

UK measles outbreak in non-immune anthroposophic communities: the implications for the elimination of measles from Europe

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SUMMARY

We describe the epidemiology of the first nationwide outbreak of measles infection in the UK since the implementation of a mass vaccination campaign. Notifications of infectious diseases, interview and postal questionnaire identified 293 clinical cases, 138 of which were confirmed by salivary IgM, measles virus isolation and PCR. Twelve were epidemiologically linked to confirmed cases. The outbreak began in London, after contact with measles infection probably imported from Italy. Measles genotyping determined by sequence analysis confirmed spread to other unimmunized anthroposophic communities in the north, south west and south coast of England. Only two cases had been vaccinated against measles infection, and 90% of cases were aged under 15 years. Measles virus can selectively target non-immune groups in countries with high vaccine uptake and broader herd immunity. Without harmonization of vaccination policies and uniform high coverage across Europe, the importation and spread of measles virus amongst non-immune groups may prevent the elimination of measles.

INTRODUCTION

Measles virus infection kills about one million children each year, mainly in developing countries [1]. In unimmunized communities, epidemics occur every 2–3 years, and almost all children acquire measles infection before the age of 15 years [2]. In developed countries, the numbers of deaths and complications associated with measles infection have fallen since the first half of the century, but vaccination programmes can still substantially reduce the morbidity and associated health care costs of measles infections [3–7].

Single-antigen measles vaccine was introduced into the UK routine childhood immunization schedule in 1968, and replaced by a combined measles, mumps and rubella (MMR) vaccine in 1988. By the early 1990s, MMR coverage for 2-year-old children exceeded 90% and notification of measles fell to historically low levels. In 1994, to avert a predicted epidemic, 92% of eight million school children aged 5–16 years were vaccinated with measles and rubella (MR) vaccine [2, 8]. This was followed 2 years later by the introduction of a two-dose strategy, offering a second dose before school entry. At the start of the outbreak described in this paper, MMR coverage for children aged 2 years in the UK had been over 90% for 6 years.

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This outbreak was first identified in a village belonging to one of the largest unimmunized communities in the UK, the Camphill Trust. This is a British organization providing care for people with special needs, allied to similar communities in central Europe, Scandinavia, North and South America, and Africa. Adults with learning disability live amongst co-worker families including their children, in active communities with a strong work ethic. There are 33 Camphill centres in Britain (schools, colleges for adolescents, training centres and working villages) involving at least 2500 residents.

This movement traces its philosophical roots back to the 17th century [9], but is influenced heavily by the work of the Austrian philosopher and seer, Rudolph Steiner (1861–1925). Steiner offered new ideas on agriculture, medicine, ecology and education, set in the social backdrop of the years following the first world war, as his own unique worldview, ‘anthroposophy’. Steiner proposed that febrile illnesses such as measles and scarlet fever were related to a child’s spiritual development [10]. Many of the disabled residents of the community will have undergone routine immunization in childhood, but the co-worker parents tend to decline measles immunization for their own children. The avoidance of immunization in these communities is more than a refusal to accept conventional medicine. It is seen, particularly in the case of measles, as a positive opportunity for the child to benefit from the illness itself.

METHODS

Epidemiological investigation

Measles was identified by the parents of the index case, a 5-year-old boy from a North Yorkshire Camphill community. He had visited a North London anthroposophic community where approximately 30 children had rash and fever typical of measles infection. The outbreak in London was not reported to local health authorities and none of the cases was confirmed by laboratory investigation.

General practitioners (GPs) in the area surrounding the North Yorkshire Camphill Village Trust were alerted to the presence of measles infection, and asked to notify suspected cases and collect saliva samples from them. Within the community the local GP collected details of the number of infected children, presence of symptoms and complications, onset date and immunization status. All children who had had symptoms suggestive of measles infection were invited

to attend the GP surgery and a salivary swab was taken. Clustering of cases (two or more cases within households) was also recorded.

One unimmunized family from a Camphill community in Gloucestershire visited the North Yorkshire village whilst the outbreak was ongoing. When the children developed symptoms of measles after returning to Gloucester, local GPs were informed and a retrospective structured postal survey was conducted of all notified cases of measles.

To raise awareness of the risk of measles infection, all health authorities in England and Wales were sent an electronic (epinet) message regarding this outbreak, and a report was published in weekly bulletin of the Communicable Disease Surveillance Centre.

Case definitions

Cases were defined as: clinical – rash and fever, saliva not tested; confirmed – rash and fever, IgM positive on saliva; epidemiologically linked – rash and fever and IgM negative or equivocal and IgG positive and a confirmed case in same household. The latter category was included because saliva from some children was taken late in the course of illness.

