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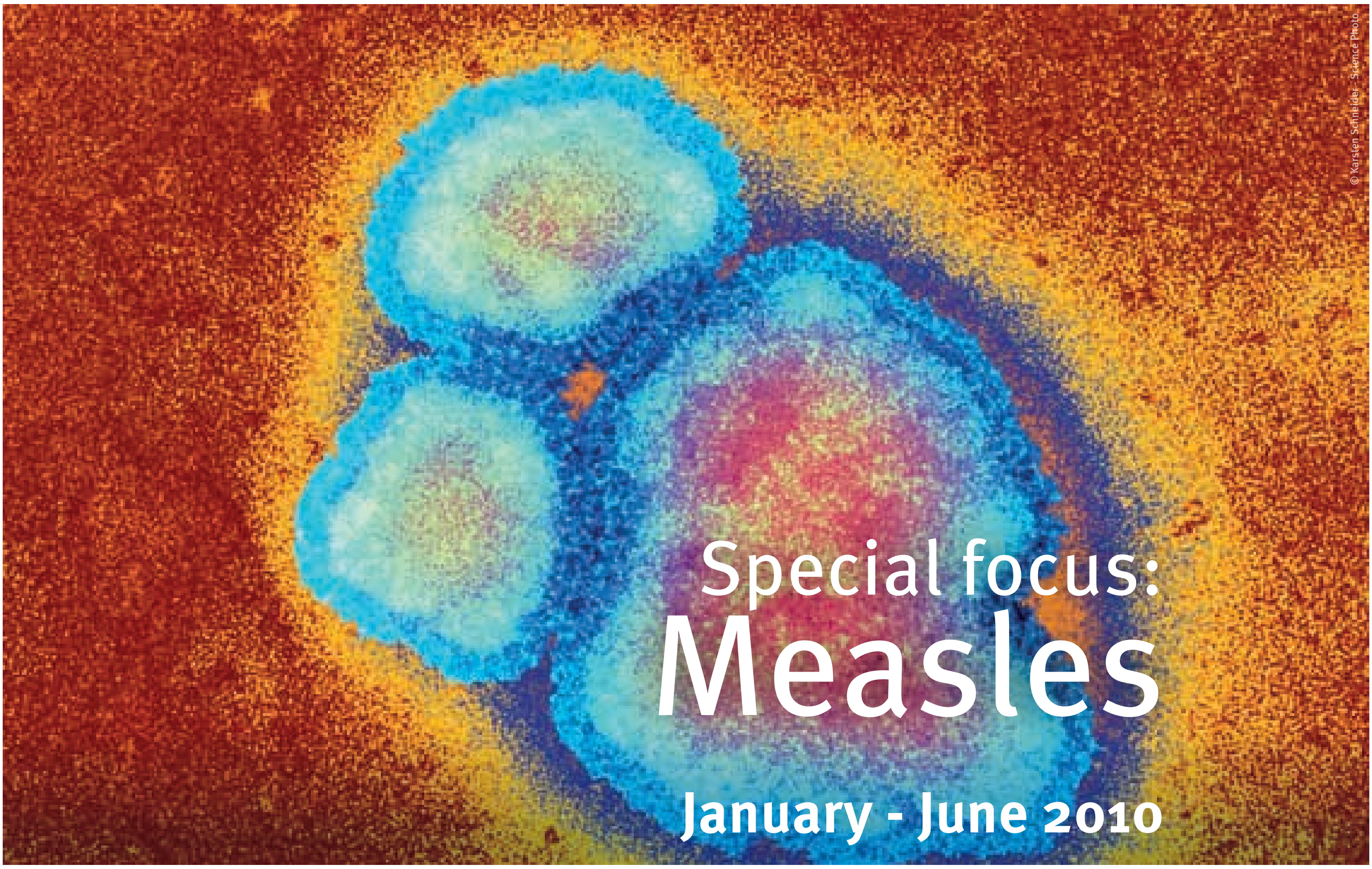

- This first part of the 2010 Eurosurveillance 'Spotlight on measles' features seven articles from five countries. The second part, covering July – December 2010, will appear in 2011

Focus:

- outbreaks of measles still occur regularly in many European countries
- continued need for targeting unvaccinated subpopulations

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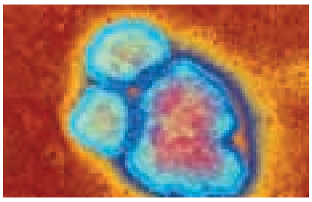

Measles virus particles. Coloured transmission electron micrograph (TEM) of a virus that causes measles (from the morbillivirus group of viruses). Measles is highly infectious and mainly affects children, producing fever and rash. One attack usually gives life-long immunity. Magnification: x144,000 when printed 10 centimetres high.

Spotlight on measles 2010

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Eurosurveillance is committed to highlight issues around measles and facilitate the rapid exchange of information that may help to implement measures that prevent the further spread of the disease. Since March 2007, we have published over 50 papers on various aspects of measles, mainly as rapid communications reporting on ongoing outbreaks but also in the form of surveillance reports and perspective papers focussing on disease trends and policy issues.

In order to support all those who tackle measles and their elimination, we have introduced a special series for the year 2010, highlighting articles that describe ongoing measles outbreaks. Under the running title *Spotlight on measles 2010* we report on ongoing outbreaks relevant for Europe with the intention to demonstrate that measles is not a problem of any one country individually, and to show creative solutions of how to deal with the challenges impeding elimination such as low coverage in various population groups and opposition to vaccines. It is true that most of the facts on measles and the reasons for their continued circulation in the European Union (EU) are well known. However, instead of entering in a measles fatigue, vigilance across Europe is needed. The fact that many outbreaks in the EU in 2009 started after importation of a case from another Member State and that cases were exported to the measles-free Americas further illustrate the potential international implications of national measles outbreaks [1].

Another occasion for the international spread of measles are mass gatherings. The 2008 European Football Championships for instance took place in Austria and Switzerland at a time when large outbreaks of measles were ongoing in both countries, a situation that required particular vigilance [2]. Curiously enough, the Football Championships seem to coincide with measles outbreaks. Currently, an outbreak is ongoing in South Africa [3], and during the 2006 International Federation of Association Football (FIFA) World Cup football tournament in Germany, a large outbreak was ongoing in parts of the country where matches were played [4]. In Canada, a community outbreak of measles started after the Winter Olympic Games in 2010 [5].

The *Spotlight on measles 2010* series started in February with a report from Ireland [6], followed by one from Germany [7]. The two articles showed the variety of aspects and approaches that need to be considered when aiming at stopping outbreaks and increasing vaccination coverage in areas where pockets of unimmunised people exist.

Much progress has been made in the fight against measles, and the goal of eliminating the disease is within reach, but to finally achieve measles elimination within the European region, all those concerned with public and individual health will now need to go the extra mile. We hope that progress is being made and that we will have to report less and less frequently on measles in the years to come. Meanwhile we hope to be able to track down outbreaks wherever they occur and look forward to receiving your contributions reporting measures taken to stop them.

...to finally achieve measles elimination within the European region, all those concerned with public and individual health will now need to go the extra mile.

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Editorials

Measles still spreads in Europe: who is responsible for the failure to vaccinate?

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It is not a secret that the goal of eliminating measles and rubella in Europe will not be met by the targeted year 2010. Over the past 10-12 years, national and international public health authorities have conducted extraordinary efforts that have led to a dramatic reduction in reported measles cases in the World Health Organization (WHO) European Region from 200,000 in 1994, to almost 30,000 in 2003 and 7,411 in 2009 [1]. Nevertheless, measles is still spreading in Europe and there is no time for complacency.

Measles is not only a vaccine-preventable disease; it is somehow a predictable disease. It is one of the most infectious diseases and outbreaks have to be expected when vaccine coverage levels in populations fall below 95% for a certain period.

The European Union (EU) countries are still experiencing the highest burden; according to WHO data, some of the lowest vaccination coverage against measles are found in Western Europe where, over the past two years, 96% of measles cases in the Region were reported [1]. According to the annual reports of the EUVAC.NET, a surveillance community network for vaccine preventable diseases, children still die from measles and its complications in the EU and many cases with severe complications are reported every year [2].

No sophisticated epidemiological methods are needed to figure out the reason for this: measles immunisation coverage has fallen below the recommended 95% (for first dose at sub-national level) in many western European countries and vaccination coverage levels for the second dose of measles-mumps-rubella (MMR) vaccine are even lower. Also, many children are not immunised in accordance with the national immunisation schedules but instead they are immunised late.

Consequently, large pockets of susceptible population have been accumulating in many EU countries. When such pockets are concentrated in the same geographical area or belong to the same population group, outbreaks occur earlier and easier. Why are these pockets increasing? While they consist of populations that share the common characteristic of being unimmunised, the reasons for this vary. They may include limited or difficult access to services for vulnerable or high-risk populations, cultural or religious beliefs, vaccine hesitancy due to vaccine safety concerns, and complacency whereby immunisation is considered a low priority with no real perceived risk of vaccine preventable diseases. The latter is a result of low knowledge and awareness of the means of transmission and severity of the disease. For some, the perceived disadvantages, drawbacks and inconvenience associated with vaccination can overrule the benefits.

Measles is not only a vaccine-preventable disease; it is somehow a predictable disease. It is one of the most infectious diseases and outbreaks have to be expected when vaccine coverage levels in populations fall below 95% for a certain period. Thus it comes as no surprise that we are observing several outbreaks every year in many European geographical areas and that measles has become endemic again in some countries.

The tool and strategy for eliminating measles and rubella is there and works: MMR vaccination is safe, effective and extremely cost-saving. Nonetheless it seems that delivery of vaccination through existing healthcare systems do not achieve the expected coverage needed for elimination.

Three articles related to measles elimination efforts in Poland are presented in this issue: first, H Orlikova *et al*. describe an outbreak in a Roma community in Lubelskie province [3], secondly, the issue includes a review of the outbreaks reported in Poland in 2008-09 highlighting that the majority of these occurred in Roma communities, by J Rogalska *et al* [4]. Finally, P Stefanoff *et al*. [5] describe a study performed during a vaccination campaign in a Roma community, reporting the challenges faced in achieving high vaccination uptake within that community.

Actually, measles outbreaks have been often described in Roma communities. The large outbreak currently occurring in Bulgaria involves mainly Roma people [6]. This is similar to the outbreak in Romania, 2005-2006 [7]. However, emphasising the linkage between outbreaks and Roma populations suggests that measles is only of concern to the EU's marginalised and minority population groups. It is therefore important to note that (i) the overall number of Roma cases represents a small proportion of the region-wide European burden; and (ii) outbreaks occurring in minority groups are easier to identify, describe and publicise. For the same reasons, during the past, outbreaks within other ethnic or religious communities have received considerable coverage in the scientific literature and mass media [8-10]; (iii) some of these communities are highly mobile which allows spread of the virus through vast areas of Europe.

Therefore, we should not only look for the presence of measles among the Roma population in Europe. As reported in the article by P Stefanoff *et al*., the current health system does not identify and reach the entire population needing immunisation. As such, the responsibility for measles and rubella outbreaks in Europe, though it may be difficult to accept, lies with us, the public health authorities. With the success of immunisation programmes over the decades, we have forgotten how serious and costly measles and rubella disease can be. The benefit and risk analysis has shifted to focus on the vaccine and not the disease.

It is us, the health authorities, that either fail to put in place all the required infrastructure and effort to implement effective MMR vaccination campaigns, or do not pro-actively campaign to meet the needs of the region's un- and under-immunised children.

It is us, doctors and nurses, who are not fully convinced about the value of MMR vaccination; ignoring the fact that some of our young patients will suffer severe disease, complications, disability or even death because we did not vaccinate them.

It is us, parents of young children, who think we have control over our children's susceptibility to an infectious virus and expose our daughter or son to an unnecessary risk of a potentially severe or fatal disease.

Finally, it is us, vaccination experts that need to remain focussed on the measles and rubella elimination goal at a time when the introduction and promotion of new and underutilised vaccines, while extremely important contributions, compete for our attention. We must recognise that without maintaining the achievements made to date, and unless we remain vigilant against measles and rubella, diphtheria and poliomyelitis, the new vaccines we have so much hope for, will not achieve their potential.

While we will not meet the measles elimination goal in 2010, it does not mean that the goal is not worth striving for and it is feasible, as demonstrated by the experience in the Americas, where the last endemic measles case was reported in 2002.

The European Region needs to show renewed commitment to the goal of eliminating measles and do its best to reach it as soon as possible. For the sake of future generations, it is our duty to make this happen. We must collectively note where we can improve our response, improve our decision-making, be more diligent in tackling the real issues that face the un- and underimmunised, and continue to attract financial resources to make sure that measles becomes a disease of the past.

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Spotlight on measles 2010: A measles outbreak in a Roma population in Pulawy, eastern Poland, June to August 2009

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We describe a local indigenous outbreak of measles in a susceptible Roma community, which occurred in Pulawy, a town of 50,000 citizens in the Lubelskie province (eastern Poland) during summer 2009. From 22 June to 30 August 2009, 32 measles cases were reported, and additionally nine possible cases were actively identified. A mass immunisation campaign was organised to stop measles transmission in the Roma community. Active surveillance of rash-febrile illnesses allowed documentation of the impact of mass immunisation in preventing further measles spread in the Roma community, and the surrounding population of Pulawy.

Outbreak notification

Between 26 June and 21 July 2009, 14 measles cases were reported by physicians to the public health authority in Lubelskie province, Poland. All affected persons were from a Roma community living in the town of Pulawy. No measles cases had been registered during the previous decade until 2008, when six cases were notified in the same Roma community in Pulawy.

The investigation suggested common exposure between the first reported cases. The index case was a Roma resident of Pulawy. On 20 June he returned from the city of Lodz, where he had been was in contact with a Roma person who had recently returned from England with rash illness (this case had not been reported to the Polish national surveillance). On 22 June he developed typical symptoms of measles, subsequently confirmed serologically, and was admitted to hospital on 26 June.

Outbreak investigation

An outbreak investigation team was formed comprising epidemiologists and public health officers at district, regional and national level.

Case definitions were set up as follows:

- Possible case: each person who resided in the town of Pulawy after 15 June 2009 and who developed febrile illness with rash;
- Probable case: each person, who fulfilled the criteria of a possible case, and for whom an epidemiological link to a confirmed case was ascertained;
- Confirmed case: each person who fulfilled the criteria of a possible case, and in whom measles was confirmed by serological (ELISA IgM) or virologal test (virus isolation or PCR).

Active case finding was implemented simultaneously. We reviewed the medical documentation from all primary healthcare facilities in Pulawy since mid-June retrospectively, to search for cases of rash-like illness, which could indicate undiagnosed measles transmission occurring inside or outside the Roma community. Beginning from 10 August 2009, enhanced surveillance was set up, requesting primary healthcare and hospital physicians to report all new rash-febrile cases, and to send weekly reports including all suspected cases or zero reporting.

Outbreak description

From 22 June until 30 August 2009, 41 cases were registered, of whom 32 (78%) were reported through the routine surveillance, and nine were actively found. According to the case definition, eight (19%) of the 41 cases were classified as confirmed, 24 (59%) as probable and nine (22%) as possible. The shape of the epidemic curve (Figure 1) indicated person-to-person propagation, with several transmission chains.

Of 41 registered cases, 35 (85%) were of Roma ethnicity, residing in two localities in Pulawy inhabited by the local Roma community. In addition, one occupational case was reported in a Polish hospital nurse working in the department of infectious diseases of the district hospital in Pulawy. A further five non-Roma cases were notified, all of whom were actively found and classified as possible cases.

