

# 2009 pandemic influenza A(H1N1) outbreak in a complex of schools in Paris, France, June 2009

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An outbreak of 2009 pandemic influenza A(H1N1), involving 81 cases with symptoms of influenza-like illness, was confirmed in June 2009 in a complex of schools in Paris, France. At that time, there was no community transmission in France. The index case, a 10-year-old girl, had travelled to the United Kingdom with her school class. Of the 81 symptomatic cases, 35 were confirmed and 46 were probable; 48 of the cases were female. Three were adults and 78 were children (median age of the children was 7.9 years, range: 6 months to 12 years). Control measures were implemented as soon as a new case was confirmed in a school, which included active case finding among the pupils in the same class as the index case, setting up a dedicated influenza outpatient clinic that families were recommended to consult if necessary, prophylactic treatment of contacts and school closure. A retrospective study was conducted on all confirmed cases and all symptomatic cases who had consulted the dedicated outpatient clinic from 17 to 27 June 2009. Further work is needed to better define conditions under which the pandemic virus can be transmitted in schools and in households.

## Background

In response to the appearance of the 2009 pandemic influenza A(H1N1) virus first detected in Mexico and the United States in April 2009 [1], France developed an active surveillance system for influenza-like illness [2-4]. Up to 8 July 2009, surveillance was aimed at preventing the introduction and community spread of the pandemic virus in France and was based on the identification of all possible cases among recent travellers coming from affected areas [4].

On 19 June 2009, pandemic influenza was confirmed in a 10-year-old girl, who attended a primary school in Paris, France. At that time, there was no community

transmission in France. The girl had travelled to the United Kingdom (UK) with her class (n=30) and three accompanying adults, returning to Paris on 12 June. She developed influenza-like symptoms on 17 June and was hospitalised the following day, for medical supervision and in order for samples to be taken, according to the recommended procedure at that time in the country [3].

Following the girl's positive test for the pandemic influenza virus on 19 June, local health authorities were alerted and began to contact families of the other children in her class in order to assess their health and organise control measures, such as chemoprophylaxis. Between Friday 19 June and Sunday 21 June 2009, families of 27 of the 30 pupils were contacted by telephone. Eight children had developed influenza-like symptoms (two of them had already recovered). The Necker Hospital for Sick Children, located close to the school, set up a dedicated influenza outpatient clinic [5].

## Setting

This pandemic influenza outbreak affected several schools. It began first in the primary school that the index case attended (School A, with 360 children aged between six and 11 years in 13 classes) and then spread to a nursery school (School B, with 253 children aged three to six years), to a day care school (School C, children aged three months to three years, total number of children unknown) and to another primary school in the neighbourhood (School D, 293 children aged six to 11 years). Siblings in the same family attended different schools, according to their age.

The children shared common spaces: children in School B shared the main entrance and other facilities (such as the canteen) with School A, a gym in School D was open to the children of School A. A playground in

a square close to all the schools was used by most of the children.

The children in the class that travelled to the UK (the index class) were aged 10–11 years. At the beginning of the outbreak, close contacts (eligible for antiviral chemoprophylaxis) were identified as the family and classmates of the index case, the adults accompanying the children to the UK and the families of probable cases. Later, as the outbreak affected other classes and schools, all the pupils in the four schools and the families of pupils with symptoms were considered to be close contacts.

In collaboration with the director of the school, the local health authorities sent information to the families of all the pupils in the school, recommending them to attend the dedicated outpatient clinic, for case management and chemoprophylaxis of contacts (all the pupils in the schools and the families of symptomatic pupils were considered close contacts at that point). Following the recommendations of the public health authorities, the primary school (School A) and a nursery school (School B) were closed by the city council from 22 to 29 June 2009.

A retrospective descriptive study was conducted on all confirmed cases and all probable cases that consulted the influenza outpatient clinic from 17 to 27 June 2009. This paper describes the epidemiological characteristics of and public health responses to this outbreak.

## Methods

### Case definitions

The following case definitions were used [3].