Laboratory investigation

Saliva collection swabs from suspected measles cases were received in the PHLS Enteric and Respiratory Virus Laboratory and processed by eluting saliva into a recovery diluent [11]. The harvested salivas were stored at -20°C until tested. The presence of measles virus-specific IgG and IgM was determined using antibody capture radioimmunoassay (GACRIA and MACRIA) [12]. Saliva specimens found to be IgM positive were tested for measles RNA using reverse transcriptase–polymerase chain reaction (RT–PCR) [13]. PCR amplicons were then submitted for nucleic acid sequencing and the resultant sequences analysed and compared to other known measles sequences [14]. In an attempt to culture the virus, samples from throat swabs taken from 11 North Yorkshire cases were inoculated into B95A marmoset lymphoblastoid cells.

RESULTS

A total of 293 clinical cases were identified. Salivary samples were submitted from 46 (100%) North Yorkshire cases and 99 (45%) of the Gloucestershire clinical cases; 117 of these cases were confirmed, and

Table 1. *Distribution of clinical, confirmed and epidemiologically linked cases*

Location	Total no. of clinical cases	IgM positive confirmed	Epidemiologically linked	Total laboratory confirmed (%)	No. of household clusters
North Yorkshire	46	31	7	38 (83)	11
Gloucestershire	221	86	0	86 (39)	15
Bristol	6	4	2	6 (100)	2
Dorset/Hampshire	20	17	3	20 (100)	5
UK Total	293	138	12	150 (51)	33

Table 2. *Age-specific attack rates North Yorkshire clinical cases**

Age range (years)	Total cases (No. confirmed)	Total population	Age-specific attack rates (%)
0-1	4 (4)	4	100
2-3	3 (3)	3	100
4-5	4 (4)	5	80
6-7	9 (8)	9	100
8-9	11 (11)	11	100
10-11	7 (7)	8	88
12-13	3 (3)	7	43
14-15	0	5	0
16-17	1 (0)	4	25
18-19	1 (0)	8	13
Total	43	64	67

* Excludes three school pupils not resident in the village.

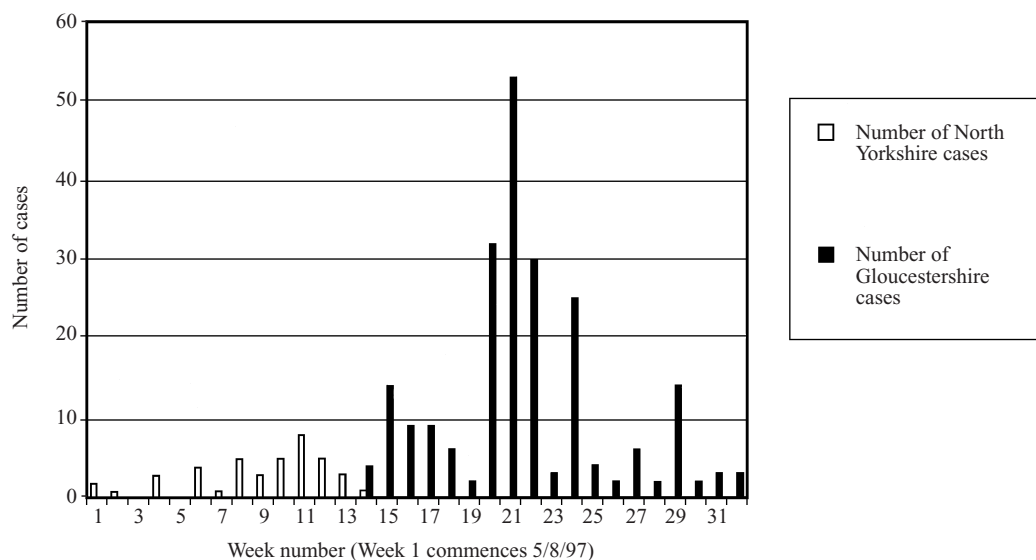


Fig. 1. Epidemic curve.

seven were epidemiologically linked. Measles virus was successfully isolated from one of the North Yorkshire samples. Four confirmed and 2 epidemiologically-linked cases were also identified in Bristol, and 17 confirmed and 3 epidemiologically-linked cases in Dorset and Hampshire. All the cases were linked epidemiologically with Camphill Trust

communities. Two of the clinical cases had a history of MMR vaccination and two did not give a history. The remaining cases had not been vaccinated. The details are shown in Table 1.