Among the 32 confirmed or probable cases, 13 (41%) were female (Figure 2). The mean age was 12 years (range: three months to 49 years) and the median age was 12 years. Four infants (12%) and nine adults (28%) were among the 32.

Twenty two of 32 (69%) patients were hospitalised in the department of infectious diseases at district hospital in Pulawy and the others were treated in primary healthcare. Practically all 32 confirmed or probable cases developed typical erythematous maculopapular rash, fever >38 °C and cough. Most of the patients had Koplik spots, coryza and conjunctivitis. Four cases, all of them unvaccinated, of whom one was classified as confirmed and three as probable, experienced severe complications; namely, three patients had pneumonia and one infant had myocarditis, encephalitis and pneumonia. All patients recovered and no fatal cases were registered. The nine cases that were classified as possible cases had very mild symptoms with rash and fever, and none of them were hospitalised.

Laboratory results

Biological samples from eight cases were tested in the laboratory, and all were confirmed as measles-positive at the National Reference Laboratory for Measles and Rubella of the National Institute of Public Health in Warsaw, three serologically (ELISA IgM-positive) and five by detection of measles virus (one through virus isolation, five through PCR testing). Genotype D4 isolate Pulawy.POL/28.09 was confirmed from two cases, detected at the World Health Organisation's European Regional Reference Laboratory for Measles and Rubella at the Robert Koch Institute in Berlin.

Vaccination status of cases

From a total of 32 confirmed or probable cases, 28 were not previously immunised, including five infants (between three and 13 months) who were not vaccinated because of young age. Only one, a 1.5-year-old boy, was previously vaccinated (three months before onset) with one dose of measles-containing vaccine. Three persons received their first dose during the mass

Figure 1

Measles cases by day of onset (two-day intervals) and by classification, Pulawy, 2009 (n=41)

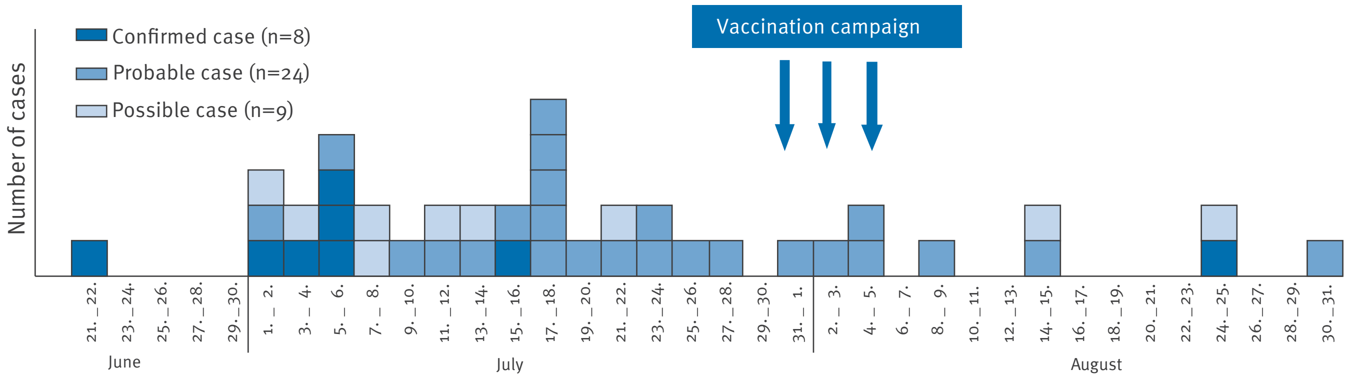
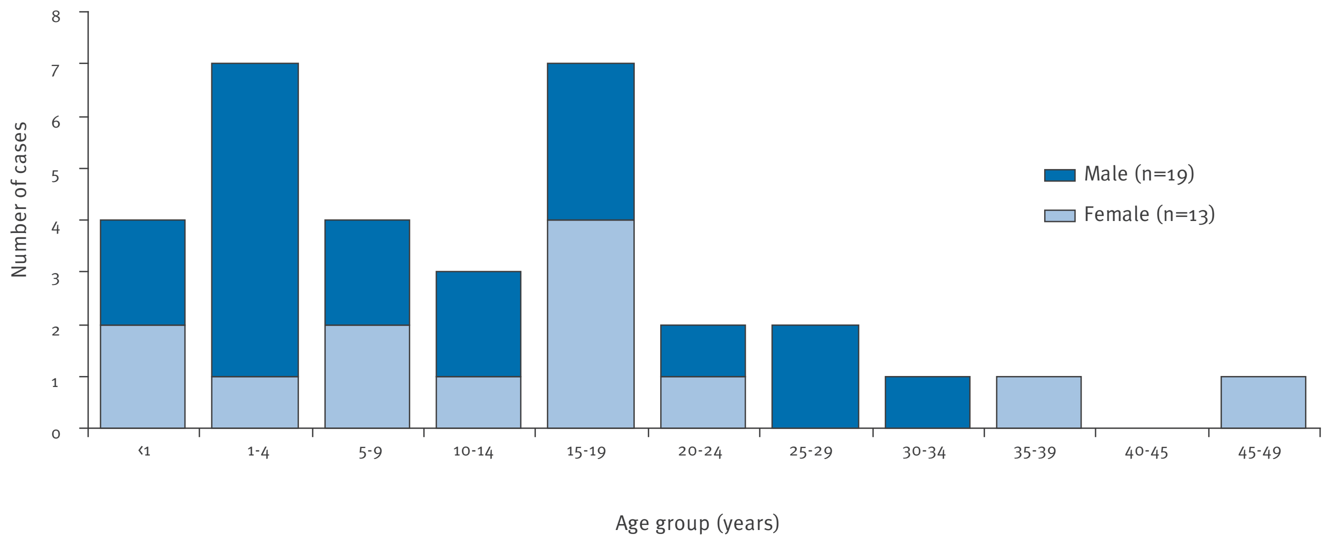


Figure 2

Confirmed and probable cases of measles by age group and gender, Pulawy, 2009 (n=32)



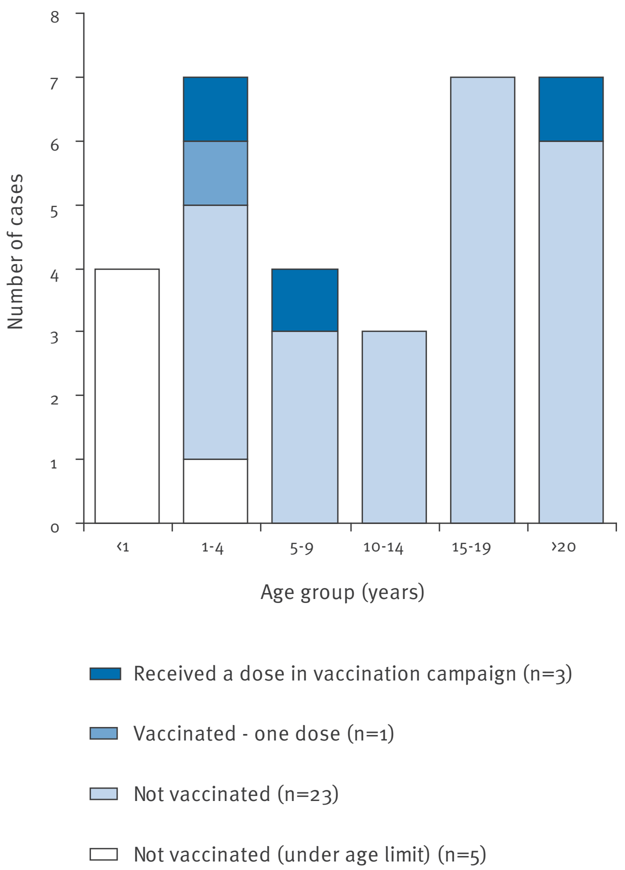
vaccination campaign that was initiated as a control measure to interrupt the spread of the outbreak. They had onset of measles four to five days after the vaccine administration (Figure 3). Among the nine possible cases, seven were previously vaccinated.

Control measures

As a response to stop the spread of the measles outbreak, the district sanitary inspectorate in Pulawy, with the support from regional sanitary inspectorate in Lublin and the National Institute of Public Health, organised a mass vaccination campaign. It was directed to the Roma residents of Pulawy, between the ages of nine months and 60 years. The invitation to the mass immunisation in Polish language was disseminated to the Roma community leaders, and through primary health units in Pulawy. It was held at a primary healthcare centre in the proximity of the Roma community, on 31 July, and on 3 and 4 August. From around 300 Roma registered at the municipality of Pulawy, 195 (102 individuals under the age of 20 years and 93 adults) attended the vaccination point and 138 (55 individuals under the age of 20 years and 83 adults) received a dose of combined measles, mumps and rubella (MMR) vaccine [1]. The reasons for exclusion of some attendants from vaccination were the following: a documented full previous vaccination (n=16), young age under nine months (n=3), pregnancy (n=3), breastfeeding shortly after delivery (n=1), confirmed or probable measles in summer 2009 or documented laboratory-confirmed measles ealier (n=22), acute measles diagnosed during the campaign (n=2), temporary contraindication due to an acute febille illness (n=9), and waiting for an attestation of contraindication (n=1).

Figure 3

Vaccination status of confirmed and probable measles cases by age-group, Pulawy, 2009 (n=32)



Ongoing active febrile-rash illnesses surveillance was continued in all medical centers in Pulawy following the identification of the first case, until twice the maximum incubation period after the onset date of the last case. The district sanitary inspectorate in Pulawy informed local healthcare professionals about the outbreak and ongoing control measures. An article summarising the outbreak and control measures undertaken was published in the national surveillance bulletin. The public was provided with up-to-date information via local websites and press articles.

The regional sanitary inspectorate in Lublin implemented investigation of the Roma communities in Lubelskie province with regards to their vaccination status, and offering immunisation to all unvaccinated and incompletely vaccinated individuals or contacts of measles cases. For example, on 17 and 19 August 2009, 45 Roma were vaccinated with MMR vaccine in a focus area of measles in Opole Lubelskie and Poniatowa. A recommendation was issued to check the vaccination status of all 10-year-old school children in Pulawy at the beginning of the new school year.

Discussion and conclusions

This outbreak has been the largest indigenous cluster of measles in the past decade in Poland, affecting one tenth of the local Roma community. Infants, children and adults had measles and several patients had severe complications.

In addition to the standard procedures (treatment and isolation of cases, contact tracing, offering of post-exposure vaccination until 72 hours after the contact), we implemented active case finding and organised a mass immunisation campaign as a response to this outbreak [1]. Moreover, vaccination coverage, size and age distribution of the Roma population in Pulawy was assessed, as described in a parallel article [2].

Factors that facilitated the spread of infection in the susceptible Roma population were low prior vaccination uptake, high contagiousness of measles, infection transmission lasting from between two and four days before to four days after rash onset, questionable home isolation of cases and numerous contacts inside the community. Children and adults fell ill, as described in other countries [3-5]. Several infants experienced measles at an age below the limit for the first vaccine dose in the national immunisation schedule. We observed several waves of propagation within the community. The herd immunity in the local Roma population was insufficient to stop the outbreak. Interruption of indigenous measles transmission is considered one of the criteria for elimination [6].

The targeted mass immunisation was efficient in limiting measles transmission. Only five cases occurred after the campaign in the Roma community. Among them were three patients with onset of disease four to five days after administration of the vaccine. They had received their first dose during the campaign and were probably vaccinated during the incubation period. Two children with onset of disease after the campaign had not previously been immunised, one because of young age (under six months-old) and the other was referred to a neurologist and an allergist to verify the contraindication, but his parents did not take the child to see the specialists.

One additional case that occurred after the campaign targeted only to Roma, was the occupational infection of the hospital nurse reported in routine surveillance. This case could have been avoided if the nurse had been previously vaccinated. Ensuring that healthcare workers are adequately protected is a key requirement to prevent healthcare-associated measles infections [7].

All nine cases identified through the active surveillance, four were of Roma ethnicity and five non-Roma, were classified as possible cases. All nine had mild symptoms and were treated in an outpatient clinic. Most of them were found retrospectively. Seven of the possible cases had previously been vaccinated against measles, of whom six with one dose, and none were laboratory-tested for measles. It is therefore possible, that they may have had a different febrile-rash disease not necessarily caused by measles virus. Nevertheless, active case finding and inclusion of possible cases was useful in order to assess how far the outbreak might have spread. The active surveillance helped us in documenting that the mass vaccination effectively stopped transmission in the Roma community and that the non-Roma population was not or just marginally affected.

Based on the above evidence, we can conclude that due to high vaccination coverage in Poland's general population, large-scale spread of measles outside the Roma community was avoided. According to the official statistics for 2008, the vaccination coverage for the combined MMR vaccine was 98.4% for the first dose administered at the age of 13-15 months, and 97.2% for the second dose given at the age of 10 years [8].

Poland belongs to the countries with moderate incidence of indigenous measles, with 0.1-0.3 cases per 100,000 population in the years 2006 to 2008 [9,10]. Fourteen percent of all cases in 2008 were imported [10]. In the current indigenous outbreak, the index case was infected in June 2009 when staying in the city of Lodz, where several measles cases were registered at the time [11]. The epidemiological investigation revealed contact with a person with a rash illness recently returned from England. This person was neither reported to the surveillance system nor identified by the index case, so remains unknown and no details regarding the travel history were obtained.
Only eight cases were laboratory-tested for measles during the outbreak, which is a quarter of the cases reported in routine surveillance and a third of the hospitalised ones. The proportion of laboratory-tested patients should be higher in the phase of measles elimination. However, samples were taken and confirmed from patients in almost every chain of transmission in the outbreak. The genotype D4 virus isolate Pulawy.POL/28.09, detected in the current outbreak, was identical with the isolates Wroclaw.POL/13.09 and Lodz.POL/27.09 in Poland and Hamburg.DEU/03.09 in North-West Germany from spring 2009 and differed by 1 nt from the sequence of the isolate Enfield.GBR/14.07 circulating in England [11]. The Pulawy strain also shows sequence identity (100%) to the virus detected in the current epidemic in Bulgaria [Regional Reference Laboratory WHO EURO, RKI, personal communication].

Several outbreaks of measles have been reported in many European countries within the past years, in particular in susceptible population groups such as orthodox Jewish communities [12], religious schools [13], anthroposophic communities [14,15], traveller communities [16,17] and in regional or national outbreaks involving a large proportion of Roma/Sinti [18], Roma migrant or indigenous populations [3,4]. Measles clusters in susceptible communities are a considerable public health problem. To reach the goal of measles elimination in Poland and other European countries, a stronger commitment by decision makers to improve vaccination coverage in all sections of the population is needed. Regional and national elimination strategies need to include steps to assess the accumulation of susceptible individuals and interrupt indigenous transmission [19].

Causes of low vaccination uptake must be defined. In the case of Roma communities we should consider factors that may contribute to the low vaccination coverage that was observed for example in Pulawy [2]. The reasons could be varied, such as socio-economical and cultural differences, level of education, language barriers, discrimination [20] or low awareness of vaccination as a preventive measure. Where there is limited access to healthcare, this must be improved. By organising the vaccination campaign in Pulawy, we have learned that for a public health intervention in the Roma population to be successful, it must be tailored and supported by Roma family and community leaders.

Education of public health and healthcare professionals must continue in the phase of measles elimination [21], and laboratory testing of febrile-rash illnesses is essential.

Recommendations

1. Cooperation between local administrative authorities, social workers in contact with the Roma, primary healthcare workers and public health professionals is necessary in reaching Roma communities to prepare and implement public health interventions including suplementary immunisation activities.
2. Offering immunisation against measles to unvaccinated inhabitants in Pulawy and other towns in which inadequately vaccinated populations have been identified could prevent further outbreaks.
3. Surveillance of febrile-rash illnesses should be enhanced by enforcing laboratory testing of all suspected measles cases to document measles elimination in the present situation in Poland.

