

THE IMPORTANCE OF SCHOOL AND SOCIAL ACTIVITIES IN THE TRANSMISSION OF INFLUENZA A(H1N1)v: ENGLAND, APRIL – JUNE 2009

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During the containment phase in the United Kingdom (April to June 2009), a cluster of influenza A(H1N1)v cases was identified prompting further investigation and public health action by the Health Protection Agency. The first confirmed case, a pupil at a school in England, was imported. During the following two weeks, 16 further cases were confirmed with epidemiological links to the first imported case. In this cluster, we found that significant transmission occurred in two classes with attack rates of 17% and 7%. In each of the two classes a case had attended school whilst symptomatic. Other settings included a party and a choir. Minimum and maximum attack rates were 14% and 25% for the party. For the choir both the minimum and the maximum attack rate was 4%. We did not find any evidence of transmission on two school bus trips despite exposure over 50 minutes to a symptomatic case and over two periods of 30 minutes to a case during the prodromal phase (i.e. within 12 hours of symptom onset). Nor was there onward transmission in another school despite exposure over several hours to two cases, both of whom attended school during the prodromal phase.

Introduction

The first case of influenza A(H1N1)v in the United Kingdom (UK) was reported by the Health Protection Agency (HPA) in April 2009 [1]. Since then, the number of cases has been steadily rising. HPA data suggest that in England children under the age of 15 years are predominantly affected, with much higher rates of primary care consultation seen amongst the under 15 year-olds compared to the over 65 year-olds [2].

In the cluster of cases described below, the first confirmed case (X1), a pupil at school X, had acquired the infection whilst visiting a country with sustained human-to-human transmission of influenza A(H1N1)v. Over the following two weeks a further 16 people became ill and were confirmed as having influenza A(H1N1)v; they all had an epidemiological link to the same index case (X1).

Investigation by the HPA identified a number of school and social interactions amongst children and adults associated with three schools, including participation in a choir, use of school buses, and a party, where transmission may have occurred. Five of the 16 further cases were confirmed in pupils at school X, seven were pupils at two other schools (schools Y and Z), one was a sibling of a pupil at school Z and three were adult members of the choir.

Estimates of the risk of transmission associated with exposure in different settings and during the prodromal phase are scant in the

literature to date. This paper describes the chains of transmission observed in a small but intensively investigated cluster in the early stages of the pandemic in the UK, and will contribute to the understanding of the risk of transmission as the pandemic continues.

Methods

During the investigation of this cluster, all cases were assessed using the HPA guidance algorithm in use at the time. Therefore, all possible cases who had either a history of travel to a country with sustained human-to-human transmission or an epidemiological link to a laboratory-confirmed case were tested using nose/throat swabs. Confirmed cases were investigated further and information on chronology, symptoms, travel history and any other exposures, as well as close contacts that may have needed prophylaxis were collected by the HPA.

For the purposes of this study, a line list was compiled of all laboratory-confirmed cases associated with the affected schools, the choir and the party. These confirmed cases were then analysed to elucidate probable chains of transmission based on day of onset of symptoms and association with different school or social settings.

Case definitions

A confirmed case was defined as an individual presenting with influenza like illness (ILI), in whom laboratory testing of a nose/throat swab had given a positive result for influenza A(H1N1)v. A secondary case was a confirmed case in whom onset of illness was between 24 hours and one week after direct contact with the index case (X1). A tertiary case was a confirmed case in whom onset of illness was between 24 hours and one week after contact with a secondary case and in whom there was no direct contact with the index case (X1).

Results

Chains of transmission

The epidemiological links observed between the confirmed cases (recorded by day of onset) are shown in the Figure. These are believed to be the most probable chains of transmission, taking into account information collected by the HPA.

School X

X1 attended school for approximately four hours whilst symptomatic with ILI on day 2 (but did not attend again until fully recovered). X1 had also attended school for the whole day on day 1. For some of that time X1 would have been in the prodromal phase,

which is defined for this study as the 12 hours prior to onset of symptoms. Over the next three days four further pupils (X2, X4, X5, X6) in the same class became symptomatic. Another pupil (X3), in the same year but different class than the index case, was also confirmed as a case. X2 and X3 were close friends.

