simply not return. USA TODAY and Ipsos

conducted an online poll between May 18 and May 21, and they found that one in five teachers said they were unlikely to return to the classroom if their school reopened in the fall. Other groups of staff are comprised of mainly older individuals, such as bus drivers. The superintendent at one of the school districts in Seattle estimates that around 30% of their bus drivers are over 60-years-old, putting them in the high risk group for COVID-19. It is estimated that around 10% of the teachers in first grade to twelfth grade are also over the age of 61 years. Other areas of the country that had staffing problems before the pandemic would have even more trouble filling all positions if teachers refused to come back due to conditions at their school.

Even with recommended protocols in place to reduce the risk of transmission, areas experiencing a high rate of community transmission would still likely have increased transmission rates in schools as well. There are numerous other reports of transmission of SARS-CoV-2 at summer camps in Texas and Arkansas where the rate of community transmission is high (Willetts, 2020). The *New York Times* illustrated the risk for the situation in Austin, Texas on July 14. The estimated infection rate in Austin at that time was about seven in 1,000 residents (Belluck, 2020). If a school has 500 students in attendance, they would have about four students sick at one time. If sufficient testing and resources were available to trace each student's contacts, containment would be possible at this level according to Lauren Ancel Meyers, a professor of biology and statistics at the University of Texas, Austin. If the schools were not adequately supplied with resources, each student could begin a new chain of infection. If community transmission is lowered, the number of students who can transmit the virus is reduced, leading to the need for fewer resources to control an outbreak.

Several groups have proposed a similar plan that is a compromise addressing the increased risk of transmission due to a high rate of new cases in almost all parts of the country and the difficulties with providing quality, online education. *The New York Times* published an editorial by Shardha Jogee that describes some of the details (Jogee, 2020).

1. Schools should offer only virtual classes this fall.
2. Students who can learn at home should do so.
3. Schools or other large unused spaces should be converted into learning centers for use by students who cannot learn at home.
4. Centers can be staffed with non-teachers to supervise and assist children.

Using this system, students could get access to computers and internet connections that might not be available to them at home. The staff at the centers would be able to supervise children and assist those children who cannot navigate the online programs by themselves. The staff would not need to be licensed teachers as teaching would all occur online, which could help to provide another source of employment for those affected by the pandemic. The number of children at the learning centers would be lower than that at school because some students would be able to participate at home, and the reduced numbers would allow for social distancing and a safer environment. Children who normally use food distribution systems would be able to access food while at the learning centers. Other service providers could also be available, such as school counselors or social workers to address any needs that arise.

Transmission at Summer Camps in the United States

A sleep-away camp for children aged 13 to 18 in Missouri reported that 82 campers and counselors tested positive for COVID-19 (Lee, 2020 and Washington Post, 2020). Testing onsite identified 31 infected individuals, and the remaining were diagnosed after returning home. It was determined that only one infected camper was from the local area, and the remaining lived elsewhere, which could lead to the beginnings of new outbreaks in areas not previously affected. Protocols reported on the camp's website to reduce the risk of transmission of the virus included health screening, temperature checks, and a two-week self-quarantine for campers before arrival (Slotkin, 2020). Other measures included installing medical-grade filtration units in the cabins, increased access to hand sanitizer, isolation areas for symptomatic campers, daily sanitation of cabins, limiting access of non-participants on camp grounds, hand-washing protocols before eating in the dining hall, a policy not to share items with other campers, changes to traditions to reduce hand-to-hand touching between campers and counselors, increased distancing between campers and counselors, reducing large gatherings and increasing the number of mealtimes, and staying outdoors as much as possible. The stated safety protocols were in line with those suggested by the CDC and other experts, and the area where the camp was located had had low transmission rates before the start of camp (Washington Post, 2020).

News reports from Florida have found that the number of children testing positive for SARS-CoV-2 is increasing (Fox 35 Orlando, 2020). A pediatrician in the area describes that testing in her office the week of July 20 indicated that one third of the children tested were positive, and many were attending summer camps throughout the area. The symptoms that have been observed include vomiting and diarrhea or a fever, runny nose and a cough.