Acknowledgements

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Spotlight on measles 2010: An epidemiological overview of measles outbreaks in Poland in relation to the measles elimination goal

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The objective of this study was to describe transmission chains of measles observed in Poland during 2008-2009. A decade ago, the incidence of measles in Poland declined and approached one case per million inhabitants one of the World Health Organization's criteria for measles elimination. Following a period of very few reported measles cases (2003 to 2005), an increase in incidence was observed in 2006. Since then, the incidence has constantly exceeded one case per million inhabitants. Of 214 measles cases reported in 2008 and 2009 in Poland, 164 (77%) were linked to 19 distinct outbreaks, with 79% of cases belonging to the Roma ethnic group. Outbreaks in the non-Roma Polish population had different dynamics compared to those in the Roma population. On average, measles outbreaks in Roma communities involved 10 individuals, seven of whom were unvaccinated, while outbreaks in the non-Roma Polish population involved five individuals, half of whom were incompletely vaccinated. The majority of outbreaks in Roma communities were related to importation of virus from the United Kingdom. In six outbreaks, the epidemiologic investigation was confirmed by identification of genotype D4 closely related to measles viruses detected in the United Kingdom and Germany. Our data indicate that Poland is approaching measles elimination, but measles virus circulation is still sustained in a vulnerable population. More efforts are needed to integrate the Roma ethnic group into the Polish healthcare system and innovative measures to reach vulnerable groups should be explored.

Background

In 1998 Poland implemented a measles elimination programme, coordinated by the World Health Organization (WHO) Regional Office for Europe. It requires monitoring consecutive stages of the elimination by tracking secondary outbreak cases, genotyping of detected measles viruses (MV) and serological testing of all suspected cases of measles [1].

Measles has been a notifiable disease in Poland since 1919. National case-based notification was initiated in 1996 and WHO case definitions [2] have been adopted. Since 2005, the case classification of the European Union [3] has been used. The first dose of the monovalent measles vaccine for children aged 13-15 months was introduced in Poland in 1975, and the second dose for seven year old children was implemented in 1991. In 2005 the monovalent measles vaccine was replaced by the combined measles-mumps-rubella (MMR) vaccine, administered at the age of 13-15 months and 10 years.

Poland belongs to the European countries with moderate incidence of measles [4,5]. Following the introduction of routine immunisation, the incidence of measles has decreased. From 2003 to 2005 the number of locally acquired cases in Poland was below the elimination threshold of one case per million inhabitants. Since 2006 the measles incidence has increased and remained continuously above this elimination indicator (Figure 1) [6]. In 2006, measles cases were mostly related to importation of MV-D4, whereas MV-D6 was detected in 2007. In 2008-2009 a substantial increase in the frequency of outbreak-related cases was observed, often related to importation.

The vaccine coverage in Poland with MMR vaccine remains well above the target of >95% for the first dose of measles vaccine (MCV1), another WHO marker for measles elimination [7]. Coverage with the first dose of MMR vaccine in three-year-olds in 2008 was 98.4%, and for two doses of MMR in eleven-year-olds it was 97.2%. Information on measles vaccine coverage in ethnic groups such as the Roma ethnic minority is not available in Poland.

The objective of this study was to describe the patterns of chains of transmission investigated in Poland between 1999 and 2009, with special focus on 2008-2009, in relation to the measles elimination goal.

Methods

In the present study, measles cases reported within the Polish enhanced measles surveillance between 1999 and 2009 were investigated. Physicians were required to report all suspected measles cases to the local health departments and to obtain samples for confirmatory IgM testing. The information collected during case investigation included demographic characteristics, vaccination status, and clinical and laboratory data. Although not routinely collected in the national surveillance system, the ethnic background

Figure 1

Secular trends of measles incidence in Poland, 1966-2009

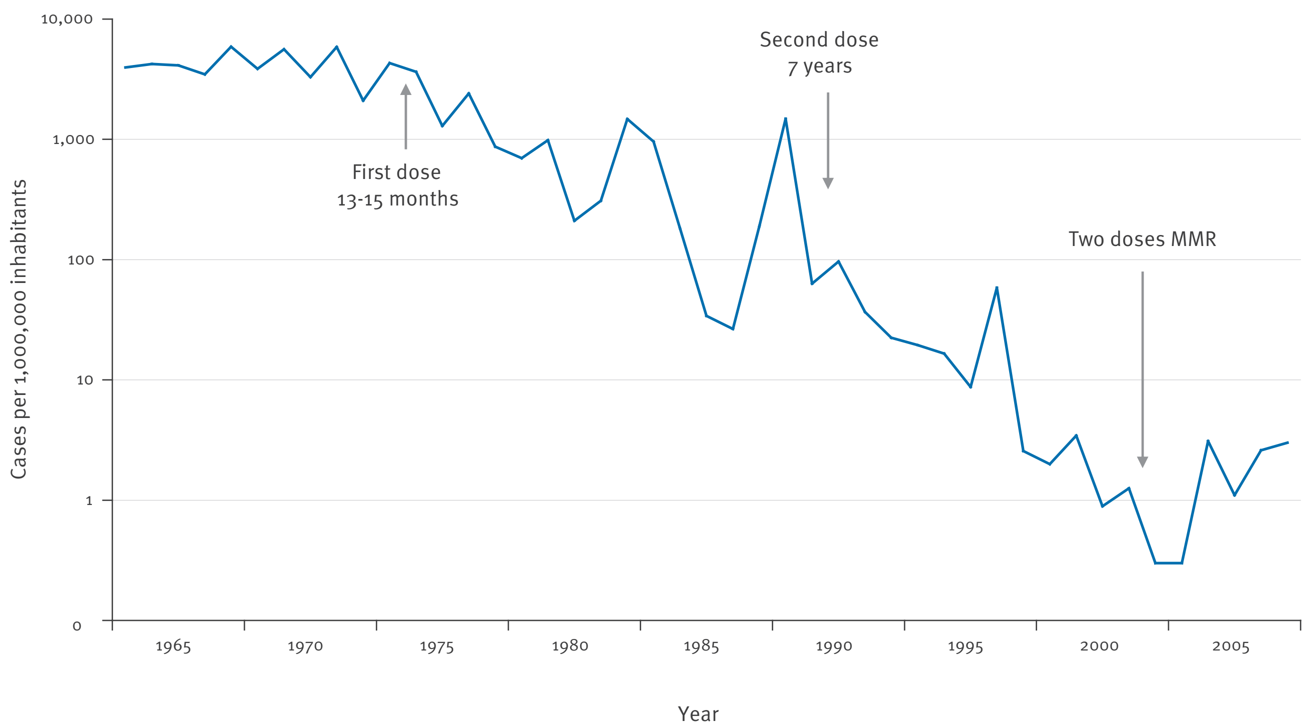
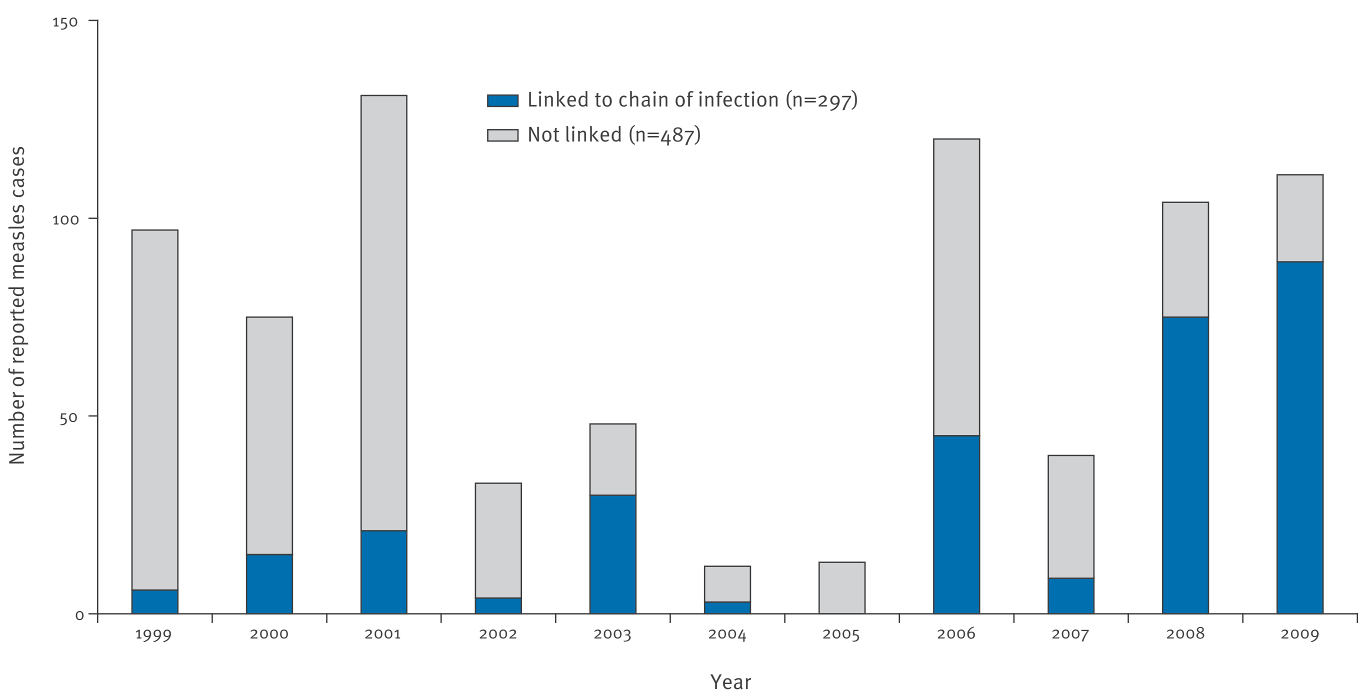


Figure 2

Number of reported measles cases, including those which could be linked to transmission chain, Poland, 1999-2009 (n=784)



of reported measles cases was recorded. Contact tracing is routinely undertaken, especially for unvaccinated and exposed individuals. Serological testing and detection of measles virus RNA are performed in the National Reference Laboratory at the National Institute of Public Health. Measles virus-containing samples are sent to the WHO Regional Reference Laboratory for Measles and Rubella (Robert Koch Institute, Berlin) for genotyping.

For the present study, we defined an imported outbreak as resulting from importation of measles virus by a person arriving from abroad who was exposed and developed symptoms outside Poland, and subsequently was the source of documented local transmission to other cases linked to the outbreak. If available, genotyping results were used for confirmation of importation-related transmission chains.

Measles case reports from 1999 to 2009 are described. Measles cases with an established link to the infection transmission chain (outbreak cases) in 2008-2009 are described in more detail to determine the role of disease importation and outbreak patterns.

Results

Over time, an increasing proportion of measles cases could be linked to identified chains of transmission in Poland (Figure 2), from 6% in 1999 to 80% in 2009. Of 569 cases of measles reported between 1999 and 2007, 133 (23%) were linked to outbreaks. In 2008 and 2009, this proportion was higher, with 77% reported measles cases linked to outbreaks.

During 2008 and 2009, 19 measles outbreaks with 164 cases were reported in Poland. Seven outbreaks were due to importation of the disease from the United Kingdom (UK), and 12 involved only indigenous transmission. Outbreaks in that period were reported from nine of the 16 provinces of Poland. One of the 164 outbreak cases, excluded from further analysis, occurred in a Ukrainian citizen who arrived in Poland in February 2009. He contracted measles while staying in a hospital where an outbreak occurred.

Fifty-three percent of cases in 2008 and 2009 were female and 90.2% of the patients were residents of urban areas. Cases were seen in all age groups, although adults aged over 19 years were predominantly affected (45 cases, 27.4%). One hundred and thirty patients (79.3%) were admitted to hospital. The proportion of hospitalised cases was highest in children aged five to nine years (90.9%). Seventy-nine percent of all outbreak-related cases during 2008 and 2009 occurred among the Roma ethnic group.

Important differences were observed between the outbreaks among the Roma community and those occurring in non-Roma Polish population (Table).

Table

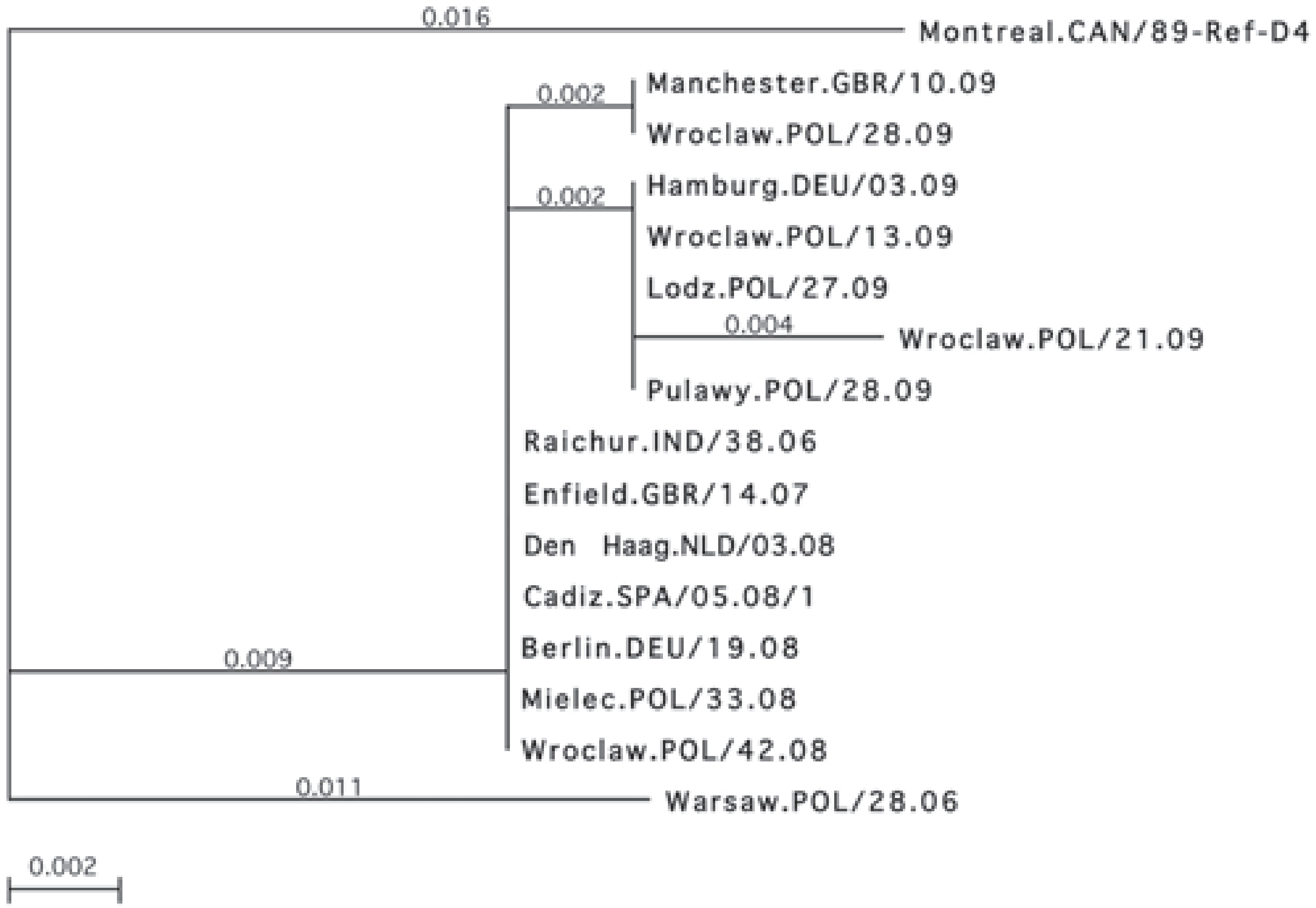
Characteristics of cases linked to chain of transmission, Poland, 2008-2009 (n=163)

