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## A secondary school outbreak of mumps following the childhood immunization programme in England and Wales

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### SUMMARY

Since the introduction of routine measles, mumps and rubella immunization for children in England and Wales in 1988, the incidence of mumps has declined steadily. We describe an outbreak of mumps in 1996 attacking 34 of a cohort of 98 schoolchildren born in 1982 and 1983. This is the largest outbreak in the UK since the introduction of the vaccine into the childhood immunization schedule. Salivary IgM assay was used as a simple, minimally invasive test to confirm the diagnosis. The occurrence of the outbreak demonstrates that British children who were just too old to receive mumps immunization in 1988 continue to be at risk of this disease as a result of diminished natural exposure. Further cases and outbreaks in this cohort are to be expected. Cohorts born before 1982 appear to be at less risk, presumably because of naturally acquired infection before the introduction of immunization.

### INTRODUCTION

Measles, mumps and rubella vaccination (MMR) was introduced into the childhood immunization schedule in the UK in October 1998 accompanied by a 'catch up' campaign to include all children aged less than 5 years. Immunization is now routinely offered shortly after the first birthday and, since October 1996, a second dose has been offered before school entry [1]. As mumps vaccine had been little used in the UK before 1988, most children born in 1983 or earlier have not been immunized against mumps. The introduction of the vaccine was followed by a fall in

the annual numbers of notifications from 20713 in 1989 to 1747 in 1996 (Office for National Statistics) and by a rise in the mean age of infection. Adolescents and young adults are now at greatest risk [1, 2].

### DESCRIPTION OF THE OUTBREAK

At the end of July 1996, 12 cases of mumps were notified in Gloucestershire, Southwest England. All were teenagers living in or near a small rural town (population 8000) in the Forest of Dean (population 75000) in West Gloucestershire. Eleven, who were born in 1982 or 1983, were in Year 8 at the main secondary school in this town. The twelfth, born in 1984, was in a different year at the same school.

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We report an investigation to determine the size of the outbreak, identify its source and consider the implications for national immunization policy.

## METHODS

### Case definitions

A case of mumps was defined as a resident of Gloucestershire with parotid swelling developing between 1 May and 31 October 1996 and/or immunological evidence of recent infection with mumps virus. Cases were classified as confirmed, probable or asymptomatic: *Confirmed*: parotid swelling with either immunological evidence of recent mumps infection (mumps specific IgM, seroconversion to mumps V and S or single high titre of mumps S antibody) or isolation of mumps virus from saliva or urine. *Probable*: parotid swelling without microbiological evidence (virus isolation or positive serology) of recent mumps infection. *Asymptomatic*: microbiological evidence of recent mumps infection (virus isolation or positive serology) without parotid swelling.

### Cohort study

Questionnaires and saliva collection kits were posted to the parents of all 106 pupils in Year 8 at the outbreak school on 7 August 1996. Questions were phrased to elicit a recent history of mumps, symptoms of mumps, past history of mumps, MMR immunization, contact with people suffering from mumps and recent foreign travel. Saliva samples were returned to the Enteric and Respiratory Virus Laboratory (ERVL), Central Public Health Laboratory (CPHL), Colindale, London where they were analysed for mumps-specific IgM as previously described [3]. Non-responders to the questionnaire were followed up and enhanced surveillance, as described below, was used to identify cases occurring after questionnaires had been returned. If the history was consistent with mumps but salivary IgM was negative on initial testing, serum and/or second saliva samples were requested. Information on MMR immunization status of all Year 7, 8 and 9 pupils was obtained from the child health service records, the most reliable local source of routine vaccinations given in pre-school and school age children. Data were entered onto a microcomputer and analysed using Epi Info [4].

Table 1. *Incidence of mumps in cohort*

	Male	Female	All
Confirmed cases	17	8	25
Probable cases	4	1	5
Asymptomatic cases	1	3	4
No. of respondents	56	42	98
Attack rate (confirmed and asymptomatic cases only) (%)	32.1	26.2	29.6
Attack rate (all cases) (%)	39.3	28.6	34.7

Vaccine efficacy was calculated by reference to confirmed and probable cases.

### Case finding outside the cohort

All Gloucestershire general practitioners (GPs) were advised of the outbreak, reminded to notify suspected cases and asked to collect saliva samples from such cases for analysis. Paediatricians and microbiologists were asked to inform the Gloucestershire Consultant in Communicable Disease Control (CCDC) of cases, as were CCDCs and microbiologists in adjacent health authorities. Head teachers of secondary schools in the Forest of Dean were asked to inform the CCDC of pupils with possible mumps.