A sleep-away camp in Texas for teenaged children also had a small outbreak reported recently (Caplan, 2020). The first case was a child who arrived at camp and then was sent home after learning they had been exposed by a relative. After arriving home the camper tested positive for COVID-19. Photos from the camp showed that campers did not wear masks when in close contact with each other, and several campers have since tested positive after returning home.

Two other sleep-away camps run by the YMCA in Georgia have also had an outbreak where 85 campers and counselors have tested positive for the virus (Willetts, 2020). The camps shut down when a counselor tested positive for the virus, and after the shutdown, others who had been at the camp were also found to be ill. The campers ranged in age from seven to 14 years of age, and the counselors ranged in age between 16 and 22. Representatives of the camp stated that the counselor who was the first to become sick had a negative COVID-19 test before arriving at camp and did not exhibit any symptoms upon arrival. Safety protocols were put in place according to CDC and Georgia Department of Health recommendations and included limiting group sizes, proper social distancing, frequent hand washing, and daily temperature checks along with other efforts.

Transmission at Day Care Facilities in the United States

Reports have been coming in about outbreaks at daycare centers around the country as well. Many of the cases are being reported in areas with high levels of community transmission such

as Texas. When transmission is high, the number of people being tested goes down due to limits on testing supplies and facilities. Therefore, the following information is expected to be an underestimation in areas where the testing positivity rate is high. The following are examples of childcare clusters where cases are rapidly increasing with a high positivity rate (Texas), rapidly increasing with a low positivity rate (California and North Carolina), steady with a low positivity rate (Massachusetts), or slightly increasing number of cases with a low positivity rate (Illinois) (JHU, 2020).

In Texas, where there has been a large surge in the number of new cases in several areas of the state, it was reported that there have been more than 1,700 cases associated with childcare facilities as of July 9, which then increased to 2,000 cases by July 13. The information collected up to July 9 is a 759% increase in the number of cases since June 15 (Steicher and Reding, 2020). Emergency rules for child care facilities were repealed in the state on June 12. The cases have occurred at 1,078 different centers of the 12,222 open facilities in the state, corresponding to 8.8% of facilities, and approximately twice as many adults associated with the center were affected than children (1,140 adults versus 555 children). Information from Austin shows that about 9% of the general population who have tested positive for SARS-CoV-2 are between the ages of one and nine while 2% of those with a positive test are over the age of 80. Officials from the Texas governor's childcare COVID-19 task force report that enrollment at facilities is lower than usual, but even with class sizes reduced to levels recommended by the CDC, outbreaks are still occurring. There has also been difficulty in getting information on the outbreaks from the Texas Health and Human Services Commission according to media sources (Swaby, 2020). Information on the number cases associated with childcare facilities is not published with other information on state websites, but when asked by reporters officials have responded. This makes it more difficult for parents to keep abreast of the situation as they have more limited access to local officials. There also are not records available to on the number of children in care or the number of staff employed in child care centers so it is very difficult to determine the proportion of people infected from the total group. A reported from El Paso reported that when asked about strategies for COVID-19 hotspots in childcare facilities, the Texas Health and Human Services Commission and the Department of State Health Service both referred the question to the other.

In areas where the spread of virus is more contained, cases are also being reported, but these incidents are more often only one or two individuals at a center rather than a cluster of infections. In Massachusetts, emergency childcare centers that were offering childcare to essential workers had reported 64 cases in 47 facilities as of June 18 with about half being adults and half being children (Ebbert, 2020). At the time of the report, the facilities were caring for approximately 4,800 children in 550 facilities, and many of those enrolled have parents who are healthcare workers with a higher risk of exposure. Health officials state that 64 cases represent a low rate of exposure in the programs. In cases where transmission occurred, a worker was often found to have moved in between classrooms, which resulted in a complete shutdown of the program for quarantine. This highlights the importance of establishing cohorts so that smaller, more targeted quarantine measures can be used that allow the facility to stay open.