Characteristic	Roma		Non-Roma Polish population		Total	
	N	%	N	%	N	%
Number of outbreaks	13	68.4	6	31.6	19	100.0
Number of cases	126	77.3	37	22.7	163	100.0
Sex						
Female	64	50.8	23	62.2	87	53.4
Male	62	49.2	14	37.8	76	46.6
Confirmation of cases						
Laboratory-confirmed	72	57.1	35	94.6	107	65.6
Epidemiologically linked	54	42.9	2	5.4	56	34.4
Vaccination status						
Vaccinated according to age	18	14.3	12	32.4	30	18.4
Incompletely vaccinated	91	72.2	18	48.6	109	66.9
Unknown vaccination status	17	13.5	7	19.0	24	14.7
Importation status (number of outbreaks)						
Import-related	7 (68 cases)	53.8 (54.0)	1 (3 cases)	16.7 (8.1)	8 (71 cases)	42.1 (43.6)
Local	6 (58 cases)	46.2 (46.0)	5 (34 cases)	83.3 (91.9)	11 (92 cases)	57.9 (56.4)
Generations of transmission identified (number of outbreaks)						
1-2	9	69.2	4	66.7	13	68.4
3 or more	4	30.8	2	33.3	6	31.6
D4 genotype identified	4 (19 cases)	30.8 (15.1%)	2 (2 cases)	33.3 (5.4)	6 (21 cases)	31.6 (12.9)

Outbreaks among Roma were considerably larger with an average of 10 cases, who were mostly unvaccinated (72% of outbreak cases), while outbreaks in the non-Roma Polish population involved an average of five cases, with 48% of outbreak cases incompletely vaccinated. The majority of outbreaks in Roma communities were related to importation of virus from the UK. In six outbreaks, measles virus genotyping identified a genotype D4 strain that was most closely related to viruses from the UK and Germany. Figure 3 presents the exact genetic relationship between viruses isolated from outbreak cases in 2008 and 2009 to closely related strains isolated in other countries. Laboratory testing was performed more often for cases from the non-Roma Polish

Figure 3

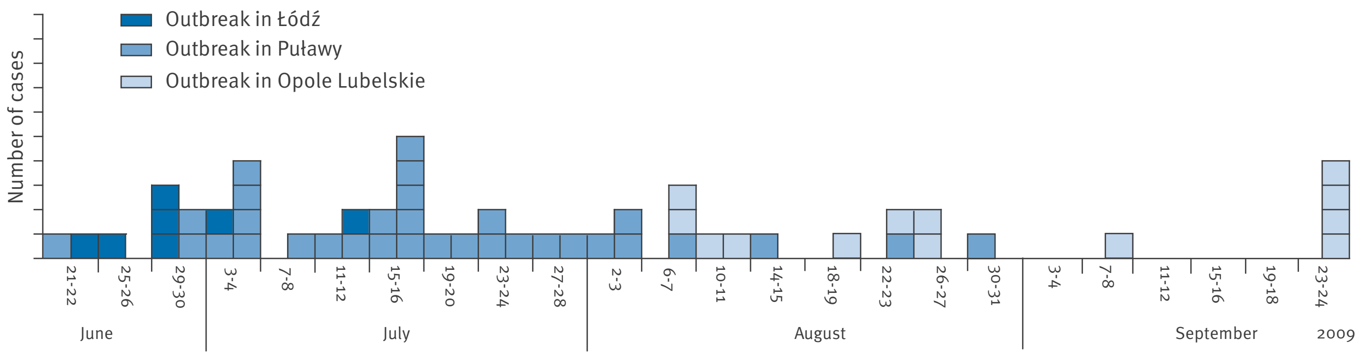
Phylogenetic analysis of measles viruses of genotype D4 detected from 2006 to 2009 in Poland and other European countries



The phylogenetic tree is based on a 456 nt sequence encoding the carboxyterminus of the nucleoprotein. It includes all measles strains identified in Poland in 2006-2009 and world strains most closely related to them.
Method: Neighbor Joining; Best Tree; tie breaking = Systematic.
Distance: Tamura-Nei; Gamma correction = Off; Gaps distributed proportionally.
Source: Robert Koch Institute, Berlin, Germany.

Figure 4

Number of reported measles cases by week of illness onset, Poland, 2009



population (94%) than for cases from the Roma community (57%). Based on the dates recorded for onset of disease, the same proportion of outbreaks recorded up to four generations of transmission among the Roma and non-Roma Polish population.

In some cases, separate outbreaks could be linked by detailed epidemiological and molecular investigation. From August to October 2008 two outbreaks occurred in Mielec and Wroclaw, which are approximately 400 km apart. A total of 32 cases were recorded from those two outbreaks in Roma communities, and both could be linked to the strain Enfield/GBR/14.07 (Accession No. EF600554) of measles virus genotype D4. The index cases were among families with young children returning from London, UK. In the same period numerous importations from England, confirmed by the detection of the Enfield strain, were notified in several other European countries (Figure 3), i.e. the Netherlands (Den Haag.NLD/03.08, GenBank Accession No. EU585844), Spain (Cadiz.SPA/05.08/1, GenBank Accession No. EU982301) and Germany (Berlin.DEU/19.08).

From June to October 2009, 54 cases were linked to three outbreaks in Roma communities living in different towns (Figure 4). The first outbreak with seven measles cases was reported in the city of Lodz. Subsequently, 47 measles cases were reported in the city of Pulawy and Opole Lubelskie in Lubelskie province. The outbreaks in Lodz and Pulawy were linked by epidemiological investigation and measles virus genotyping, since the measles virus detected in Lodz and Pulawy was identical to the strain Hamburg/DEU/03.09(D4) observed in northwest Germany in the first quarter of 2009. The outbreak in Opole Lubelskie was linked to the Pulawy outbreak by an epidemiological link, and no samples were collected for genotyping.

Discussion

Measles outbreaks have recently been described in many European countries. Large outbreaks were reported in 2008 and 2009 in France [8], Switzerland [9], and Bulgaria [10].

WHO defined measles elimination as a situation in a large geographical area in which endemic transmission of measles virus cannot occur and imported measles cases do not initiate sustained transmission [11]. Despite public health efforts and maintaining high levels of vaccination coverage, outbreaks due to measles virus importation continue to occur in Poland. Similarly as in other European countries, herd immunity has not been achieved despite a national measles vaccination coverage above 95%. This failure is possibly related to the existence of specific vulnerable populations, who are often not reached by the public health services regarding vaccination. Common causes of limited access to public health services may involve particular attitudes or beliefs of these populations [12-14].

There could be several reasons for the increased proportion of cases for which a chain of infection could be traced in 2008 and 2009, compared with the previous period. On the one hand, local public health officers may have been investigating the epidemiological links more efficiently during the recent years. When approaching the measles elimination phase, it becomes more important to monitor infection chains and, if necessary, to intervene. On the other hand, well defined outbreaks were identified in 2008 and 2009 with several cases occurring in the same households. This rather indicates an appearance of pockets of unvaccinated persons, who are sustaining measles transmission, possibly in relation to anti-immunisation beliefs, or poor access to healthcare.

Similar to other European countries, Poland has not succeeded in controlling measles enough to reach one case per million inhabitants, one of the WHO criteria for measles elimination. In recent years, most outbreaks in Poland were detected in ethnic minorities and were often related to measles importation from the United Kingdom or Germany. Currently, the emphasis of measles elimination activities should be directed to immunising all sections of the population that are not adequately protected. Considering that ethnic minorities are often marginalised and discriminated against, we need to better understand the health problems, attitudes and beliefs of these communities. An assessment performed during a large outbreak in August 2009, revealed limited access to healthcare and low life expectancy of a settled Roma community [15]. Both in Roma and in the non-Roma Polish population, a considerable proportion of unvaccinated cases in the under 19-year-olds indicates the need to address at least some high-risk groups in Poland. The best approach would be to focus on healthcare workers and persons working in crowded environments like schools, universities or airports.

Genetic characterisation of detected measles viruses has been done in Poland continuously since 2006 [16]. Molecular and epidemiological investigation of the recent outbreaks revealed five independent transmission chains with a duration of under three months. Genetic data demonstrated a close relationship of four of the five distinct subvariants of genotype D4 identified in Poland to viruses of western Europe (GenBank Accession No. EF600554, EU585844, EU982301, GQ370461) from where they were imported, and to a virus from India (GenBank Accession No. EU812270) considered to be the source of the recent European D4 viruses [Regional Reference Laboratory WHO EURO, Robert Koch Institute, personal communication]. The present analyses document that Poland has made progress on its way to reach the elimination goal for measles virus in the WHO European region. Considering increasing airline travel, and anti-vaccination beliefs, continuous efforts are necessary to maintain a high vaccination status of the Polish population, and implement innovative measures to reach vulnerable groups.

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Mass immunisation campaign in a Roma settled community created an opportunity to estimate its size and measles vaccination uptake, Poland, 2009

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During a mass immunisation campaign following an outbreak of measles in a Roma community settled in the town of Pulawy, Poland, we performed an estimation of the size of this Roma population and an assessment of its vaccination uptake. We obtained a list of Roma residing in Pulawy from the local municipality and estimated using a simple capture-recapture formula that Pulawy had 377 Roma residents (43% under 20 years old), which was 27% more than the 295 registered at the municipality. During the vaccination campaign, demographic information was recorded that could be linked to information from the municipality list as well as to prior immunisation status. Among the people whose data were recorded during the vaccination campaign, 14% were not registered at the primary healthcare centres, and were therefore deprived of access to healthcare. Among 102 screened subjects under the age of 20 years, 51% were vaccinated according to schedule. Vaccine uptake for the first dose of measles-containing vaccine was 56% (54/96) and for the second dose 37% (18/49). The present study indicates the need to get a better demographic overview of Roma communities living in Poland and to understand the barriers limiting their access to healthcare and social services. Organisation of catch-up immunisations of this vulnerable population is necessary.

Background

From 2003 to 2005, Poland was approaching the World Health Organisation's measles elimination target, with the recorded incidence of locally-acquired cases below one per million inhabitants. In 2008 and 2009, several measles outbreaks were notified in Poland, many of which were related to cases imported from United Kingdom [1]. Also in other European countries, an increase in measles incidence was observed in those years, mainly due to ongoing transmission among different vulnerable populations [2-4].

Vaccination against measles is mandatory and free of charge in Poland. Since 1975 the first dose of monovalent measles vaccine had been recommended at the age of 13-15 months, and in 1991 a recommendation for the second dose at the age of six years was introduced. Since 2004, the vaccine has been given as the combined measles-mumps-rubella (MMR) vaccine at the age of 13-15 months and 10 years. In 2008, the national vaccination coverage for measles for three year old children with the first dose was 98% and for 11 year-olds with the second dose 97% [5]. The vaccination coverage in high-risk groups or in any sub-populations in Poland is not routinely assessed.

From 22 June to 30 August 2009, an outbreak of measles with 41 registered cases occurred in a Roma community in the town of Pulawy in eastern Poland [6]. An interventional vaccination campaign was organised in the affected community in order to stop further spread of measles. The objective of the present study was to estimate the size and age distribution of the Roma population in Pulawy based on data collected during the mass immunisation, and to assess prior vaccination coverage against measles in the studied population.

Methods

To estimate the size of the Roma community in Pulawy, we obtained the list of Roma residents registered at the local administrative authority of the municipality of Pulawy (status: mid-July 2009), including the social security number (PESEL), name, surname, sex, date of birth and address of residence. According to Polish law, each person residing in a given location for a period exceeding two months has to be registered at the local municipality. Residents registered at the municipality are entitled to social benefits and have access to school and healthcare systems. The list from the municipality included the Roma ethnic status, which was additionally verified by the municipality administrators responsible for Roma ethnic minority.

During the vaccination campaign, which was organised at the beginning of August 2009, we recorded the demographic information, prior vaccination status, the registration rate at a primary healthcare centre and registration at the municipality. The immunisation campaign was organised at a local healthcare unit. It was advertised by social workers going from house to house within the Roma community, through newspaper and website advertisements in Polish language and through regional Roma leaders. During the campaign, immunisation was offered to Roma residents between the age of nine months and 60 years.

The capture-recapture method was used to estimate the population size and age distribution of the community. Because of high mobility of the Roma communities, it was assumed that only part of the Roma residents were registered at the local municipality. Therefore, the campaign was considered as an opportunity of re-capturing some of the persons who were not registered. The following standard formula was used for the calculation:

$$\text{Estimated Roma population} = \frac{(\text{Registered at municipality}) \times (\text{Attending mass immunisation})}{\text{Registered individuals attending mass immunisation}}$$

The immunisation status recorded during the vaccination campaign was further verified with actual documentation from general practitioners. Because of incomplete documentation for adults, which is true for all Polish citizens, the present analysis of vaccine uptake was limited to individuals under the age of 20 years.

Results

Description of the studied community

The capture-recapture assessment is summarised in Table 1. Altogether, 297 Roma (130 persons <20 years) were registered in the Pulawy municipality. From 195 attendants at the vaccination campaign, 156 (82 subjects <20 years) were registered. Based on our performed computation, the estimated size of Roma population in Pulawy was 377 persons (162 subjects <20 years), which was 27% more than the registered population.

The age-by-sex distribution of the estimated population of Roma residents was compared to the official statistics for the entire population of Poland (Figure 1). Altogether, 39 of 195 (20%) Roma attending the vaccination campaign were not registered in the municipality, including 20 of 102 persons under the age of 20 years (20%). In addition, 27 of 195 Roma (14%), including 20 of 102 under the age of 20 years (20%), were not registered in any of the primary healthcare facilities in Pulawy.

Sporadic unstructured interviews with members of the studied community indicated that it was common practice for young people or families with children to live for several weeks to several months with relatives in another community in Poland or abroad.

Assessment of vaccination coverage

In total, 102 persons under the age of 20 years attended the vaccination campaign. Five were younger than 13 months, which constitutes the age limit of the first vaccination according to the national schedule and were therefore excluded from the denominator. Vaccine uptake for the first dose was 56% (54/97) and for the second dose 37% (18/49) (Table 2).

Among the screened subjects under the age of 20 years, 51% were vaccinated according to the national schedule (Figure 2). Considering the previously estimated size of the Roma population under 20 years of age, this would mean that 83 persons in the studied population were insufficiently vaccinated.