The choir

Both X2 and X3 were members of a large choir comprising 107 adults (parents, staff, past pupils) and 62 children from schools X and Y. Choir members spent several hours together over the course of two days, during which time X2 became symptomatic. For some of that time, during day 2, X2 would have been in the prodromal phase. X3 was not symptomatic whilst at the choir. However for some time, during day 3, X3 may also have been in the prodromal phase. In addition to the two initial cases (X2, X3), a further six members became unwell with ILI and were subsequently confirmed as cases. Three of these six tertiary cases (P1, P2, P3) were adult members of the choir, and three (Y1, Y2, Y3) were pupils at school Y.

School Y

Two pupils, Y2 and Y3 attended school Y all day on day 5 whilst in the prodromal phase. Both became symptomatic on the evening of day 5 (symptom onset approximately 5 to 6 hours after school attendance). They did not subsequently attend school whilst symptomatic with ILI. There was no evidence of onward transmission at school Y.

A party

Two pupils from school X (X5, X6) attended a party of nine children, one of whom, the host's sibling, subsequently became

unwell and was confirmed as the first case (Z1) in a third school (school Z). X5 was symptomatic on the day of the party which lasted for at least six hours. X6 became unwell the following day and Z1 two days after the party. It is possible that X6 was in the prodromal phase whilst at the party if infection had already been acquired from X1.

School Z

Z1 was symptomatic whilst at school for approximately four hours. Three further cases occurred at school Z. Two of these cases (Z2, Z3) were in the same year group as Z1. One additional confirmed case (Z4), in a different year group, was believed to be a result of sibling-to-sibling transmission (from Z2).

School buses

Case X1 used a school bus along with 42 other pupils from school X and Y for approximately 50 minutes whilst symptomatic. Two pupils from the bus subsequently reported ILI, but tested negative when swabbed.

Y3 also travelled on a school bus whilst in the prodromal phase on day 5. The journey was approximately 30 minutes in each direction with 17 other pupils from school Y. No child on the bus trip apart from Y3 reported ILI.

Other

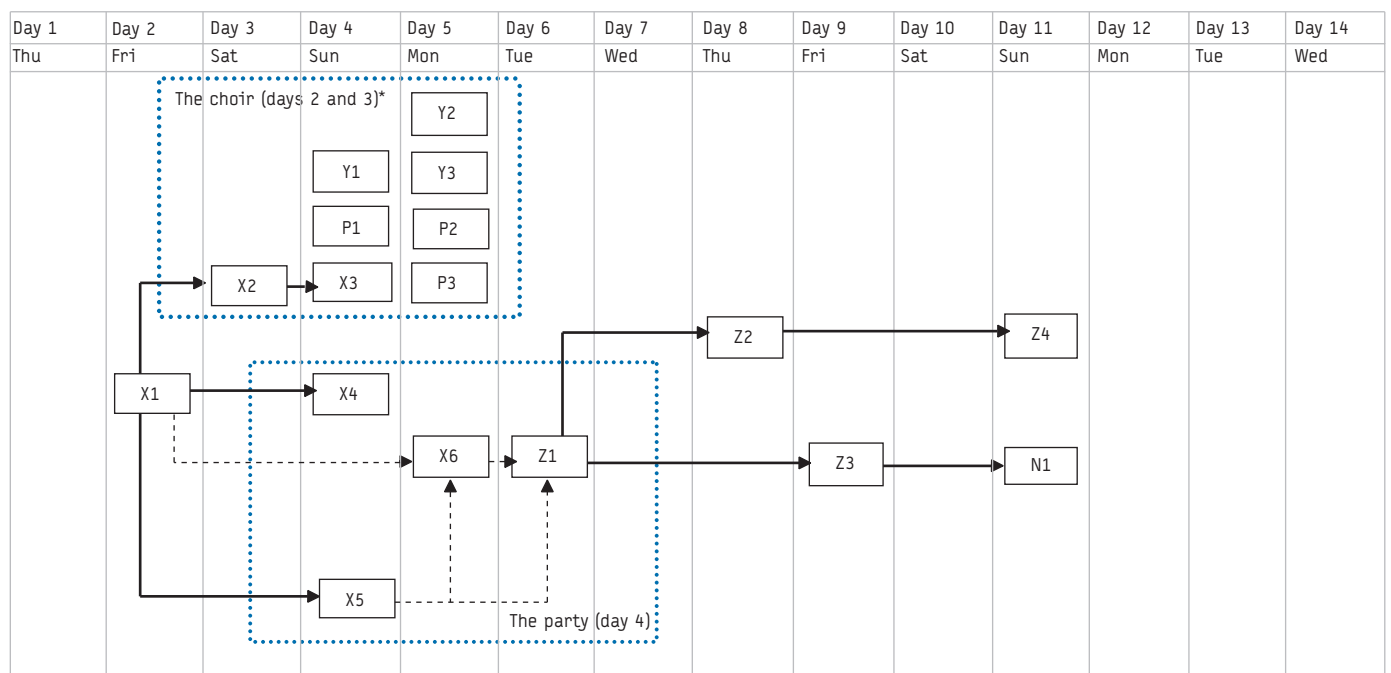
A further case (N1), who attended another school, was the sibling of Z3.