### Culture of mumps virus and genotyping

In cases where notification was received within 2 weeks of the onset of illness, patients were contacted to collect throat swabs and urine samples for virus culture. Samples were inoculated into baboon kidney cells at Gloucester PHL and one mumps virus isolate was forwarded to ERVL for genotyping. Mumps RNA was extracted from tissue culture fluid and was reverse transcribed into cDNA using a procedure essentially the same as previously described for measles virus [5, 6].

## RESULTS

### Cases within the cohort

After follow-up, completed questionnaires were returned by 102 (96%) of 106 pupils in the cohort. Saliva samples were provided by 98 (92%). Only those pupils who returned both questionnaire and saliva sample were included in the analysis. Thirty-four cases (25 confirmed, 5 probable, 4 asymptomatic) were identified in the cohort (Table 1) with dates of

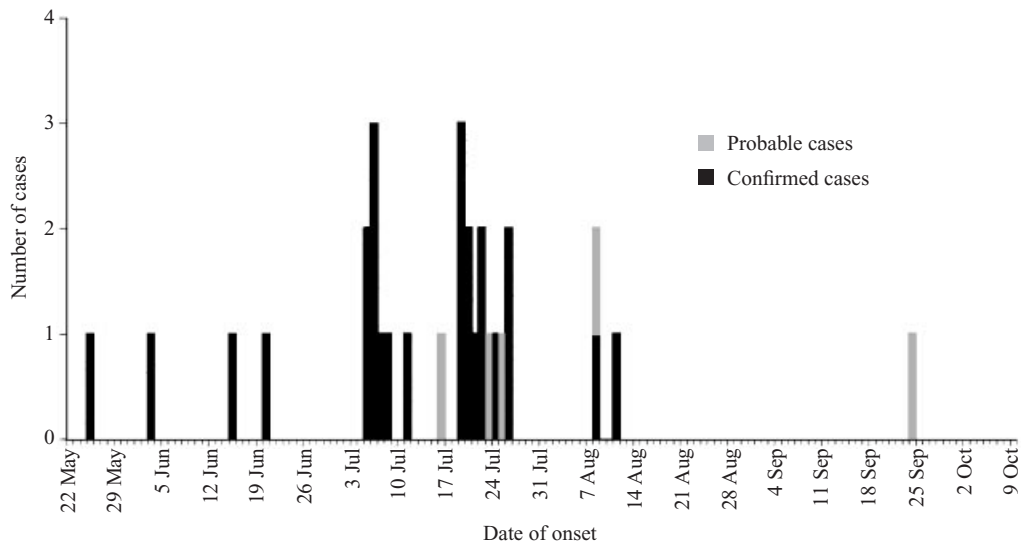


Fig. 1. Epidemic curve: mumps outbreak, Forest of Dean, May–October 1996. Cases within cohort.

Table 2. *Confirmed cases of mumps with negative salivary IgM on testing at time of questionnaire*

Case no.	Time between onset of illness and salivary sampling (days)	Evidence of infection
1	8	Virus isolated from throat
2	19	Repeat saliva sample positive for IgM antibody at 49 days
3	35	Earlier saliva sample (sent by GP) positive for IgM antibody
4	62	Raised serum titres of mumps anti-S (64) and anti-V (128) 19 weeks after illness
5	66	Raised serum titres of mumps anti-S (32) and anti-V (64) 21 weeks after illness
6	81	Serum sample sent by GP at time of illness consistent with recent mumps infection
7	107	Raised serum titres of mumps anti-S (32) and anti-V (128) 23 weeks after illness

onset between 25 May and 24 September (Fig. 1). This included two boys who fell ill after completing their questionnaires (dates of onset 8 August and 24 September 1996). Eighteen (60%) out of the 30 confirmed and probable cases were notified formally.

Of the 25 confirmed cases, 18 had salivary IgM in a sample taken at the time of the questionnaire. Further microbiological evidence of infection was found in seven respondents who had a history consistent with mumps but negative salivary IgM on initial testing (Table 2). Mumps virus was isolated from the throat

swab of one case but technical problems made the culture unsuitable for genotyping. Of the five probable cases, three had negative salivary IgM (25, 29 and 55 days after illness respectively) and two became ill after returning their questionnaires and did not repeat the saliva samples.

No cases were admitted to hospital. Pupils who were ill during term time were mostly off school for 1–2 weeks. Of the confirmed and probable cases, more than half reported headache and/or stiff neck, and four (14.3%) reported severe headache and stiff neck.