Table 1

Estimation of Roma population size, Pulawy, Poland, July-August 2009

	Age (years)									Total
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	
Registered at municipality	63	67	49	40	43	26	4	4	1	**297**
Male	21	36	22	17	25	11	1	0	0	**133**
Female	42	31	27	23	18	15	3	4	1	**164**
Attending mass vaccination	50	52	26	24	19	24	0	0	0	**195**
Male	19	30	9	10	9	12	0	0	0	**89**
% registered	68	87	78	50	78	75	0	0	0	**75**
Female	31	22	17	14	10	12	0	0	0	**106**
% registered	84	77	77	93	90	92	0	0	0	**84**
Estimated Roma population	81	82	63	59	52	31	4	4	1	**377**
Male	31	42	28	34	32	15	1	0	0	**183**
Female	50	40	35	25	20	16	3	4	1	**194**

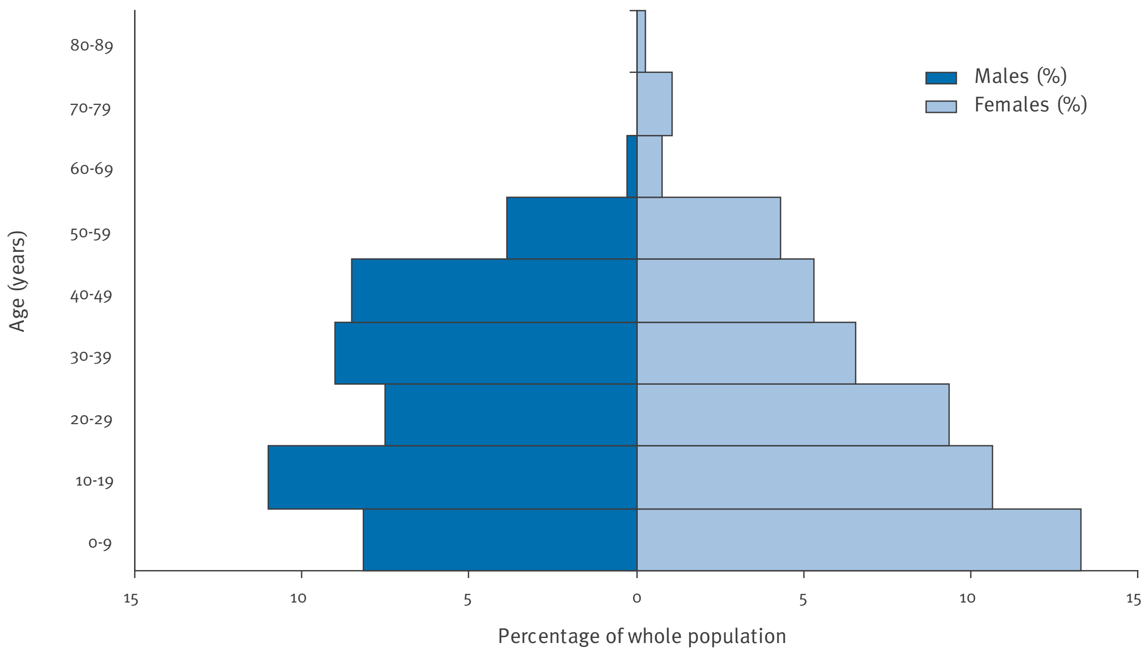
Discussion

One of the possible limitations of this study is the low representativeness of the evaluated Roma population. Roma communities greatly differ in terms of size and integration with the local population, and are usually quite mobile. We attempted to evaluate the population settled in a single town, which could be captured during a mass immunisation event. A considerable number of Roma residents attended the campaign because the event was organised in proximity to the Roma settlements and measles was recognised as a potentially severe disease after one of the early cases in this outbreak had developed serious complications [6]. In addition, persons aged 60 years and older were not captured during the mass immunisation, thus

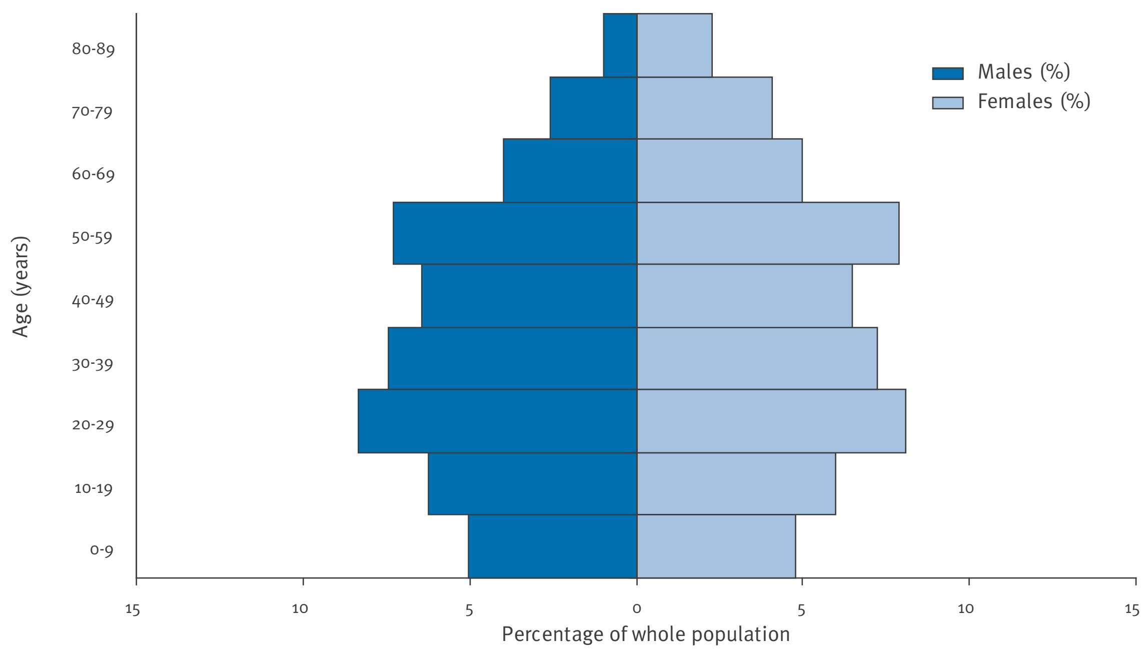
Figure 1

Age-by-sex distribution of the estimated Roma population of Pulawy (a), compared with the population of Poland as a whole (b), 2009

(a) Roma community in Pulawy, August 2009



(b) Polish population, census 30 June 2009



Note: The population older than 60 years was underestimated because they were not invited for the mass immunisation (recapture opportunity).

Table 2

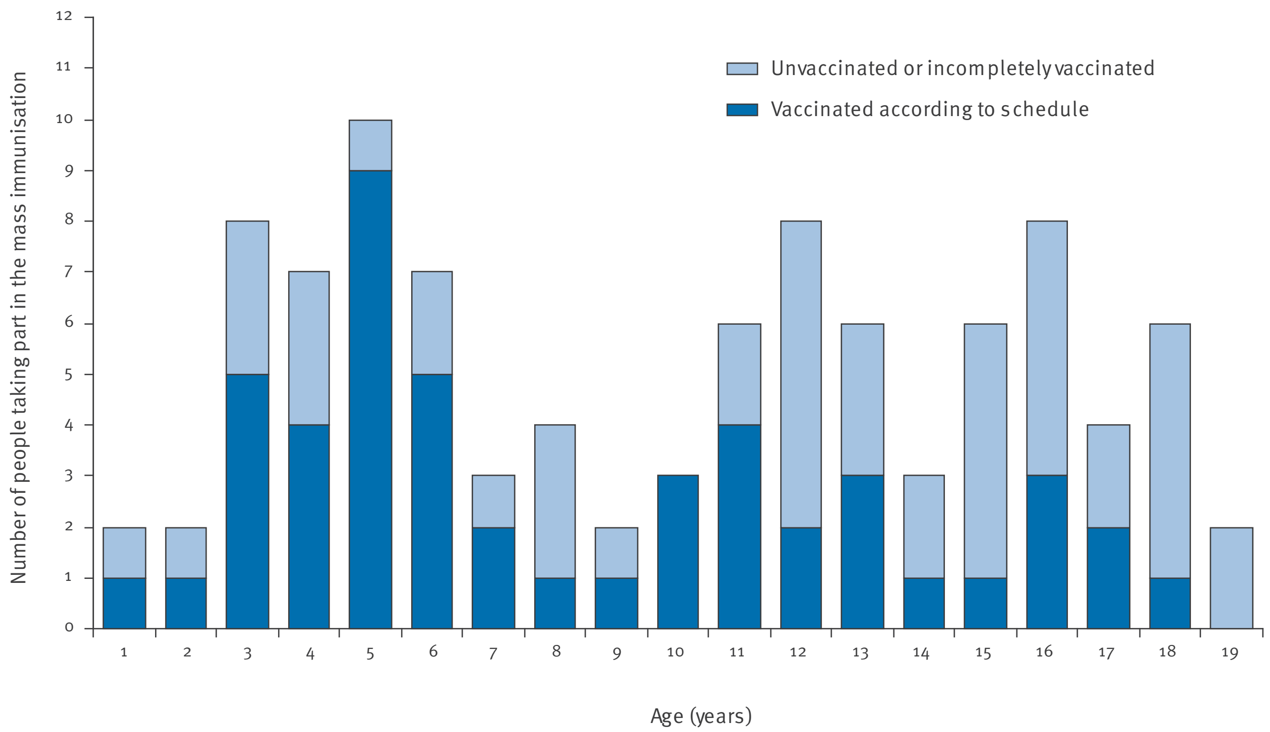
Immunisation status[a] of Roma residents under the age of 20 years, as recorded during mass vaccination campaign, Pulawy, Poland, July-August 2009 (n=102)

Year of birth	Age (years)	Number of prior doses					Total number of children	1-dose uptake	2-dose uptake
		0	1	2	3	Unknown			
2009	0	2[b]				1[b]	3[b]	-	-
2008	1	3[b]	1				4[b]	1 of 2	-
2007	2	1	1				2	1 of 2	-
2006	3	3	5				8	5 of 8	-
2005	4	2	4			1	7	4 of 7	-
2004	5	1	9				10	9 of 10	-
2003	6	1	5			1	7	5 of 7	-
2002	7	1	2				3	2 of 3	-
2001	8		1			3	4	1 of 4	-
2000	9		1			1	2	1 of 2	-
1999	10		2		1		3	3 of 3	1 of 3
1998	11		1	4		1	6	5 of 6	4 of 6
1997	12	2	1	1	1	3	8	3 of 8	2 of 8
1996	13		1	2	1	2	6	4 of 6	3 of 6
1995	14			1		2	3	1 of 3	1 of 3
1994	15	2	2	1		1	6	3 of 6	1 of 6
1993	16			3		5	8	3 of 8	3 of 8
1992	17	1		2		1	4	2 of 4	2 of 4
1991	18			1		5	6	1 of 6	1 of 6
1990	19					2	2	0 of 2	0 of 2
Total		19	36	15	3	29	102	56%	37%

[a] Immunisation status prior to any vaccinations received during the campaign.
[b] Children below legal age of first dose (12-15 months)

Figure 2

Vaccine uptake in the Roma population by age, Pulawy, Poland, July-August 2009 (n=97)



limiting the precision of estimates for older residents. Moreover, participation in the campaign was not independent of registration in the municipality. Therefore it is likely that the crucial assumption for the capture-recapture computation was not met.

We have no definite explanation why 20% of residents were not registered at the municipality. It could be explained by barriers to social services identified in previous studies, such as the high mobility of Roma communities, their stigmatisation, marginalisation and/or discrimination [6]. Another plausible explanation could be that several Roma residents from nearby communities may have come to Pulawy specifically to receive the vaccine injection. In any case, the present analysis illustrates that a considerable proportion of Roma are not officially registered, and therefore have limited access to social benefits including healthcare. Individuals who are not registered cannot find a legal job and cannot obtain health insurance. In theory everyone under the age of 18 years has free access to healthcare in Poland, irrespective of nationality and health insurance. The large number of attendants of the mass immunisation who were not registered in primary healthcare indicates, however, that those children did not have access to regular health checks, vaccination services or any kind of prophylactic programmes.

Another consequence of a substantial part of the Roma community not being registered could be underestimation of the size of the Roma population living in Poland. Lack of a good demographic overview of the local ethnic minorities makes it impossible to develop targeted social and public health programmes which would fit the needs of those vulnerable groups. According to the official national census data collected in 2002, 12,731 persons belonging to the Roma ethnic minority were living in Poland (0.033% of the population). This figure was mainly based on settled communities that the census could reach. The real number of Roma residents in Poland is probably higher, as illustrated in review published in 2000 [8]. The Roma ethnic group is the largest minority in several central and eastern European countries, comprising approximately seven million people [7]. In addition to a lack of research, interpretation of the literature is hampered by the absence of a standard definition of who is, and who is not, Roma [9].

The presented estimates indicate that the studied Roma population was young, with 61% of residents younger than 30 years. The demographic pyramid differs greatly from that of the overall population in Poland and the populations of most European countries. Because Roma communities have many children, they are good reservoirs for childhood infectious diseases. Access to healthcare and integration with health systems including immunisation programmes should be equal for all citizens of Poland irrespective of ethnicity.

An assessment of the measles vaccine uptake in the Roma population revealed a very low coverage with the second dose in the studied community. High vaccine uptake was observed in 5-7 year-olds, and 10-11 year-olds and may be related to health checks before entry to primary school (six-year-olds) and secondary school (12-year-olds).

The present findings are probably an indication of that the measles vaccination coverage among other Roma communities in Poland, and supposedly in other European countries may also be low. Populations with low vaccination coverage impede measles elimination in Europe. The current goal encompasses stopping transmission of indigenous measles by 2010 [10]. To reach this goal in Poland, a stronger commitment by decision makers to improve vaccination coverage in all sections of the population is needed and innovative measures to reach vulnerable groups should be explored.

Conclusions and Recommendations

1. We recommend an assessment of the size and vaccination status of Roma communities living in Poland to better integrate them in healthcare services including immunisation programmes. It will be necessary to approach Roma leaders and to understand the needs and motivations of this large ethnic minority.
2. Factors influencing low vaccination of Roma communities need to be assessed to better target health education campaigns.
3. Catch-up immunisations in Roma communities should be organised, including all age groups.

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Immunisations among school leavers: is there a place for measles-mumps-rubella vaccine?

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To ascertain measles-mumps-rubella (MMR) immunisation coverage among school leavers in an inner city London borough following a local MMR catch-up initiative, a questionnaire was sent to parents and guardians of adolescents who attended the 12 secondary schools in Haringey and were due for the school leavers' vaccination. The questionnaire enquired about previous history of MMR vaccination and a history of adverse events or contraindications to the vaccine. The electronic immunisation records of 400 children (30-35 students from each school) included in the catch up initiative were randomly selected. The childrens' school health records were manually compared with the electronic records. The mean age of the children was 14.7 years, and 224 (56%) were male. Of the 373 records examined prior to the local MMR catch-up initiative, 98 children (26%) had never received MMR, 173 (46.5%) had only had one dose, 100 (27%) had two doses, and two children had three doses of the vaccine. During the school leavers' MMR immunisation, 171 (43%) received a dose of MMR and the number of children immunised with two doses increased to 206 (55.3% versus 27% P<0.001), doubling the coverage. Offering MMR vaccination as part of the school leavers' immunisation is logistically convenient and it may limit the extent of outbreaks.

Introduction

In 1988 the measles-mumps-rubella (MMR) vaccine was introduced in the United Kingdom (UK) and offered to children aged 12-15 months (born after October 1987) [1]. A catch-up campaign for those who were born between 1983 and 1987 accompanied the launch. In 1994, a measles-rubella (MR) vaccine was offered to children born between January 1978 and March 1989 [1]. In October 1996 a second MMR dose was added at the same time as the preschool booster, with a catch-up for those born between January 1990 and March 1992. For the first decade following its introduction in the UK, the MMR vaccine uptake was high, reaching 90% in most areas. With the adverse publicity (from 1998 onwards), the national uptake of the vaccine has fallen to 81% (in children up to the age of two years) and to less than 60% in some areas of London [2]. In 2005, over 40,000 cases of mumps were reported to the Health Protection Agency; half of those cases were children in the age group from 15 to 19 years [3]. In 2006, 739 cases of measles were reported and 129 of those were between 10 and 19 years old [4].

Many studies have suggested that children and adolescents who had two doses of the MMR vaccine are better protected against measles, mumps and rubella compared with those who had only one dose of the vaccine [5-8]. Since 1990, the number of children born with congenital rubella has decreased and only 40 cases were reported for the period between 1991 and 2002 [9-11]. An uptake of 80% is required to prevent the circulation of rubella in the population. If the uptake is lower than that then the average age of infection rises, which leads to an increased risk for women of child bearing age [12].