Attack rates

Attack rates have been calculated for each of the settings where cases were confirmed and are shown in Table 1. For school settings,

FIGURE

Probable chains of transmission amongst all laboratory-confirmed cases over a two-week period associated with the three schools (X, Y, and Z), the members of the choir, and a party according to day of onset of illness, England, April-June 2009 (n=17)



X1 – X6: pupils at School X; Y1 – Y3: pupils at School Y; Z1 – Z4: pupils at School Z; P1 – P3: adult members of the choir; N1: a sibling at another school
 → Single epidemiological link --→ One of two possible epidemiological links * No arrows show more than two possible epidemiological links

attack rates were calculated for the case's class, for other classes in the same year (excluding the case's class) and for the whole year. This is to reflect differences in cumulative exposure times. Both X1 and Z1 spent approximately four hours at school whilst symptomatic. During this time they were in contact with other pupils from their class. However, mixing with other pupils from the same year but different classes may occur for assembly and individual subjects. As a minimum, contact occurred during school breaks (morning break, lunch break) and in corridors between classes, with cumulative exposure times of at least one hour. For the choir and the party, both maximum and minimum attack rates

have been calculated to reflect uncertainty around where and how infection was acquired and the possibility of co-primary infections. For example X3, who was close friends with X2, may have acquired the infection from X2 during the time spent together within the choir or outside the choir, i.e. in a different setting.

Attack rates were highest within the setting of the party and the classroom. The maximum attack rate for children at the party was 25% (2/8) and the minimum, 14% (1/7). Within the classes of X1 and Z1, attack rates were 17% (4/23) and 7% (2/27) respectively. These attack rates were substantially lower when the cases' year groups, rather than the class, were considered. The maximum and minimum attack rate for the choir was 4%.

There was no onward transmission on either of the two school buses, nor in school Y.

Public health measures

At the time of this cluster, the UK was following a policy of epidemic containment. A risk assessment in line with HPA guidance was carried out in each setting to ascertain whether there was potential for transmission, and if school closure and the use of antiviral prophylaxis were indicated to prevent further spread of infection.

All three schools were advised to close for a period of one week, although in two cases this extended into scheduled school breaks. Antiviral treatment for cases and prophylaxis for contacts was provided as described in Table 2. In addition, all household contacts of confirmed cases were given antiviral prophylaxis. Advice was given to report any cases of ILI to the HPA, all of which were investigated with nose/throat swabs.

TABLE 1

Numbers affected and attack rates of laboratory-confirmed cases by setting, England, April-June 2009 (n=16, excluding index case X1)

Setting	Numbers affected		Attack rate(s) (%)	
School X				
Class of X1	4/23		17	
Other classes in the same year	1/96		1	
Total for whole year	5/119		4	
Choir	Minimum	Maximum	Minimum	Maximum
	6/167	7/168	4	4
Party	Minimum	Maximum	Minimum	Maximum
	1/7	2/8	14	25
School Z				
Class of Z1	2/27		7	
Other classes in same year	0/57		0	
Total for whole year	2/57		4	

TABLE 2

Summary of public health measures that were implemented at each of the settings: schools X, Y, Z, the choir, school buses, and the party, England, April-June 2009

Setting/ Age group	Days between last exposure to case and prophylaxis	Group identified for prophylaxis	Proportion of group that were given prophylaxis	School Closure (if applicable)	Number of subsequent cases
School X/ Age 11-12	3	Year group of index case	100%	Closed for 10 days	5 in the same year (4 in the same class)
School Y/ Age 12-13	4	Year group of children who were prodromal whilst at school (i.e. within 12 hours of onset of illness)	93%**	Closed for 19 days (including half-term break)	0
School Z/ Age 7-8	3	Year group of first case identified at school.	100%	Closed for 21 days (including half-term break)	2****
Choir/ All age groups including adults	4	All choir members who attended events	78%***	Not applicable	6
Bus of X1/ Mixture of age groups	3	All children on the bus	100%	Not applicable	0
Bus of Y3/ Mixture of age groups	5	All children on the bus	100%	Not applicable	0
Party/ Mixture of age groups	3*		Not applicable	Not applicable	1

* Except for two who received prophylaxis one day and four days after the last exposure respectively.