- A possible case of pandemic influenza virus infection was defined as a person with fever ( $\geq 38$  °C) or asthenia or myalgia and at least one acute respiratory symptom (cough or dyspnoea) or diagnosis of influenza-like syndrome and a medical history of curative treatment (with oseltamivir for five days) for influenza.
- A probable case was defined as a person with a history of close contact with a confirmed case during the period of possible viral excretion (from 24 hours before to seven days after the onset of symptoms).

When more than one person in a school was a probable or confirmed case, all possible cases attending that school were classified as probable.

- A confirmed case was defined as a person in whom infection with the pandemic virus confirmed by real-time polymerase chain reaction (PCR).

Information about the cases (demographic details and potential exposure to the pandemic virus) was obtained by telephoning the parents or from hospital medical records. Information about the classes and schools (e.g. how the classes were distributed, the size of the

school and their playgrounds and entrances) and the neighbourhood (e.g. common spaces) was obtained by telephoning the directors of the schools.

The study population consisted of children from all four schools and their close contacts.

## Results

### Outbreak description

The investigation team identified a total of 81 symptomatic cases (35 confirmed and 46 probable) between 17 and 27 June 2009 (Figure 1).

Nasopharyngeal swabs were taken for 44 (54%) of the symptomatic cases: the pandemic virus was detected by PCR in 35 (80%) of the samples, nine were negative. Those that were negative were classed as probable cases. The distribution of confirmed and symptomatic cases by school is shown in Table 1.

Of the symptomatic cases, 48 (59%) were female; three were adults and 78 were children. The mean age of the children was 7.5 years (standard deviation (SD): 3.1; median: 7.9; range: six months to 12 years).

All confirmed cases were children: their mean age was 8.4 years (SD: 2.8). Of these, 26 (74%) were girls. The age range for the girls was from 1 to 11 years and for boys from 4 to 11 years.

There were 11 symptomatic cases in the index class (eight confirmed and three probable): the first (a confirmed case) developed symptoms on 17 June 2009, five days after returning from the UK, where the pandemic virus was already circulating in the community. Ten classmates of the index case developed symptoms, four on 18 June and six more between 19 and 22 June (Figure 2).

In the rest of School A, there were 29 symptomatic cases, of which 18 were confirmed cases. The outbreak started on 17 June (the day the index case developed symptoms), with symptoms developing in two other confirmed cases. These cases were in the same class, which was different from the index class. The infection then spread to 10 other classes; the peak number of cases developed symptoms on 22 June. The number of cases then decreased.

The first case at School B developed symptoms on 18 June. The number of cases increased substantially from 21 June; the peak was seen on 23 June.

At School C there were four cases: the first became symptomatic on 19 June. At school D there were three cases: the first developed symptoms on 20 June.

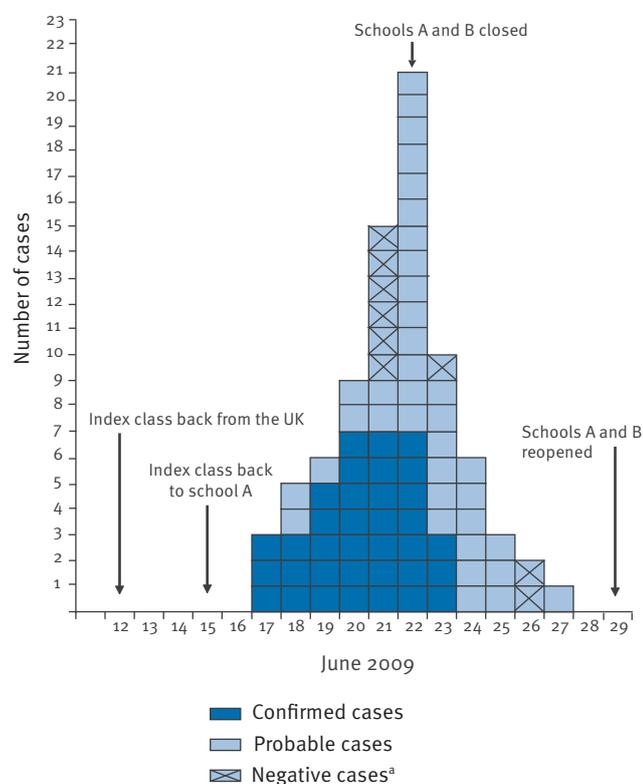
We identified 13 family clusters (more than one person affected in the same family). Of the family members affected, 15 did not attend school or attended other schools. The first case developed symptoms on 21

June; the peak number of cases developed symptoms on 22 June (Figure 2).