The age distribution of the laboratory-confirmed cases was as follows: < 1 year: 3 (2%), 1-4 years: 37 (25%), 5-9 years: 55 (36%), 10-14 years: 40 (27%),

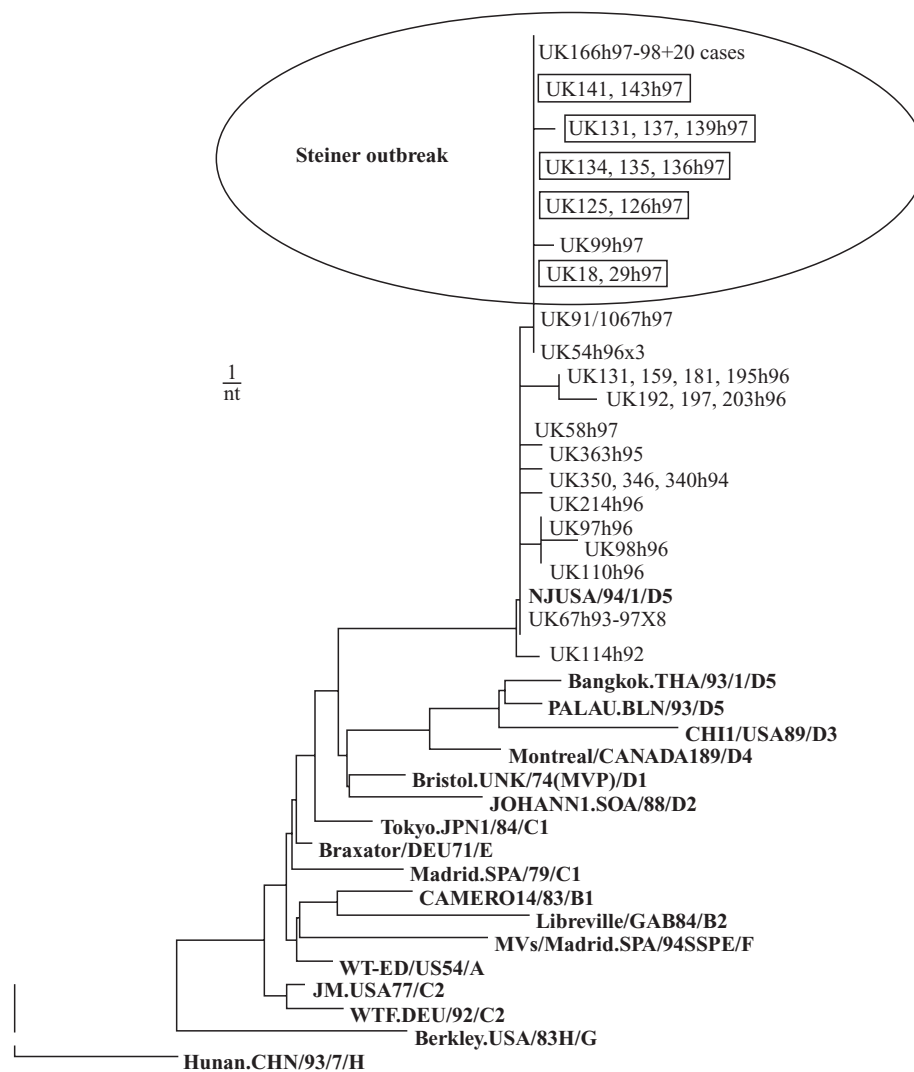


Fig. 2. Phylogenetic tree.

15 years + : 12 (8%), unknown: 3 (2%). Age-specific attack rates have been calculated for the North Yorkshire cases, where the size of the denominator population is known (Table 2). The epidemic curve is shown in Figure 1.

Sequence comparison of a region of the measles haemagglutinin (H) gene showed the viruses detected in this outbreak to be strains of measles genotype D6, designated by WHO [16] formerly assigned genotype 1 [13]. Almost all had identical sequences to each other (Fig. 2). A family cluster of three cases showed a strain with a single base mutation in this region, as did one other single case in the outbreak. These mutations were synonymous, that is, they do not affect the proteins coded.

A questionnaire was returned from 117/221 (53%) infected in Gloucestershire. Common complications reported included 'ear infection', 'tummy upset' and

Table 3. *Complications of measles in Gloucestershire (n = 127)*

Complication	No. reporting symptoms (% of respondents)
'Ear infection'	29 (23)
'Tummy upset'	44 (35)
'Chest infection'	30 (24)
Eye infection/conjunctivitis	11 (9)
Febrile convulsion/'type of fit'	1 (< 1)
Quinsy	1 (< 1)
Pilonidal abscess	1 (< 1)
Total	117 (92)

'chest infection' (Table 3). In North Yorkshire, the only complications identified after direct questioning of parents by the GP were three cases of otitis media and one case of diarrhoea.

DISCUSSION

We have reported the first outbreak of measles infection since the 1994 'catch up' immunization campaign, and the introduction of a two-dose vaccination strategy to the UK. The main finding is that high vaccination coverage rates produce effective herd immunity for the general UK population, but unvaccinated groups remain vulnerable to imported measles virus.