** A number of pupils refused.

*** 35 members refused.

**** There were three more cases but not believed to be directly linked to the first case at school Z

It is possible that the patterns of transmission seen in this cluster were modified by the public health measures implemented, although, the same measures being applied in all settings, the direction of any effect should be the same across all settings.

Discussion

In this intensively investigated cluster of cases, high attack rates for influenza A(H1N1)v were observed in the classroom, at a choir and a party. In each of these settings there was cumulative exposure of several hours duration to a symptomatic case. Transmission of influenza A(H1N1)v was much lower amongst year groups of symptomatic cases who had shorter exposure times. There was no evidence of transmission on two school bus trips, despite exposure times of 50 minutes to a symptomatic case, and two periods of 30 minutes to a case who was in the prodromal phase. Nor was there any onward transmission in school Y despite exposure over several hours to two cases who had attended school during the prodromal phase.

Estimates of the risk of transmission of influenza A(H1N1)v in different settings and during the prodromal phase are scant in the literature to date. However, attempts have been made to model how children interact and thereby predict the likely patterns of spread in the event of a pandemic. One such modelling study [3] predicted that the school class and household were two of the most critical settings in terms of duration of contact and risk of transmission of infection. Events such as parties, though infrequent, were also associated with high predicted risk of transmission, as when they did occur, contact was prolonged. Other studies modelling the spread of respiratory pathogens have drawn similar conclusions, with school and social group activities generally involving closer contact of longer duration than travel activities [4].

The patterns of transmission anticipated by these modelling studies are partially borne out by our experience with this cluster of cases: higher transmission was seen amongst classmates and social groups compared with those sharing transport. On the other hand, very little transmission was seen amongst household contacts of confirmed cases. This may be due to effective antiviral prophylaxis which was administered to all household contacts as soon as a swab result tested positive for influenza A (before typing confirmed H1N1v).

Aside from duration of exposure, which in this cluster was a strong determinant of onward transmission, specific characteristics of the exposure setting may have contributed to the spread, particularly closeness of contact as predicted in certain social settings [3], and in the case of the choir, increased aerosolisation of respiratory secretions during singing. This has been documented with high levels of transmission of tuberculosis within choir settings before [5-6].

As part of the management of this cluster, all children, in the same year or sharing a school bus with a case who was within the prodromal phase, were given antiviral prophylaxis. This was in line with HPA guidance [7] at the time, during the containment phase. Policy with regard to school closure and use of antiviral prophylaxis changed later as the UK moved from the containment phase to the treatment phase.

In this cluster, we did not see any onward transmission of influenza A(H1N1)v from cases Y2 and Y3, both of whom were at school during the prodromal phase. Neither did we observe any transmission as a result of contact with Y3 on the school bus. This

would indicate that risk of transmission during the prodromal phase is low. However, it is possible that the short incubation periods (of approximately 24 hours) observed before the onset of symptoms in X2 (following exposure to X1), and in those members of the choir who became symptomatic on day 4 (X3, Y1 and P1), may be accountable, in part, to exposure to cases (X1 and X2 respectively) during their prodromal phases.

Limitations

The patterns of transmission described are highly possible based on public health investigation of laboratory-confirmed cases. Given the small numbers described, caution in interpretation is needed. Although the HPA advised all individuals to report symptoms, there is a possibility that some individuals did not. Patterns of transmission are likely to have been modified by the public health response. Moreover we have no measure of the extent, if any, of asymptomatic carriage.

Conclusions

This study describes a small cluster in of influenza A(H1N1)v cases which was thoroughly investigated and epidemiological links characterised with reasonable precision. Our findings add weight to the argument that social activities are important routes of transmission which means that in the containment phase, school closure alone may not be enough to interrupt transmission. On the other hand, we did not find any evidence for transmission on school buses in this cluster. Given that the closeness and frequency of contact on public transport is likely to be less than amongst children using dedicated school buses, it may also be hypothesised that risk of transmission on public transport would also be low. Further work is warranted looking at the usefulness of social distancing measures in each of these settings (school, social groups, transport) in interrupting transmission of influenza A(H1N1)v.

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