In five of the 13 family clusters, two or more affected children in the same family attended one or more of the affected schools.

- In cluster 1, three members of the same family were affected: two sisters attended School B: one developed symptoms on 18 June; her sister and father developed symptoms on 21 June.
- In clusters 2 and 5, all children attended School A and developed symptoms within a two-day interval starting 19 and 20 June.
- In cluster 3, the first child attended School A and became symptomatic on 19 June; two days later his sister in School C developed symptoms.
- In cluster 4, the first child attended School C and developed symptoms on 19 June. Her sister, who attended school D, developed symptoms the following day.
- In clusters 6-13, only the index case in the family attended an affected school. Other family members developed symptoms between zero and eight days after symptom onset in the index case.

**FIGURE 1**  
Symptomatic cases of 2009 pandemic influenza A(H1N1) in Schools A–D and in family and friends by date of symptom onset, Paris, France, June 2009 (N=81)



UK: United Kingdom.

<sup>a</sup> Symptomatic cases whose polymerase chain reaction (PCR) test was negative (as they had a history of close contact with a confirmed case during the period of possible viral excretion, they were included as probable by definition).

Some affected children neither attended an affected school nor had siblings attending any affected school; however, they had had contact with a confirmed or probable case attending one of the affected schools. These cases were identified from the hospital's medical records.

### Attack rates

Including all symptomatic (confirmed and probable) cases attending any of the affected schools (n=66), the attack rate was 37% for the index class and was 30% overall in the three classes in the same school and year group as the index class. The attack rate was 10% in School A, 7% in School B and 1% in School D (Table 1).

Including only confirmed cases (n=35), the attack rate was 27% for the index class, 20% in the three classes of the same school and school year as the index class, 7% in School A, 2% in School B and 0.3% in School D.

### Clinical epidemiology

The reported symptoms of the confirmed and probable cases (n=81) were fever (n=78), cough (n=50), asthenia (n=23), headache (n=28), rhinorrhoea (n=18), sore throat (n=15), abdominal pain (n=5) and vomiting (n=3) (Table 2).

Symptoms were similar in confirmed and probable cases. All cases who tested negative by PCR had fever; seven of them also had a cough. Negative cases were tested a median of one day (range: zero to five days) after the onset of symptoms.

Seven children were hospitalised but recovered without complications.

One child received oseltamivir prophylactically for two days; however, he developed symptoms after the second day and swabs were taken. After testing positive for the pandemic virus, the child was then prescribed curative treatment.

### Public health response

The local health authorities recommended that the families attend the Necker Hospital for Sick Children for examination and test and/or treatment (prophylactic or curative) if needed (if they developed symptoms or were in contact with a confirmed case).

A specific mobile paediatric emergency response team worked in a tent in front of the emergency department of the hospital in order to care for potentially infected children. Two examination rooms, a waiting room and medical equipment were installed in three hours. This outpatient clinic was open 24 hours a day, staffed by additional personnel who usually worked in the emergency department. All children and families arriving at the emergency department were evaluated by a nurse. Anyone with symptoms resembling those of influenza was taken straightaway to the tent once they had put

on a mask. A similar model has recently been described in Houston, Texas, in the United States [5].

Asymptomatic close contacts were advised to adhere to isolation measures (i.e. remain at home and avoid contact with others) until they had taken the second prophylactic dose of oseltamivir.

Schools A and B were closed for five days from 22 to 29 June 2009. A school party planned for Saturday 20 June was cancelled by the City Council of Paris; an information meeting for parents was held that Saturday morning in the school.