This study has a number of limitations. Not all of the clinical cases were confirmed by laboratory testing, and it is possible that cases in the wider community may have been missed. However, this risk was minimized by alerting local GPs and encouraging their active participation in the prospective monitoring of the outbreak. We are confident that data capture was complete in North Yorkshire, as the anthroposophic community was geographically contained and served by one GP practice. In Gloucestershire, however, a low response rate to the postal questionnaire may have introduced bias.

Compliance with salivary testing was high in North Yorkshire, and it is unlikely that the same level of confirmation would have been achieved in this community if a blood test had been required. This is important for measles surveillance, which has traditionally relied upon notification, based on a clinical diagnosis by a physician. As measles infection becomes less common, the predictive value of a clinical diagnosis will fall and there is a need for laboratory confirmation to provide more reliable data [16]. Saliva sampling provides an acceptable (non-invasive) alternative to blood testing for laboratory confirmation and has formed part of the enhanced surveillance of measles (mumps and rubella) in the UK since the MR campaign in November 1994 [11, 16]. Currently, around half of notified measles cases are investigated by saliva testing [16].

Recent advances in molecular biology enabled us to monitor the geographical spread of the epidemic and to confirm that infections in different communities were part of a national outbreak. The measles genotype (D6) causing this outbreak was detected previously in the UK and recently in other European countries [17]. Despite an increase in international travel in recent decades, imported measles infections in the UK commonly originate from western Europe (J. White, personal communication). This probably reflects the low coverage of measles containing vaccines in European community countries with

frequent travellers to the UK. In the USA, importations of measles infection also commonly arise from Western Europe, whereas those from Latin America have fallen due to better control in the source country [18].

The proportion of patients in Gloucestershire with self reported symptoms other than fever and rash was high (Table 3) compared to other studies [19]. Most of these were probably mild symptoms and did not require a GP consultation. In North Yorkshire, where one GP took a detailed history from parents during the examination of their children, the proportion of reported complications was much lower. Our data may reflect recognized differences in the way professional and lay audiences report and define symptoms, highlighting the need to interpret self-reported and professionally ascertained data with caution.

The epidemic curve for this outbreak was prolonged. In North Yorkshire there were 14 weeks between the onset of the first and last cases and in Gloucestershire 20 weeks. In North Yorkshire, rapid person-to-person spread may have been prevented because the outbreak started during the school holidays, a factor which highlights the importance of schools as foci of communicable disease transmission. In Gloucestershire, the members did not live in a defined residential setting and not all subscribed to all the core philosophies. This may also have reduced the density of susceptible children and therefore delayed transmission.

Unconfirmed reports suggested that the measles infection was introduced from Italy. Cases from North Yorkshire subsequently travelled to Denmark and Estonia, and may have re-exported the infection to mainland Europe. The ability of measles virus to infect geographically dispersed susceptible populations has implications for both measles elimination strategies and national immunization programmes. At present, all countries of the European community except Italy use two doses of measles-containing vaccines [20], but uptake varies widely from country to country. In Italy, for example, coverage is 56% and measles incidence rates are estimated at 10–120 per 100000 [20]. With a single dose of vaccine, high coverage will produce prolonged periods of freedom from measles. Eventually, however, cohorts of susceptible persons (those who did not receive vaccine or those who failed to respond to a single dose of vaccine) will accumulate. Epidemics of measles will follow, usually amongst older children [21, 22]. A single dose strategy, therefore is unlikely to eliminate

measles infection. Countries that have managed to interrupt measles transmission by achieving high vaccination coverage for two doses [23, 24] still risk the re-introduction of measles from neighbouring countries where coverage is poor into their non-immune groups.

This outbreak indicates that the risk to the general population from imported measles is small, when coverage has been high for some years. The failure of the infection to spread to the general community indicates the high degree of herd immunity imparted by this high coverage. More recently, however, claims of a link between measles-containing vaccines and Crohn's disease and autism have resulted in some loss of public confidence in MMR vaccine [25]. Despite overwhelming evidence against this link [26, 27] vaccine coverage in the UK is now only 88% for 2-year-olds [28]. If coverage remains at this level, or falls further, future outbreaks amongst unvaccinated groups are liable to produce large measles epidemics in the general UK population. In particular, the potential for rapid spread of measles in the school setting will occur when the cohorts with low coverage reach school age in 2 or 3 years time.

The European Region of the World Health Organisation has accepted a target for measles elimination from the region by 2007. To achieve this, high coverage of two doses of measles vaccines and harmonization of vaccine policy and implementation are needed. Until measles infection is eradicated, unvaccinated communities will be susceptible to imported infection, and could promote the indigenous transmission in the UK.

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