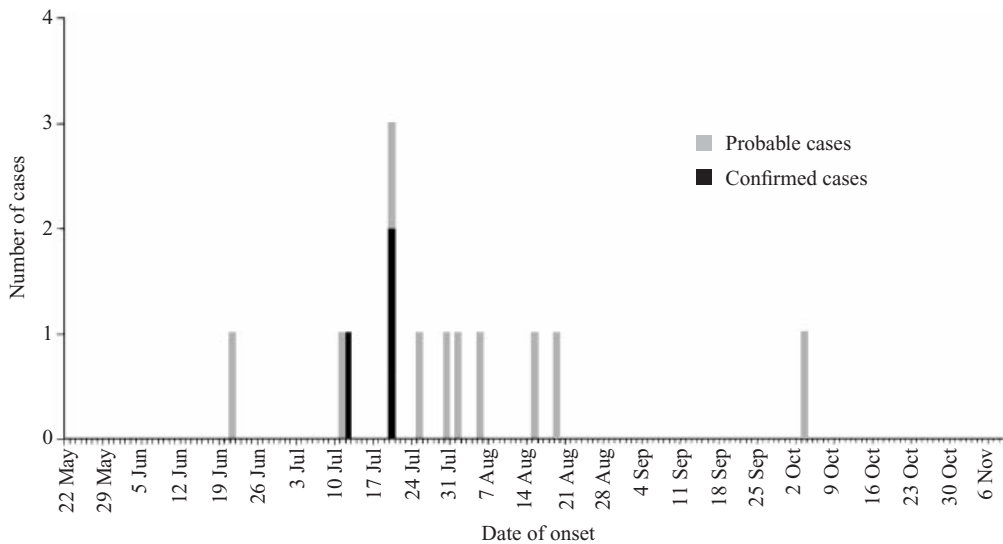


Fig. 2. Epidemic curve: mumps outbreak, Forest of Dean, May–October 1996. Cases outside cohort.

Some children from the cohort had been on two organized school holiday trips during the period investigated (one to Italy in early June, the other an outdoor pursuits holiday in the UK in mid June). Of 17 who went to Italy, 3 developed mumps within the next 3 weeks. Of 23 who went on the outdoor pursuits holiday, 2 had had mumps at least a week beforehand, 2 became ill during the holiday and 2 were ill 3 weeks afterwards.

According to the child health service records, 34 (34.7%) of the 98 respondents in Year 8 who returned saliva samples had received MMR vaccine, compared with coverage of 75% in Year 7 and 26% in Year 9. Two (6.9%) of the 29 students with laboratory evidence of recent mumps infection had been immunized as had 3 of the 5 (60%) probable cases. Twenty-nine (45.3%) of the 64 non-case pupils had been immunized. Including all cases in the calculation, vaccine efficacy (1-relative risk) was 67.5% (95% CI 23.8%, 86.2%).

Parents of 16 children (16.3%) said that their child had had mumps in the past. Seven of these 16 had also had MMR vaccine and one had a laboratory confirmed mumps infection during this outbreak.

#### Cases outside the cohort

Fourteen cases, not in the Year 8 cohort, were identified in residents of the same town and surrounding villages between 21 June and 3 October (Fig. 2). Three were in Year 7 at the same school, three were at other schools with siblings or close friends in the cohort and two were parents of cases at the school.

No connection with the school was established in seven cases. No cases occurred in older pupils at the outbreak school and no cases were reported from other local secondary schools. No saliva samples from these cases were returned to the ERVL, but laboratory evidence of infection was obtained for three (virus grown in urine of one, raised serum titres of mumps anti-S and anti-V in two). The virus, isolated from the younger sibling of a member of the cohort, was genotype D.

Seven other cases were notified from other parts of the county during the study period. None of these seven was confirmed; two had negative saliva tests.

#### DISCUSSION

This is the largest mumps outbreak to be reported in a UK secondary school since MMR immunization became routine. It confirms the hypothesis that the introduction of routine MMR immunization might result in school outbreaks of mumps while cohorts which have not been routinely vaccinated, i.e. those born before 1984, remain of school age [7]. The attack rate of 34.7% in the school year was higher than that reported in a junior (7–9 year olds) and infant (5–7 year olds) school outbreak in 1988 and 1989 (2.1 and 11.7% respectively) [8]. However, the children in the earlier outbreak were from earlier birth cohorts and data from national surveys [7] indicate that they probably had higher levels of naturally acquired immunity.