Staff of the local health authorities were present at the reopening of the schools on 29 June in order to answer parents' questions.

## Discussion

In this report we describe an outbreak of the 2009 pandemic influenza (N=81) involving four schools in the same neighbourhood of Paris, France, which arose following the visit of one school class (in School A) to the UK. Virus transmission occurred in the school, in their families and to the other three schools. Provision of information to the families, the setting up of a mobile paediatric emergency team, mass antiviral prophylaxis and school closure were the main public health responses.

The fact that the peak of the outbreak in the rest of School A (on 22 June 2009) was reached four days

after the peak in the index class suggests that a large number of the cases in the school were secondary cases resulting from person-to-person transmission within the school or their families. The peak of the outbreak in family cases was concomitant to the peak of the outbreak in all cases.

Cases started in two classes of School A at the same time; however, the infection spread more quickly in the index class. As shown in Figure 2, there was a lag in the distribution of the cases in the rest of the school and another lag for cases in the nursery (School B) and in the affected families.

Transmission of the virus to the other three schools occurred through infected pupils who were siblings of affected pupils in School A. In School B, the proximity of the two buildings and the sharing of facilities could also have helped transmission by increasing direct contact between pupils from both schools.

The source of the outbreak was assumed to be the index case, a 10-year-old girl, who had returned from a country with sustained human-to-human transmission of the pandemic virus five days before symptom onset. This case could have had a long incubation period and then spread the virus to other pupils in the school, mainly those in her class. This hypothesis is supported by the length of the incubation period of the pandemic influenza, which was estimated to be between one and seven days [6] and also by the fact that children might shed virus several days before illness onset, and that

**TABLE 1**

Distribution and attack rates for confirmed (n=35) and all symptomatic<sup>a</sup> (n=66) 2009 pandemic influenza A(H1N1) cases in Schools A–D, Paris, France, June 2009

School	Number of pupils	Confirmed cases		All symptomatic cases <sup>a</sup>	
		Number	Attack rate (%)	Number	Attack rate (%)
<b>A</b>					
Year group (age in years)					
6–7	70	5	7	6	10
7–8	77	4	5	8	10
8–9	79	1	1	1	1
9–10	61	1	2	3	5
10–11: all pupils	73	15	21	22	30
10–11: index class <sup>b</sup>	30	8	27	11	37
<b>Total</b>	360	26	7	40	11
<b>B</b>					
Year group (age in years)					
3–4	76	1	1	6	8
4–5	93	3	3	9	10
5–6	84	2	2	4	5
<b>Total</b>	253	6	2	19	8
C	No data	2	–	4	–
D	293	1	0.3	3	1
<b>Total</b>	–	<b>35</b>	–	<b>66</b>	–

<sup>a</sup> Confirmed and probable cases.

<sup>b</sup> The only class that travelled to the United Kingdom.

children can be infectious for 10 days or more after onset of symptoms [6].

