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Influenza A: infection and reinfection

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SUMMARY

Twenty-nine boys in a boarding school were present during a large outbreak of influenza A H1N1 in 1978 when 27 were infected, 21 with clinical influenza. These boys were bled annually and were still in school when another outbreak of influenza A H1N1 occurred in 1983. Twenty-three of them were reinfected but only nine had symptoms. These results are compared with the experience of a similar group of boys in the early years of the influenza A H3N2 era.

Strains of the influenza A H1N1 subtype first reappeared in the winter of 1977–8 after an absence of 20 years and were responsible for numerous outbreaks of clinical influenza in children and young adults (Schild, 1978). Strains of this subtype have continued to circulate in the UK and outbreaks and sporadic cases have occurred in those too young to have encountered this virus previously (Pereira & Chakraverty, 1982).

A long-term study of the epidemiology of influenza has been in progress at Christ's Hospital, a boarding school for 800 boys, since 1970. There was an outbreak of influenza caused by influenza A H1N1 in February 1978 when there were 420 clinical cases. It was estimated that 90% of all the boys in school were infected (Davies *et al.* 1982). In the Spring of 1979 there was a further small outbreak caused by this subtype, which affected mainly those boys who had joined the school in the previous autumn. However, there were a few reinfections (some with associated symptoms) in those who had been present during the earlier outbreak. In February 1983 another outbreak occurred with approximately 200 cases caused by influenza A H1N1.

Sera collected annually were available from 29 boys who were present throughout this period. These serial sera were examined for antibody to both the haemagglutinin and neuraminidase of H1N1 viruses by radial haemolysis (Grilli & Smith, 1983).

Twenty-seven of these boys were infected in 1978, 21 with symptoms (Table 1). The two boys who escaped infection in 1978 were infected in 1979 when there were also three reinfections. Between 1979 and 1983 there were a further four reinfections. The fate of all these boys in 1983 is shown in Table 1. Cases were assessed by examination of paired sera collected at onset of symptoms and approximately 2 months later. Infection in boys without symptoms was determined by examining sera collected in April 1982 and April 1983. The case and infection rates

Table 1. *Experience of 29 boys in two outbreaks of influenza AH1N1*

Fate in 1978	Fate in 1983			Total
	Infected		Not infected	
	Case	No symptoms		
Infected:				
Case	8	9 (2 – 1979)*	4 (3 – 1981/82)	21
No symptoms	1	3 (1 – 1979)	2 (1 – 1981/82)	6
Not infected	—	2 (2 – 1979)	—	2
Total	9	14 (5 – 1979)	6 (4 – 1981/82)	29

* Intercurrent infections: number – year.

Table 2. *Comparison of two outbreaks of influenza A H1N1*

	Number (%) of 29 boys investigated in	
	1978	1983
Clinical influenza	21 (72)	9 (31)
Total infections	27 (93)	23 (79)
Case: subclinical infection	21:6	9:14

in the two outbreaks are compared in Table 2. The infection rate was high on both occasions but there was a marked difference in the clinical to asymptomatic infection ratios. During the 5 years 1978–83 not one of the 29 boys escaped infection. Two boys had been infected once, 24 boys had been infected twice and there were three boys who had been infected three times.

These results can be compared with events at the beginning of the A/Hong Kong (H3N2) era. During the period 1970–5 there were two outbreaks of influenza in the school caused by strains of the H3N2 subtype. The first was in 1972 when there were 180 clinical cases; the strain involved was similar to A/England/42/72. The second was in 1974 when an A/Port Chalmers/1/73-like strain caused approximately 80 cases. Sera were collected annually from 30 boys who were never vaccinated and who had no antibody to the H3 haemagglutinin in 1970 (Smith & Davies, 1976).

Six of these boys were infected before the first outbreak. In 1972, 20 were infected – 13 with symptoms. Five were infected in the 1974 outbreak; of these three had not previously been infected and two had been infected before 1972. The outbreaks are compared in Table 3. The infection rate in both outbreaks was lower than that recorded in the H1N1 outbreaks. Over the 5-year period 1970–5 there were 31 infections in 30 boys; one boy was never infected and two boys were infected twice.

Both studies give some indication of the impact of a new subtype on a susceptible population. There are some similarities: in the first outbreaks of the H3N2 and H1N1 subtypes in 1972 and 1978 respectively the infection rates were high and infection was often associated with clinical influenza. In the second outbreaks of

Table 3. *Comparison of two outbreaks of influenza A H3N2*

	Number (%) of 30 boys investigated in	
	1972	1974
Clinical influenza	13 (43)	2 (7)
Total infections	20 (67)	5 (17)
Case: subclinical infection	13:7	2:3

the two subtypes in 1974 and 1983 respectively there were more asymptomatic infections than cases of clinical influenza. There were also differences. The H3N2 virus had a neuraminidase similar to that of strains of the H2N2 subtype which preceded it and almost all of the boys bled in 1970 had antibody to H2N2. In 1978 none of the boys had experience of either the haemaglutinin or the neuraminidase of H1N1. Reinfections with the H3N2 subtype were rare between 1970 and 1975 but common following infection with the H1N1 subtype in 1978. All of those infected with H3N2 in 1972 produced antibody which reacted with A/Port Chalmers, the H3N2 variant causing the 1974 outbreak. Indeed infection in 1972 was shown to confer almost complete protection against challenge with A/Victoria/3/75 in 1976 (Hoskins *et al.* 1979). Only six of 26 boys infected with H1N1 in 1978 produced antibody which reacted with the 1983 outbreak strain and this was no longer detectable by 1982. (A detailed analysis of the response to infection and the persistence of antibody will be reported.) The high reinfection rate with H1N1 may reflect the poor immunizing capacity of a primary experience with a completely new subtype, perhaps combined with considerable antigenic drift.

These studies would not have been possible without the co-operation of the boys of Christ's Hospital and their medical officer, Dr T. W. Hoskins.

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