The outbreak described was well circumscribed,

occurring almost exclusively within a single year group at a single school. Most of the local cases outside this school year cohort either attended the same school or had close contact with known cases. This is as expected, given the low transmissibility of mumps virus [9]. As the degree of contact between the cohort and younger or older school year groups was probably similar, it is of note that no cases were reported among older cohorts in the school who had lower rates of MMR vaccine coverage. Again this is likely to be due to their greater chance of having acquired natural immunity [7].

A large outbreak reported in USA was related to a school gathering [10]. No such event was identified in this outbreak although two school holidays, during which pupils slept in dormitories or travelled in coaches or minibuses, were identified and analysed to determine whether they might have contributed to the persistence of the outbreak. There was no evidence that either trip served to amplify the outbreak.

Several cases in the cohort were not notified, even after GPs were contacted. Although parents of several cases might not have sought medical confirmation of mumps, some unreported cases were known to GPs since they were identified from samples sent to the laboratory for confirmation. While such under-reporting is unlikely to have affected case ascertainment within the cohort, the incidence of disease outside the school year cohort was probably underestimated.

Measurement of salivary IgM has been shown to be a useful test for identifying recent mumps [3]. The PHLS Communicable Disease Surveillance Centre (CDSC) advises that the optimum time for sample collection is between 2 and 4 weeks after the onset of the first symptoms although a range of 1–6 weeks is acceptable. In this study saliva collected from seven cases confirmed by other means was negative for mumps IgM (Table 2). Of these, six were collected less than 2 weeks or more than 4 weeks after onset of clinical disease.

There was no laboratory confirmation of mumps in five members of the cohort, three of whom had had previous MMR immunization. All five, however, gave a clear history of a short self-limiting illness associated with parotid swelling.

Four asymptomatic cases were identified. It is assumed that these cases were part of the outbreak, but no information was sought on whether they had been immunized in the past or their close contacts had recently received MMR vaccination. High titres might

occasionally be found in contacts of the recently vaccinated due to the booster effect of a live attenuated virus.

As the reported complication rate following mumps is between 0·9 and 2·4% [11], few complications would have been expected in this outbreak. No cases were admitted to hospital, but a substantial amount of missed schooling was identified and four cases reported symptoms consistent with mild meningitis. During the investigation consideration was given to the value and practicality of offering immunization to those pupils who did not have a clear history of recent mumps and who had not received MMR immunization. However, a mass immunization campaign would have been difficult to organize during the school holidays and, by the time school recommenced, 33 of the total cohort (31·1%) had had clinical or subclinical mumps, of which 29 infections were confirmed, and the outbreak appeared to have abated. As 80–85% of this birth cohort was likely to be immune [7] we considered that few, if any, children were still at risk. One more case occurred shortly after the beginning of term but an immunization campaign was not initiated and no further cases were reported.

Although the virus isolate in this study came from a case outside the cohort, and different virus strains may circulate in one area at the same time, it is likely that this outbreak was caused by a genotype D strain. The case, although at a different school, was the younger sibling of a member of the cohort and became ill 14 days after his brother. It is reasonable to assume that he was infected by his brother.

Outbreaks of mumps due to genotype B and C virus strains have been reported among highly vaccinated populations in Switzerland and Portugal where Ribini strain vaccine is widely used [12, 13]. No outbreak has been described in Britain in a highly vaccinated group and this is the first UK outbreak to be described in a partially vaccinated population. All children in this cohort would have received vaccines containing either Urabe Am/9 or Jeryl Lynn mumps strains.

Although genotyping of mumps virus allows several strains to be identified, there is not believed to be any immunological significance in the difference between genotypes [14]. Different strains of mumps virus are seen in different parts of the world and, although several different strains may circulate simultaneously, typing helps to document transmission patterns. The group D strain identified in this outbreak was distinguishable from, but closely related to, other D strains circulating in England in 1997.

Vaccine efficacy in the affected cohort was 67.5% (95% CI 23.8%, 86.2%). This is similar to the efficacy calculated in studies of cases reported to the PHLS CDSC and of secondary cases of mumps in Geneva [8, 15]. Although mumps is generally a mild illness, the greater risk of complications in patients over the age of 15 is well documented [11]. The high levels of uptake of MMR immunization in children born in Britain after 1982/3 and the high levels of naturally acquired antibody in older cohorts indicate that the birth cohort identified in this outbreak is most susceptible to mumps and at increasing risk of complications from infection as it ages. If surveillance identifies a continuing high risk of disease, a targeted immunization programme of this cohort may be required.

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