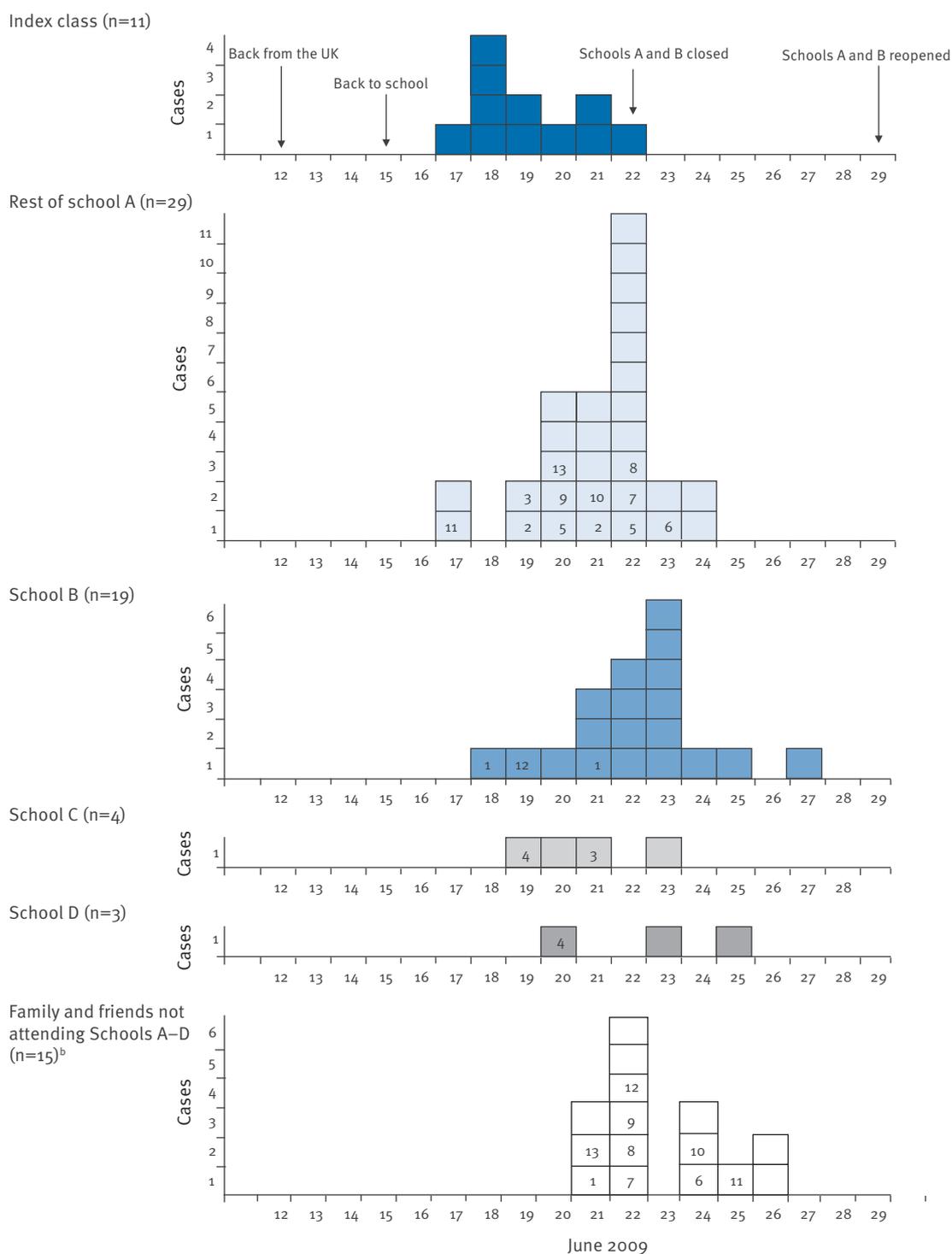
The lag between last potential exposure in UK and the peak in the index class suggests that the whole index class was not infected in the UK. As the typical

incubation period for influenza is one to four days (mean: two days), a mean incubation of six days for the whole index class is unlikely [6].

Two other confirmed cases in a different class (in the same year group) of School A also developed symptoms

**FIGURE 2**

Symptomatic cases of 2009 pandemic influenza A(H1N1) in Schools A–D by date of symptom onset and school, Paris, France, June 2009 (N=81)<sup>a</sup>



UK: United Kingdom.

<sup>a</sup> Numbers in boxes refer to cases in the same cluster of family and friends not attending Schools A–D.

<sup>b</sup> Blank cells in this curve represent cases who neither attended an affected school nor had siblings attending any affected school.

on 17 June 2009 (Figure 2, data on classes not shown). Therefore, exposure to a non-identified case at some point between 12 and 17 June cannot be excluded.

In fact, the teacher of the index class, who also travelled to the UK, presented general symptoms (fever and myalgia) from 16 to 18 June. However, as she presented no respiratory symptoms she did not meet the definition of possible case. She could have infected some pupils in the index class in the coach coming back from the UK or when she was back at the school on 15 June, 24 hours before the onset of her symptoms. She gave her classes on 18 and 19 June.