In California, where initial efforts in controlling the spread of SARS-CoV-2 were successful, there has been a five-fold increase in the number of confirmed cases at childcare facilities in the week of July 13 compared to a month ago (Stavely and Willis, 2020). Childcare facilities were

able to reopen to all families in early June in California, and before June, only children whose parents were classified as essential workers were allowed to attend. **However, while the rate of cases has increased, only 2% of the open facilities across the state have reported cases, which corresponds to 658 out of 38,113 facilities**. The number of facilitates opening back up increased by about 14% while the number of cases increased 394%. As of July 12, **adults associated with the centers were the most likely to be diagnosed**, with 34.8% of the cases in staff and 33.7% in parents of children at the centers. The remaining individuals were split between children at the centers and individuals who are part of the staffs' households. Health officials were not able to determine if the children were exposed to the virus at home or at the centers. They found that most of the sites that have reported cases have only reported one or two. Based on previous experience with pandemics, when there are only a few infections in a group, it suggests that people have been infected elsewhere and there is not spread occurring within the group. **Health officials currently think that the pattern of infection suggest that most staff members and families are getting sick from exposure in the community and not at the child care centers in California.** More cases seem to be occurring in the Los Angeles area, where more facilities have stayed open throughout the pandemic, than in areas such as the San Francisco Bay area, where many facilities were temporarily closed (Burdyk, 2020).

In North Carolina, there were twelve ongoing SARS-CoV-2 clusters associated with day care centers as of July 24 (North Carolina DHHS, 2020). The number of individuals at the facilities who were infected was higher than those observed in Massachusetts in most cases and ranged from two to 15. Nine of the twelve clusters involved six to nine people at one facility, suggesting that spread was occurring at the centers. Only one center has less than five people infected.

The Illinois Department of Public Health has reported that the number of cases in the state have been low (Center Square Illinois, 2020). There have been a total of 12 outbreaks as of July 13 at different centers that involved 247 people, of which 32 were children. However, officials from the group Illinois Directors and Owners of Childcare Centers state that, while the facilities that are open are operating safely, there are very few options available for parents due to a lack of staff and requirements to reduce the number of children in each class.

Outcomes of School Reopening in Other Countries

Reporters at the journal *Science* compiled the strategies of multiple different countries to reopen schools, and they found that there were patterns that emerged that may be able to help the process in the United States (Couzin-Frankel et al., 2020).

> **The most successful strategies involved a combination of keeping student groups small and requiring masks and some social distancing.**

When these measures were followed, younger children rarely spread the virus to one another or to their family members at home. Another important component is the level of viral transmission occurring in the community on a whole because high levels of transmission in the community suggest that staff and students would be more likely to bring an infection from outside into the school environment.

Researchers at the University of Washington in the Department of Global Health complied a summary of the models and implementation approaches to re-opening schools that had been reported around the world as of July 6 (Guthrie et al., 2020).

Based on the researchers' evaluation most models of school re-opening involve:

- Reductions of class size (typically 10 to 15 students or classrooms at 50% capacity)
- Increased physical distance between students
- Keeping students in defined groups with limited interaction between groups to reduce the potential for wide-scale transmission within schools
- Staggering the start, stop, and break times within the school

Other protocols that were implemented by several schools include alternate shifts (morning, afternoon) or alternate days while a smaller number of countries have maintained relatively normal school schedules. Additionally, some countries re-opened schools only for younger or older students in order to accommodate the increase in resources required for smaller class sizes (e.g. classroom space, teachers, etc.). More countries have re-opened only for younger students than have re-opened only for older students. Face masks are a common requirement for students and/or staff in schools, but there is variability in the lower age limit for face mask requirements. There are some schools not using facemasks as a part of their re-opening model. Systematic school-based testing for SARS-CoV-2 virus or antibodies is being done on a small scale in a limited number of settings, but this approach is not widely implemented at this time.

Assessment of the transmission rates before reopening schools and after they were opened showed that in four European countries there is some evidence that school closures led to declines in the epidemic growth rates of COVID-19. After reopening schools, the following trends have been observed.

- In areas with low levels of community transmission (Denmark and Norway), reopening of schools did not result in an increase in the growth rate of COVID-19 cases.
- In Germany, where there was a higher level of community transmission, opening of schools was accompanied by increased transmission among students, but not school staff.
- Increases in the number of cases in the community or local outbreaks led to Israel and South Korea re-closing schools.
- Primary schools in Sweden never closed while secondary schools in Sweden reopened June 14, and antibody testing suggests substantial spread in schools with 4.7% of children and teenagers testing positive for antibodies compared to 6.7% of adults.