In 2006, an increasing number of mumps cases were reported among secondary schools pupils in Haringey (North London). In an attempt to control the growing number of cases, we offered a catch-up dose of MMR to all adolescents who were leaving school in 2006 and had not previously had any or only one dose of the MMR vaccine.

Methods

A consent form which included a short questionnaire was sent to all parents and guardians of adolescents who attended the 12 secondary schools in Haringey and were due for the school leavers' vaccination, which includes diphtheria (low dose), tetanus, and inactivated polio vaccine (dT-IPV). The questionnaire enquired about previous history of MMR vaccination (number of doses and dates) and any history of adverse events or contraindications to the vaccine. If parents or guardians were unsure and there was no documentation of previous MMR vaccination in the child's school records, the vaccine was recommended. Those who consented to vaccination were given the MMR dose in school at the time of school leavers' vaccination. Immunisations in all secondary schools were conducted by school nurses. Immunisation records of those vaccinated were entered in the children services' electronic vaccination database that holds the vaccination records of children living in or attending a school in the borough.

Three months following the school MMR initiative, the electronic immunisation records of 400 students (30-35 from each school) born between 1 September 1990 and 31 August 1991 who were due for the school leaver's immunisation (dT-IPV) in 2006 were randomly selected. We then examined the records to ascertain firstly, the number of MMR doses given previously and secondly, if the student received a dose of MMR following the school leavers' vaccination initiative. Because of concerns over the completeness of electronic immunisation records, we also reviewed the childrens' school health records for ascertainment and validation of the MMR vaccine history.

Results

The mean age of children was 14.7 years and 224 (56%) were males. Based on information gathered from the school health and electronic immunisation records prior to the catch-up activity, 27 of 400 (8%) immunisation records were either missing or incomplete. Of the remaining 373 records, 98 (26%) had never received MMR vaccine, 173 (47%) had had one dose, 100 (27%) had had two doses, and two children had received three doses of the vaccine. During the school leavers' MMR vaccination a total of 173 (47%) children received a dose of MMR vaccine increasing the number of those who had a total of two doses to 206 (55.3% versus 27% $P<0.001$) (Table). The reasons for MMR vaccine refusal were not mentioned in the medical records.

Discussion

To our knowledge, no previous studies have looked at the feasibility and benefits of giving MMR immunisation as part of the school leavers' vaccination (as a catch-up initiative) for those who had received no or only one dose of MMR vaccine previously. The children in the study were born between 1990 and 1991 and hence a significant proportion had only one dose of MMR vaccine as they may have missed the second dose introduced in 1996. As one dose of the vaccine offers only 80-85% efficacy against mumps [13], a large number of children in this study are at risk of acquiring this disease. Moreover, part of the same group of children are also not fully protected against measles because of their incomplete vaccination [6]. This was clear from recent measles outbreaks where almost one in five cases were adults [14].

Following the school immunisation, the risk of these infections was reduced by more than twofold. However, the number of children who had two doses of MMR and could therefore be considered to have adequate protection against measles, mumps and rubella is still very low (55%). The low MMR uptake may explain the outbreaks of mumps among older school children and university students. This group might also have contributed indirectly, because of low herd immunity, to the increasing number of measles cases in younger age groups. Rubella has been eliminated from the United States (US) and Scandinavian countries except for occasional imported infections. In the UK, there is a danger of rubella infection in unvaccinated young women in the future due to earlier low uptake of MMR vaccine [11]. As some parents may be particularly reluctant to immunise very young children with MMR, they may be more willing to do so when the children are older and therefore more likely to accept such catch-up campaigns. Providing this vaccine in school and at the same time as the school leavers' immunisation is logistically convenient and it may limit the extent of mumps and measles outbreaks which may involve also younger children who are not fully vaccinated.

Some evidence of waning immunity was found, with the estimated vaccine effectiveness declining from 99% in 5-6 year old children to 86% in 11-12 year-olds during the large outbreak in the UK in 2004-2005 [15]. Waning immunity has been postulated as one of the contributing factors for the large mumps outbreak in 2005 in Canada because young adults in the age group of 18-24 year-olds would most commonly have received their most recent dose of mumps-containing vaccine six to 17 years previously [16,17]. Despite high coverage with two doses of mumps vaccine large outbreaks of mumps have been happened in the US [18]. If population immunity is already near the herd threshold, even negligible waning immunity, particularly when combined with increased exposure, could potentiate an outbreak [19].

Table

Coverage with measles-mumps-rubella vaccine among school leavers before and after catch-up immunisation at schools, North London, 2006 (n=400)

Number of MMR doses	Before school leavers' MMR vaccination Number (percentage ± 95% CI)	After school leavers' MMR vaccination Number (percentage ± 95% CI)	Change in number of vaccine doses
0	98 (26±4%)	33 (9±3%)	-66%
1	173 (47±5%)	132 (36±5%)	-24%
2	100 (27±4%)	206 (55±5%)	106%
Unknown	27	27	
› 2 doses	2 (0.5%)	2 (0.5%)	

CI: confidence interval; MMR: measles-mumps-rubella vaccine.

MMR vaccination for the school leavers will help to boost the herd immunity, but further studies are needed to establish the potential for waning of immunity in adolescents and young adults. Notwithstanding, every effort should be made to improve the MMR uptake in younger children who are at greater risk of the three diseases.

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Spotlight on measles 2010: Measles outbreak in Ireland 2009-2010

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Measles cases are increasing in Ireland, with 320 cases notified since August 2009. Nearly two-thirds of these cases (n=206) were unvaccinated. In the early stages of the outbreak a substantial number of cases were linked to the Traveller community with some cases also reported among the Roma community, other citizens from eastern Europe and children whose parents objected to vaccination. By February 2010, there had been considerable spread to the general population.

Background

Measles is a highly infectious disease that can result in serious complications. The only way to prevent infection is through measles vaccination. Measles vaccine was introduced in Ireland in 1985; this was followed by the introduction of the combined measles-mumps-rubella (MMR) vaccine in 1988 for children aged 15 months. In 1992, a second dose of MMR was recommended for all children aged 10 to 14 years. In 1995, there was a measles and rubella vaccination campaign for children of primary school-age (5-12 years old). In 1999, the age of the second dose of MMR was changed to 4-5 years. In 2002, the age of the first dose of MMR was changed to 12-15 months, and since 2008 it is recommended at 12 months of age.

In 1985, the year when measles vaccine was introduced, 9,903 measles cases were reported, declining to 201 cases in 1987. However, despite the routine immunisation programme, further major outbreaks have occurred in 1989 (1,248 cases), 1993 (4,328 cases) and 2000 (1,603 cases).

Since the national collation of quarterly MMR_1 (first dose) immunisation uptake statistics commenced in 1999, the MMR_1 uptake rate in those aged 24 months has ranged between 69% (Quarter 4, 2001) and 91% (Quarter 3, 2009) [1]. While the immunisation uptake rate is below the target rate of 95%, measles outbreaks like the one seen in 2000 [2] will continue to occur. In addition, there are subpopulations in Ireland who are highly susceptible to measles, e.g. those who refuse the MMR vaccine and communities with low uptake of MMR due to social exclusion and disadvantage.

Methods

Measles figures presented in this report were based on data extracted from the Computerised Infectious Disease Reporting (CIDR) system on 26 February 2010 and are provisional. Incidence rates were calculated based on population data taken from the 2006 census. Crude area rates and numbers of notified cases are shown according to the eight Health Service Executive (HSE) Area Departments of Public Health.

Case classifications are assigned to notifications in Ireland as per the *Case Definitions for Notifiable Diseases* [3].

The measles case definition is as follows:

Clinical description: Clinical picture compatible with measles i.e. a generalised erythematous rash lasting for more than three days and a temperature over 38°C and one or more of the following: cough, coryza (rhinitis), Koplik's spots or conjunctivitis.

Laboratory criteria for diagnosis are one of the following:
- Detection of measles IgM antibody in the absence of recent vaccination,
- Fourfold or higher rise in measles IgG antibody level in the absence of recent vaccination
- Detection of measles virus (not vaccine strains) in a clinical specimen.

Case classification:
- Possible: clinically compatible cases,
- Confirmed: a case that is laboratory-confirmed or a clinically compatible case which is epidemiologically linked to a confirmed case. A laboratory-confirmed case does not need to meet the clinical case definition.

A measles case is epidemiologically linked if there was exposure to a laboratory-confirmed case during the infectious period (four days before to four days after rash onset) and this exposure occurred within the expected incubation period of the case under investigation, 7 to 18 days (mean 14 days) before rash onset.

Epidemiology

In week 31 in 2009 (week ending 8 August 2009), a confirmed measles case, in an adult who worked in a general practice, was notified in the HSE-Southern Area (Figure 1 shows this location).

Figure 1

Number of notified measles cases and crude incidence rate per 100,000 population in the eight Health Service Executive Area Departments of Public Health, Ireland, week 31, 2009 to week 7, 2010

CIR: crude incidence rate; HSE: Health Services Executive.

In week 33 in 2009, a measles case in a Roma child was notified in the same Area, this case's general practitioner (GP) worked in the same building as the previous case. In week 37, 2009, two measles cases, one in a child from the Traveller community (an indigenous minority group many of whom maintain a nomadic way of life [4]) and one in a hospital contact of this case, were notified in the HSE Southern Area. During weeks 38 and 39, six cases in Travellers were notified in the HSE-Southern Area. From then on measles continued to circulate and spread to other HSE Areas.

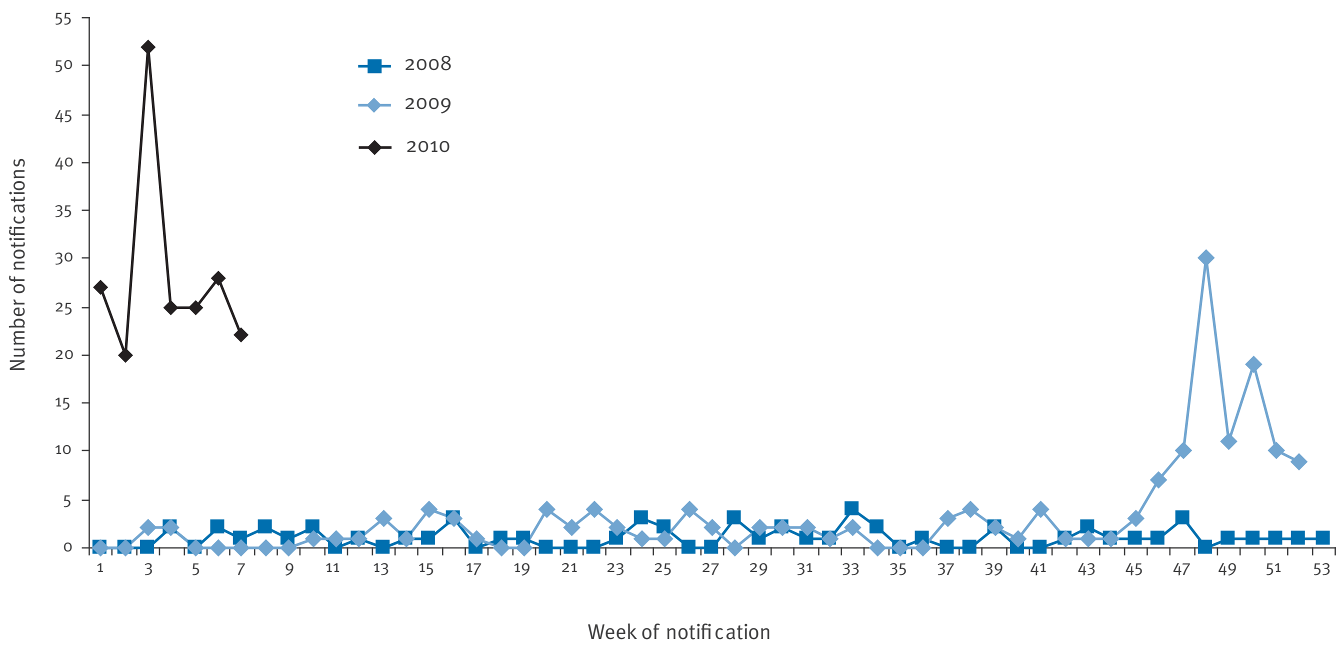
Although ethnicity is not routinely collected as part of notification data and may be difficult to establish and report on, it was evident in the early stages of the outbreak that a substantial number of cases were linked to the Traveller community (anecdotal reports). By December, verbal reports from the HSE Southern Area highlighted transmission was now also among children whose parents objected to vaccination, either for perceived safety reasons or for philosophical reasons. During the course of the outbreak a small number of cases were also reported, in different HSE Areas, among the Roma community and other citizens from Eastern Europe. By February 2010, there was considerable spread to the general population.

Measles notifications from 2008 to week 7 of 2010 are shown in Figure 2. During weeks 1-30, 2009 43 measles cases were notified. In contrast, 320 measles cases were notified between week 31, 2009 and week 7, 2010 (outbreak period to date).

Of the 320 cases notified, 227 (71%) were classified as confirmed and 92 (29%) were classified as possible,

Figure 2

Measles notifications by week, Ireland, week 1, 2008 to week 7, 2010



while one had no case classification specified. Measles notifications and crude measles incidence rates by HSE Area are shown in Figure 1. The majority (89%) of cases were under 20 years of age with the largest number of cases (21%) in the age group of 1-2-year-olds (Figure 3).

The highest incidence rate was seen in those younger than one year (Figure 4). Of the 320 cases notified, 174 (54%) were male and 144 (45%) were female, while sex was not recorded for two cases (1%).

Of the 320 notified measles cases, 206 (64%) were unvaccinated; 45 (14%) were reported to have had one dose of MMR; six (2%) were reported to have had two doses of MMR and for 63 (20%) the number of doses of MMR was unknown/not reported. Vaccination dates were reported for one of the six cases with two MMR doses and for 36 cases with one MMR dose (nine of these were vaccinated less than nine days before onset of illness and were probably incubating measles at the time of vaccination).