A party at School A on Friday 19 June, which the index class and other classes attended, and a party in the local parish church on Sunday 21 June could also have contributed to dissemination of the virus.

Family contacts probably played a role in the transmission. Several cases were siblings, so we could hypothesize transmission at home followed by the reintroduction of the virus by these secondary family cases into other classes of the school and to other schools.

In the family clusters in which there were affected siblings who did not attend any of the four schools involved in the outbreak, household transmission is the most likely explanation. However, transmission may have occurred outside the family (e.g. in playgrounds and through interfamily activities). Indeed, in order to understand the spread of the virus in this outbreak, it is important to note the intense social life in this neighbourhood. There were many activities between the families of children in the different schools. In addition, there were two after-school centres: one in one school and the other in the parish church (schools in France are closed on Wednesdays, so children attend outdoor pursuits centres). There was also a park just in front of

the schools where children from the four schools and other children from the neighbourhood played.

Antiviral prophylactic treatment of contacts and school closure may have contributed to the rapid decrease in the number of cases after the weekend (20–22 June). However, we cannot exclude the possibility that some symptomatic cases may have not visited the Necker Hospital for Sick Children and could therefore have been missed.

The symptoms recorded for cases were limited by the case definition, which was not very sensitive: a patient needed only general and respiratory symptoms to be classified as a possible case. One child presented only fever, and was therefore not considered to be a case, according to our definition. However, he was tested at the outpatient clinic and turned out to be positive. The definitions used may not have been appropriate as the clinical presentation of this new virus was not well known at the beginning of the outbreak [7].

It is evident from previous reports (and unpublished data) that schools are important in transmission of the pandemic virus and that outbreaks in schools occur frequently [8]. Since the start of the 2009 pandemic, several school outbreaks have been reported around the world [7–11] and a notable proportion of household transmission has been attributed to children [12].

Previous studies suggest that the majority of contacts in school-age children are with their peers [13]. This could explain why attack rates in the year group 10–11 (which included the index class) were higher than in other year groups in the school (School A).

## Conclusion

Up to early July 2009, surveillance of pandemic influenza cases in France was based on the identification of all possible cases in order to implement control

**TABLE 2**

Symptoms reported by the confirmed (n=35), negative<sup>a</sup> (n=6) and all symptomatic<sup>b</sup> (N=81) cases of 2009 pandemic influenza A(H1N1) in Schools A–D and in family and friends, Paris, June 2009

Symptoms	Confirmed cases n=35		Negative cases <sup>a</sup> n=9		All symptomatic cases <sup>b</sup> N=81	
	Number	(%)	Number	(%)	Number	(%)
Fever	34	97	9	100	78	96
Cough	23	66	7	78	50	62
Asthenia	17	49	1	11	23	28
Headache	16	46	2	22	28	35
Rhinorrhoea	10	29	1	11	18	22
Sore throat	6	17	2	22	15	19
Abdominal pain	5	14	0	0	5	6
Vomiting	2	6	1	11	3	4

<sup>a</sup> Classed as probable cases.

<sup>b</sup> Confirmed and probable cases.

measures around each of them, aimed at delaying the spread of the virus.

In this outbreak, nasopharyngeal swabs were taken from the first 44 cases. The large number of cases in this outbreak led to the adjustment of case management and to restrict biological confirmation. Every other new symptomatic case that had been in contact with a probable or confirmed case was assumed to have pandemic influenza. The global dissemination of the virus and the start of community transmission in France led to a shift to population-based surveillance [4,7]. Indications for sampling of possible cases were restricted to three cases in each suspected pandemic influenza cluster.

During the outbreak, decisions had to be made without delay and had to be adapted according to new information available and changes in management protocols. In this context, good communication and cooperation among the different people involved (healthcare authorities, the city council, clinicians, staff from schools, parents and children) were of major importance.

This epidemic shows the transmission of the pandemic virus in a school setting and in households. The measures established appeared to have stopped the transmission. The absence of transmission in the community at that time in France justified the measures taken.

Further work is needed to better define conditions under which the pandemic virus may transmit in a school setting and in households [12,13].

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