The specific procedures being used in Denmark include "micro-groups" of 12 students who arrive at a separate time, eat lunch separately, stay in their own zones in the playground, and are taught by a single teacher. Extra space to allow for additional classes of children was

achieved by only opening primary schools. Neither the children nor teachers are asked to wear masks during the day.

In Germany, schools of all grade levels were reopened. Everyone has an assigned desk that is spaced six feet from other desks. Seating charts are available to contact tracers to allow for trancing of infections. The school day was shortened and children attend school in shifts to allow for smaller class sizes of no more than ten students. Learning is also being supplemented with online instruction so that students get a full day of school. Masks are required for the most part, but some schools are testing students every 4 days, and those with a negative test are allowed to attend school without a face mask.

Israel began opening schools with smaller class sizes, but restrictions were removed in May. Rather than using physical distancing of students within schools, control measures involve closing schools with reported cases, extensive testing, and quarantine of students and staff with a potential SARS-CoV-2 exposure. Additionally, teachers and students over the age of seven are required to wear masks. Outbreaks were observed within two weeks of reopening schools, and in one school there were 130 cases. By June 3, the government ordered the closure of any school with a cases of SARS-CoV-2 infection. As of June 8, 139 facilities had been closed indefinitely, and by June 24 isolation or quarantine had affected 1% of Israeli students.

In South Korea, schools started to reopen at the end of May. Limits on the capacity in each school were enacted, and high schools are limited to two-thirds of their student population while kindergartens, elementary, middle, and special education schools are limited to one-third of their students at a time. Both physical distancing and use of barriers on table tops and at lunch were being used. All school staff and students are required to wear masks and follow hygiene measures, and temperature checks are required before entry. After some schools started to reopen, they were closed again due to increased levels of new cases in the community, and other schools in areas with increased rates of infection postponed their reopening.

Other countries have reopened, but the effects on transmission have not been reported.

- France staggered the opening of its schools by age, with nursery and primary schools opening first. Certain secondary schools were opened in regions where community transmission was limited. Face masks are mandatory in secondary schools, and class sizes have been reduced.
- Belgium reopened nursery and primary schools with limited classes of ten students. Students attend school on alternate days to allow for sufficient space. Children stay with their class groups all day, and teachers are encouraged to wear face masks.
- Switzerland has implemented smaller class sizes accommodated by in-class attendance on two days each week for primary and middle school. Desks are spaced apart and guidelines have been added to floors to facilitate movement without crowding.

School Reopening Plan Tracker

The Johns Hopkins Berman Institute of Bioethics has made an analysis available that explores education recovery plans put forth by states, territories, and national organizations to examine

the ways these plans are designed to support students and teachers. The available plans were examined to determine if they addressed the twelve criteria determined to be of importance for reopening schools. Plans were given credit for the category if they addressed the topic in some way, even if it was not comprehensive.

https://bioethics.jhu.edu/research-and-outreach/projects/eschool-initiative/school-policy-tracker/

Resources for Children to Learn about the Coronavirus Pandemic

The editors of The Lancet have compiled a group of publications that may be useful for communicating about the pandemic with children. They also describe some of the shortcomings of the books to allow parents to address the issues (Mitchell, 2020).

A Message from Corona by Charity Tedder

> A story about viral particles travelling across the world. It is cautioned that giving personality and intelligence to the virus could easily confuse some children and might not be a suitable approach if caregivers are unable to explain the reality. The book includes a game out of spotting people not adhering to regulations, which could encourage shame and blame by focusing on what people shouldn't be doing.

Coronavirus: a book for children by Elizabeth Jenner, Kate Wilson, and Nia Roberts

> The book is not a story and describes the virus and implications specifically, which might be too direct for some children. However the expertise of those involved in the book led to a thorough and clear text which is informative without being overwhelming.

My Hero Is You: how kids can fight COVID-19 by Helen Patuck

> By focusing on specific things a child can do, this book may be useful for children with anxiety due to a lack of control from the pandemic. The story is about a girl who is overwhelmed by feeling inadequate in the face of the virus. The book was developed with input from global experts, parents, caregivers, teachers, and children in 104 countries and is available in multiple languages.

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