Of the 320 cases, 115 (36%) were hospitalised and 162 (51%) were not hospitalised, while hospitalisation status was unknown/not reported for 43 (13%). Length of

Figure 3

Measles notifications by age group and case classification, Ireland, week 31, 2009 to week 7, 2010

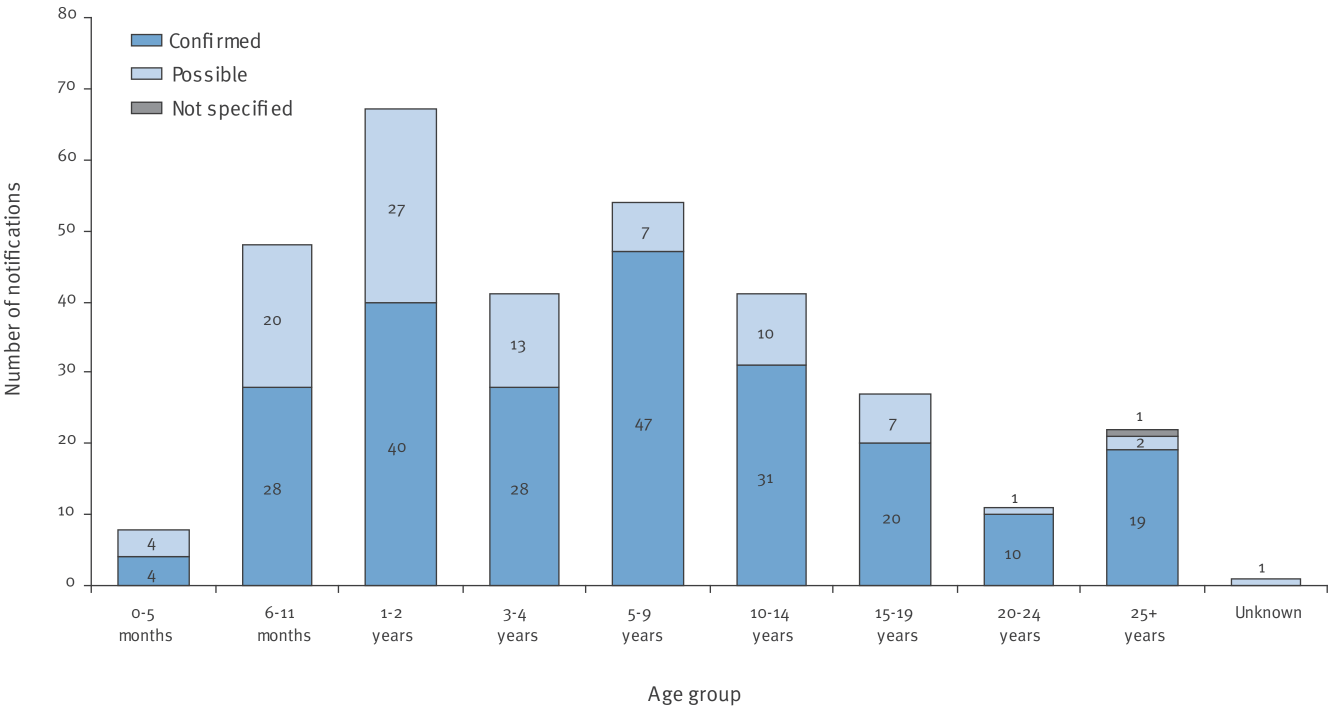
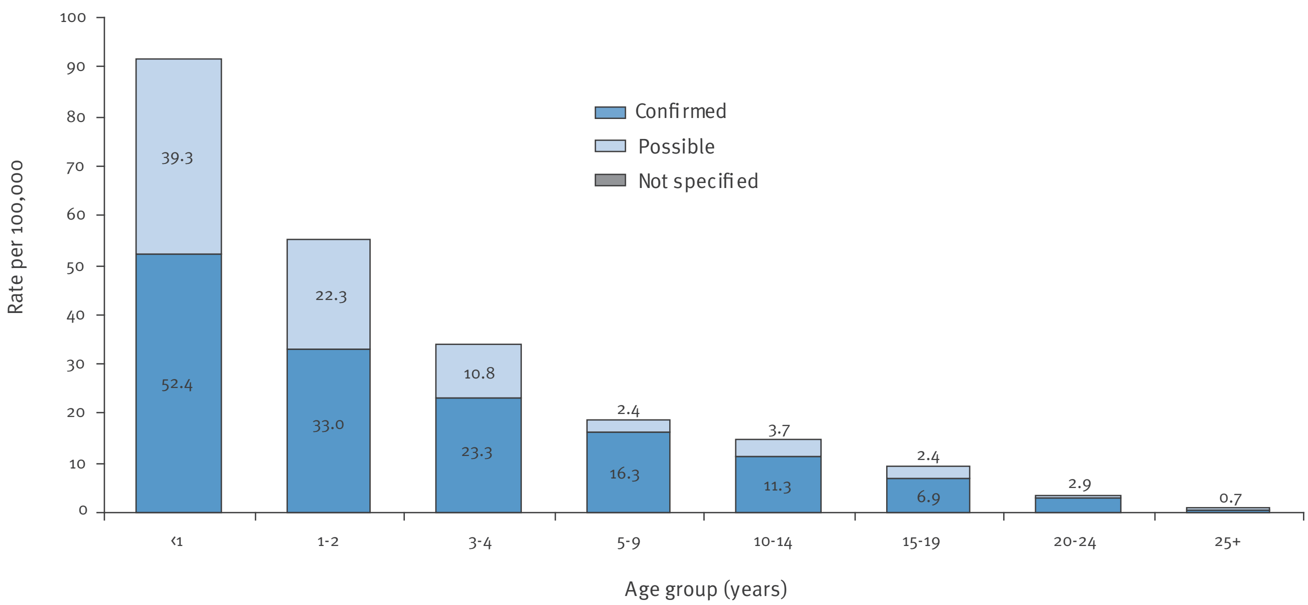


Figure 4

Age specific incidence rates of measles notifications, Ireland, week 31, 2009 to week 7, 2010



hospitalisation was reported for 73 cases; the median duration of stay was three days (range one to 11 days).

Complications reported included pneumonia (n=16), ear infection/otitis media (n=4), dehydration (n=2), chest infection (n=1), dehydration, nausea and vomiting (n=1), pharyngitis (n=1), pneumothorax (n=1), seizures (n=1) and tonsillitis (n=1).

National outbreak control team

At the start of the outbreak, a national outbreak control team was convened, which includes health professionals from the departments of public health in the HSE Areas, HSE-Health Protection Surveillance Centre, HSE-National Immunisation Office, HSE Population Health, HSE Social Inclusion, the Institute of Obstetricians and Gynaecologists, the National Virus Reference Laboratory and the field of Paediatric Infectious Disease. This group agreed public health strategies (vaccination and management of cases and close contacts, awareness-raising among clinicians and community) to control the outbreak at national and local level. Some of the guidance and strategies recommended by the outbreak control team are outlined here.

General guidance

All children should be vaccinated at 12 months and 4-5 years, as per the routine childhood immunisation schedule. All children who have not had two MMR vaccines by the age of five years should be offered vaccination opportunistically. Control measures for measles outbreaks were distributed to various settings and healthcare staff and are available on the HPSC website [5].

Traveller community

All Traveller children who have not had two documented doses of MMR are recommended MMR. All Traveller children aged 6-11 months during the current outbreak are recommended MMR (these children are also recommended MMR again at 12 months and at 4-5 years, as per the normal childhood immunisation schedule). Traveller children who have received MMR_1 are recommended MMR_2; MMR_2 may be given one month after the first dose (if children under 18 months of age are given MMR_2 less than three months after MMR_1, these children need a third dose at 4-5 years of age). MMR vaccine clinics and GP sites were organised to provide MMR to the Traveller community. A subgroup of the outbreak control team was established to liaise with social inclusion groups and non-governmental organisations to find ways to increase vaccination among ethnic minority groups.

Contacts of cases

MMR given within 72 hours of exposure may prevent infection. Children in outbreak situations who have received MMR_1 are recommended MMR_2; MMR_2 may be given one month after the first dose.

Healthcare staff

All healthcare staff born since 1978 should either be immune to measles or have had two documented doses of MMR. Healthcare staff born before 1978 should be offered MMR if they are considered at high risk of exposure. Guidance on preventing measles transmission in healthcare settings (such as rapid triage and case isolation in addition to vaccination) was distributed to healthcare staff and is available on the HPSC website [5].

MMR catch-up campaign

An MMR catch-up campaign is planned for school children aged approximately four to 15 years (older school children aged were previously targeted in an MMR campaign in 2009).

Conclusion

As 29% of cases in this outbreak are currently classified as possible cases, and although the laboratory results of some of these cases are pending at the time of writing, there is a continued need to strengthen measles surveillance in Ireland and ensure rigorous case investigation and laboratory confirmation of all suspected measles cases. This outbreak highlights once again the need for an MMR vaccine uptake of at least 95% to prevent measles outbreaks and the importance of increasing coverage in all groups, in particular those groups who are hard to access. The simultaneous occurrence of the 2009 influenza A(H1N1) pandemic and the ensuing pandemic vaccination programme has put enormous pressure on vaccination teams trying to address MMR defaulters at the same time. There is a concern that this current outbreak may develop into a large outbreak similar to the one that occurred in 2000 [2].

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Spotlight on measles 2010: Preliminary report of an ongoing measles outbreak in a subpopulation with low vaccination coverage in Berlin, Germany, January-March 2010

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Since early January 2010, Berlin has been experiencing a measles outbreak with 62 cases as of 31 March. The index case acquired the infection in India. In recent years, measles incidence in Berlin has been lower than the German average and vaccination coverage in school children has increased since 2001. However, this outbreak involves schools and kindergartens with low vaccination coverage and parents with critical attitudes towards vaccination, which makes the implementation of public health interventions challenging.

Background

Since the implementation of the new national Protection Against Infection Act (Infektionsschutzgesetz; IfSG) in Germany in 2001, clinically suspected measles cases as well as laboratory confirmation for measles has to be reported to the District Health Offices [1]. The District Health Office evaluates the information according to the case definition for measles [2] and enters case-based data into the electronic reporting system. Since 2001, the number of measles cases and the annual measles incidences in Berlin have been low compared with the national average. The highest annual number of measles cases in Berlin was reported in 2006 (n=57). The annual incidences ranged from 0.06 to 1.51 cases per 100,000 inhabitants in Berlin compared with 0.15 and 7.32 per 100,000 country-wide (Table) [3]. The measles vaccination coverage in children at school entrance examination has increased significantly during the past years. In 2001, 91.2% of children presented with at least one measles vaccination at school entry and only 24.0% had two vaccinations [4]. In 2008, 95.2% were vaccinated once and 88.2% twice against measles [5]. In the neighbouring Federal State of Brandenburg the vaccination coverage is significantly higher: 93.4% of children had two measles vaccinations at school entry in 2008 [6]. Despite these efforts, a measles outbreak with so far 62 cases was observed in Berlin between early January and 31 March 2010.

Outbreak description

The index case of this outbreak, a secondary school student from Berlin was diagnosed on 5 January 2010. The patient was not vaccinated against measles and the medical history pointed to travel-related acquisition of the infection, since he had travelled to India at the end of 2009. The diagnosis was laboratory-confirmed on 14 January 2010 and the result was reported to the responsible District Health Office on 15 January 2010. Since samples of the index case were not available, PCR was performed at the National Reference Centre for Measles, Mumps and Rubella at the Robert Koch-Institute (RKI) on a sample of a related case diagnosed on 19 January 2010. This analysis confirmed measles virus genotype D8 (MVs/Berlin.DEU/03.10) which is identical to viruses endemic in India (MVs/Imphal.IND/19.09) and therefore supported introduction from the Indian subcontinent. To date, genotyping revealed measles virus genotype D8 in 13 cases. However, genotyping is not yet completed for all cases. There is evidence that some of the measles cases currently observed in Berlin are not linked to the outbreak. These infections might be concurrently imported from other regions (e.g. Bulgaria, South Africa). Epidemiological and laboratory investigations are ongoing to clarify the situation thoroughly.

As of week 12, 2010, the total number of cases has reached 62. So far, the outbreak has affected 52 residents living in four of the twelve Districts of Berlin (Figure 1) and 10 residents of the surrounding Federal State of Brandenburg. The number of cases per week related to the outbreak is shown in Figure 2. The index patient is attending a private school (Waldorf-Schule; anthroposophic education). The proportion of students vaccinated against measles in this school is estimated to be significantly below 70%. Parents sending their children to Waldorf schools and kindergartens are known for their critical attitudes towards vaccinations in general and especially with regards to measles vaccination. Thus, the outbreak spread mainly among unvaccinated children and adolescents attending Waldorf institutions (schools and kindergartens in two districts) and their siblings. In addition, children and adolescents attending public schools and kindergartens were exposed and infected via direct contacts with Waldorf students and their families. None of the reported cases had been vaccinated against measles before being exposed during this outbreak (some children received an active post-exposure vaccination). All measles cases resident in Brandenburg were students attending schools in Berlin or unvaccinated siblings of such students. No measles transmission was observed in schools and kindergartens in this Federal State. The mean age of the cases was 10.5 years (range: 1-18 years). To date, there have not been any reports of hospitalisations or complications due to measles infections in connection with this outbreak.

Public health intervention and challenges

After diagnosis of the index case in early January the responsible District Health Offices implemented public health interventions according to the Protection Against Infection Act to interrupt the spread of measles. The measures included:

- Temporary exclusion of students and teachers without measles vaccination or naturally acquired immunity from schools with confirmed measles cases;
- Offering measles vaccination for unvaccinated students and teachers in affected schools (vaccinations in collaboration with private practitioners);
- Equivalent measures in kindergartens with measles cases;
- Active detection of contacts and exposed persons;
- Sampling of clinical material from measles patients to confirm diagnosis and perform genotyping at the National Reference Centre for Measles, Mumps and Rubella;
- Recommendation of temporary restrictions of private contacts with unprotected persons and of any public activities in groups for patients and their unvaccinated family members;
- Public health information to increase regional clinicians' alertness regarding measles in their area;
- Enhanced communication with educational institutions and parents with critical attitudes towards vaccination of the children.

These measures showed some success. The peak of the outbreak was seen in the week 5, 2010 (n=17), with decreasing case numbers in the following weeks. However, only few of the offered measles vaccinations were accepted (numbers are currently not available because the exposed unvaccinated children were sent to private practitioners for measles vaccinations). Four students developed measles after receiving a post-exposure measles vaccination (vaccination 4–5 days after the last contact). This observation underlines the importance to apply active vaccination earlier after exposure (preferably within three days after first exposure); furthermore passive vaccination with the specific immunoglobulin should be considered for effective individual post-exposure measles prevention. After the initial peak, the outbreak continued to spread on a relatively low level, and the first case in a district not directly neighbouring the district of residence of the index case occurred at the end of week 11 (Figure 1). Currently most concern is directed towards a

Table

Number of reported measles cases, measles incidence and measles vaccine coverage at school entry examination in the Federal State of Berlin and in Germany 2001–2008

	Case reports				Vaccination coverage	
	Berlin		Germany			Germany
	n	n/100,000	n	n/100,000	1st/2nd dose (%)	1st/2nd dose (%)
2001	51	1.51	6,037	7.32	91.2 / 24.0	91.4 / 25.9
2002	24	0.71	4,656	5.64	not available	91.3 / 33.1
2003	2	0.06	777	0.94	not available	92.5 / 50.9
2004	11	0.32	123	0.15	93.4 / 71.7	93.3 / 65.7
2005	39	1.15	781	0.95	93.5 / 78.8	94.0 / 76.6
2006	57	1.67	2,308	2.80	93.8 / 83.6	94.5 / 83.2
2007	8	0.23	566	0.69	94.5 / 86.8	95.4 / 88.4
2008	29	0.85	916	1.11	95.2 / 88.2	95.9 / 91.3

Source: [3-5].

Waldorf kindergarten in a neighbouring district with a measles vaccination coverage of less than 60%.

In early February, parents whose children were affected by the temporary school exclusion filed an action against the respective District Health Office at the Berlin Administration Court. The claim argued that the health authority's decision impeded the unvaccinated children's rights to visit school and to acquire immunity against measles through natural infection. Measles was claimed to be a harmless infection in children without severe complications and possible long-term disabilities. The specific vaccination against measles was perceived to be inefficient and dangerous. However, in mid-February the Berlin Administrative Court decided to dismiss the claim and declared that the measures taken by the public health authorities had been adequate to contain the outbreak. However, further claims are pending at the Berlin High Administrative Court.

For now, parents must be aware that their unvaccinated children can acquire the infection while travelling in regions with endemic measles or ongoing measles outbreaks. Physicians should be encouraged to focus on parents with unvaccinated children and strongly recommend active measles vaccination before travelling.

Conclusion

We give a preliminary overview of a measles outbreak in Berlin. There is epidemiological and laboratory-confirmed evidence that the index case acquired the infection when travelling in India. The outbreak affected unvaccinated children and adolescents whose parents

FIGURE 1

Measles outbreak, cases by district, Berlin, 5 January-31 March 2010 (n=52)

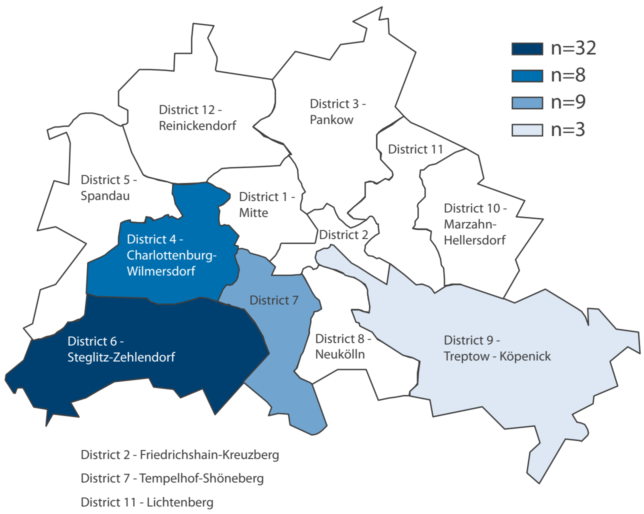
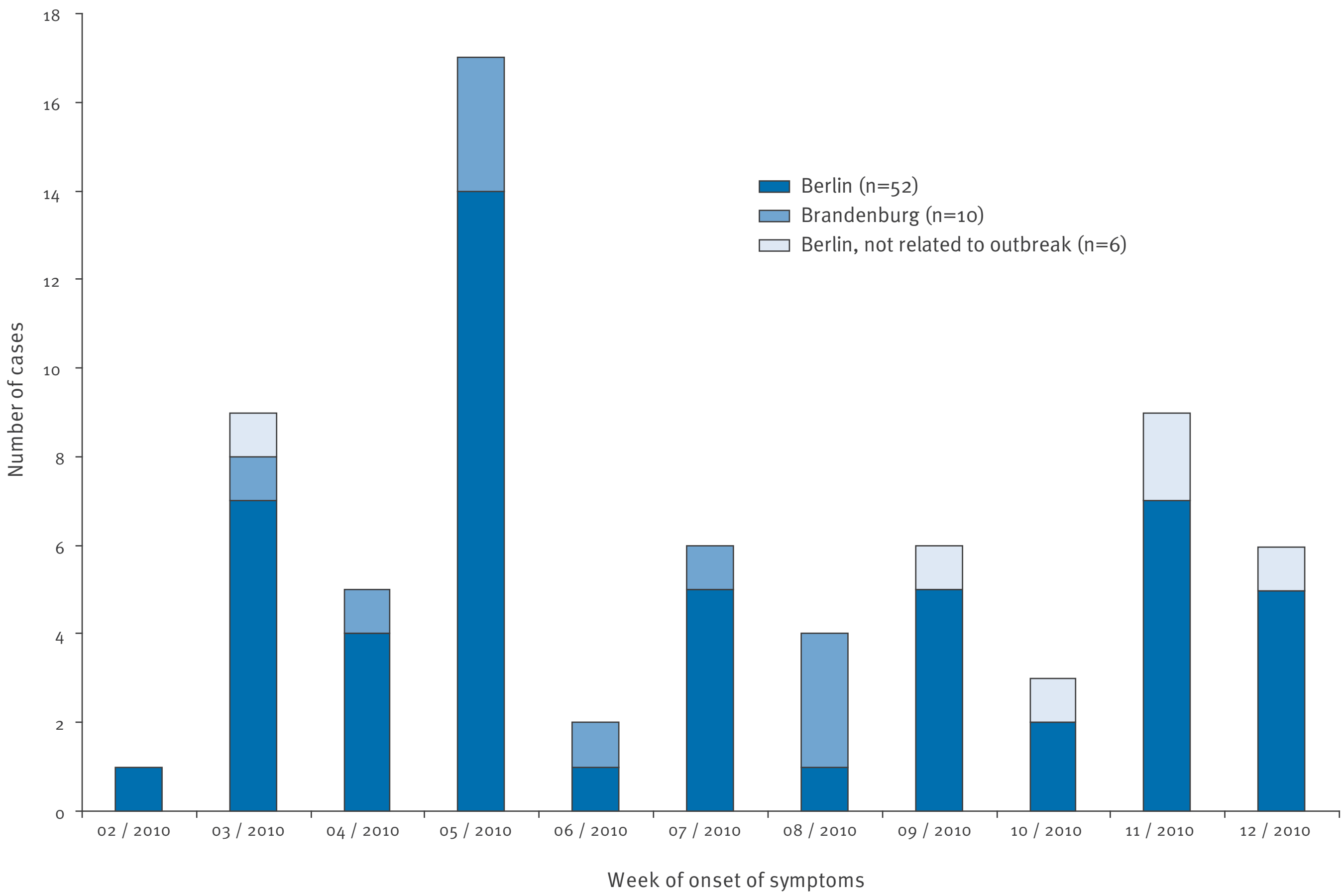


FIGURE 2

Measles outbreak, cases by week of onset of symptoms and place of residence including reported cases from week 2 to 12 2010 (n=62 outbreak-related cases, n=6 cases not related with the outbreak)



are known to have critical attitudes towards measles vaccination. Although vaccination coverage in Berlin has increased significantly in general, measles transmission chains can still be established in schools and kindergartens with high proportions of unvaccinated children. Public health authorities were extremely challenged in this situation because the measures taken according to infectious disease protection legislation were not generally accepted by the parents. Thus measles could be re-introduced and continue to spread on a low level within the unvaccinated parts of the population in Berlin for a not clearly foreseeable time.

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Spotlight on measles 2010: A cluster of measles in a hospital setting in Slovenia, March 2010

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After ten years of being measles free, Slovenia experienced a cluster with secondary transmission in a hospital setting in March 2010. The index case, a resident of Ireland, was hospitalised on the day after his arrival to Slovenia and diagnosed with measles two days later. After his discharge, two cases of measles were notified, a hospital staff member and a visitor to the clinic, suggesting transmission in a hospital setting.

Background

Measles is a highly infectious disease which can be successfully prevented only by vaccination. Notification of measles cases has been mandatory in Slovenia since 1948. According to the Infectious Diseases Act, a case of measles (even a suspected case) has to be reported within three to six hours to the regional Institute of Public Health, responsible for public health interventions and from there immediately to the National Institute of Public Health (NIPH) where data are collected and analysed. In 2005, the European Union case definition [1] for measles was widely publicised and general practitioners and paediatricians were actively encouraged to confirm every possible case of measles (rash fever) with appropriate laboratory diagnosis.

In Slovenia, mandatory vaccination against measles was introduced in 1968 for 12 months old children. In the first years the vaccination coverage was quite low, but already in 1972 (birth cohort 1971) it reached 60%. In 1979 the coverage reached 80% and increased further in the following years. The second dose of measles vaccine was introduced in 1978 for children entering school at the age of seven years (birth cohort 1971), and was replaced by a combined vaccine against measles and mumps in 1979. The coverage for the second dose at seven years of age reached 90% already in the first year, and has been higher than 95% since 1983 (data from annual reports of NIPH) [2]. In 1990, the combined measles-mumps vaccine was replaced by a trivalent vaccine against measles, mumps and rubella (MMR); since then children have been immunised with this vaccine at 12 to 18 months (first dose) and at six years of age (second dose).

After the introduction of measles vaccination the occurrence of measles was substantially reduced compared with the highest reported incidence rate of 407 per 100,000 in 1967, and followed a declining trend (Figure 1). The size of epidemics decreased and inter-epidemic periods lengthened. The last case (indigenous) was reported in 1999. The last reported epidemic started in 1994 and peaked in 1995 when 405 cases (20.4/100,000) were reported, mostly from two regions of Slovenia.

Before the introduction of measles vaccination in Slovenia, measles was a disease of pre-school children. After that, the age distribution of morbidity shifted to older age groups. The average age of reported cases increased gradually from 5.4 years before the vaccination started (1965-1968) to 11.4 years in the 1990s (1989-1998) (unpublished data). However, since 1984, an increased proportion of cases has also been observed among infants under the age of 12 months who are not targeted by MMR vaccination (although only seven, nine and 13 cases were reported in 1996, 1997 and 1998, respectively) (Figure 2).

With regard to susceptibility profiles obtained from serosurveys conducted in Slovenia in 1998 and 2000, the population born before 1960 could be considered immune against measles (the proportion susceptible was 1.5% in those older than 40 years) [3]. Most people borne after 1971 received two doses of measles vaccine. Thus, the cohorts born between 1960 and 1971 would be most at risk of getting measles if the infection was imported to the country.

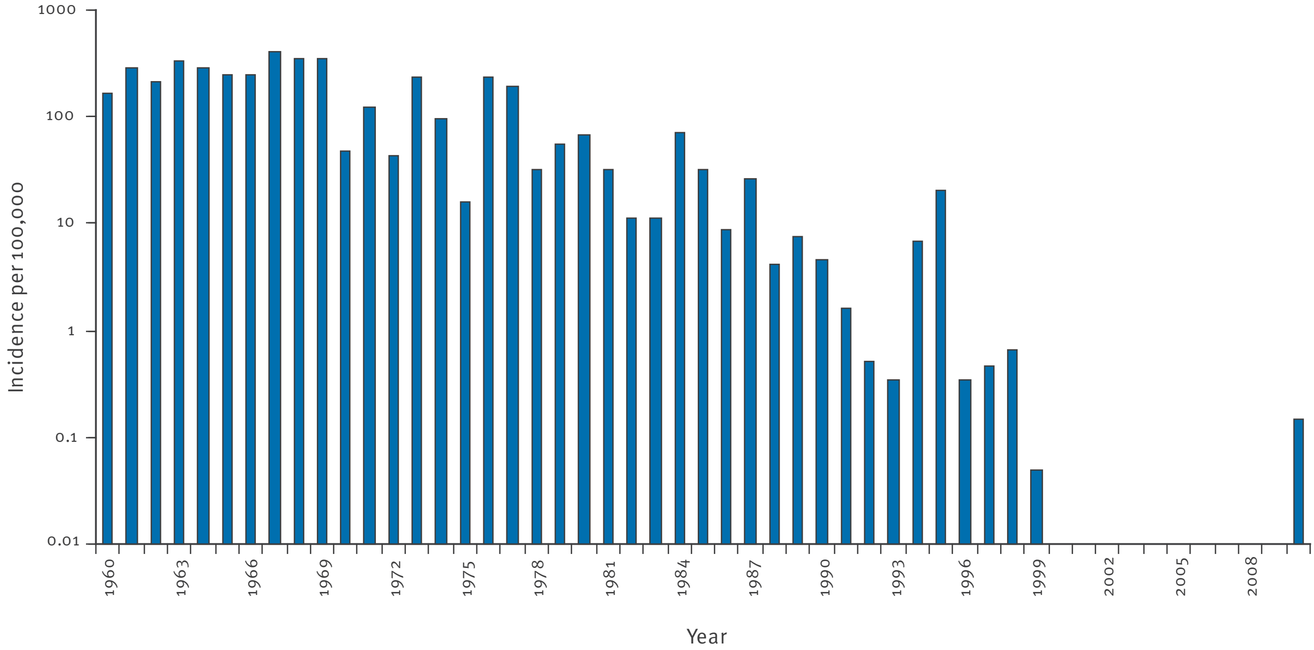
Cluster description

On 11 March the NIPH was notified of a suspected case of measles (Patient 1) in a 19 year old resident of Ireland, who was hospitalised in the Clinic of Infectious Diseases at the University Medical Centre Ljubljana

(CID). On the morning of the same day he was first examined in an emergency outpatient clinic where he presented with an atypical rash (a few abdominal papulae). The patient informed the staff that his brother had been diagnosed with measles a week before and was hospitalised while travelling through Rome, Italy.

Figure 1

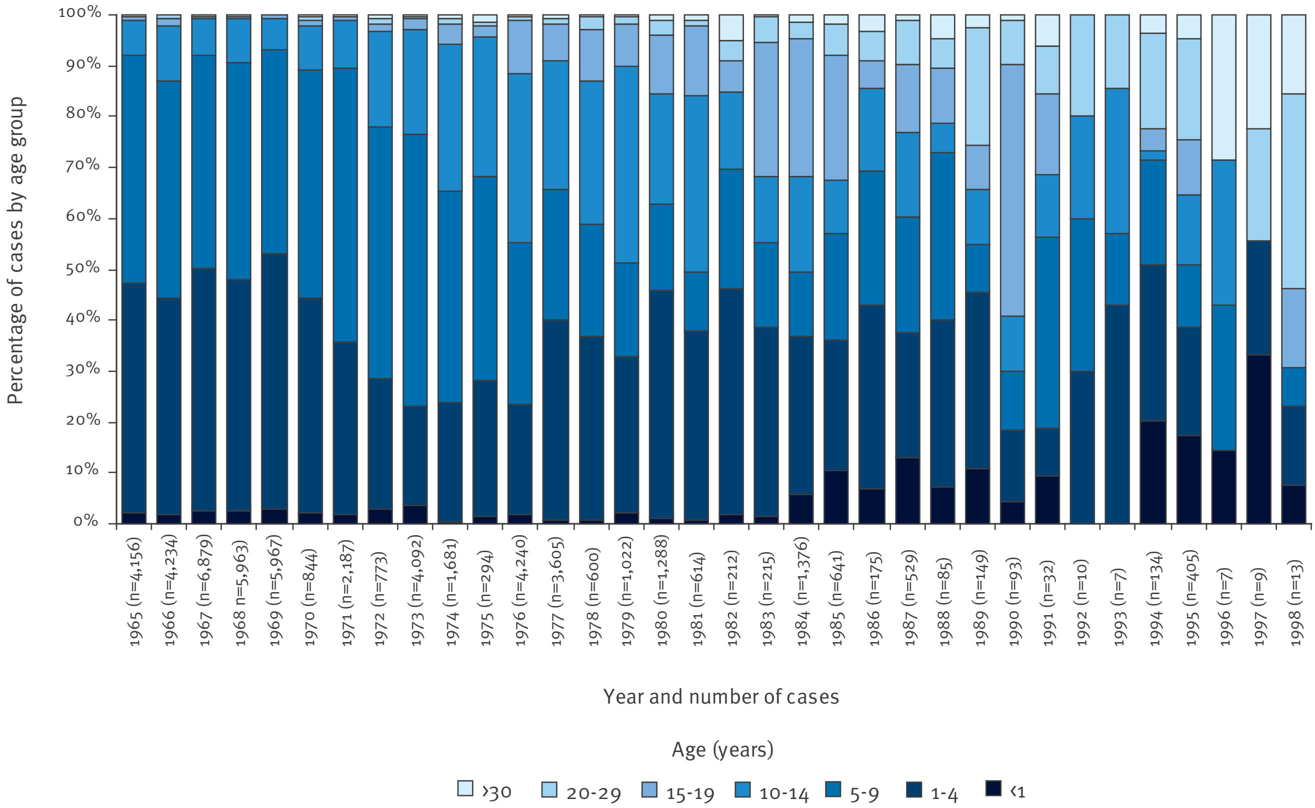
Reported measles incidence rates, Slovenia, 1960-2010



Data as of end April 2010.
Source: National Institute of Public Health of Slovenia.

Figure 2

Age-specific proportions of reported measles cases, Slovenia, 1965-1998



Source: National Institute of Public Health of Slovenia.

The brother did not accompany the family to Slovenia. Patient 1 was therefore transferred to CID in the afternoon of 11 March, where he was isolated with fever, a few abdominal papulae, conjunctivitis, and widespread Koplik spots. A blood sample and throat swab (from Koplik spots) were taken on the same day. The patient's serum was tested for measles-specific IgM and IgG by ELISA (Siemens Enzygnost) and was negative for both. In the swab MV was confirmed by PCR of the nucleoprotein gene, and material from the swab was sent for MV isolation and genotyping to the WHO Regional Reference Laboratory for MMR at the Robert Koch Institute, Berlin. The detected MV belonged to genotype D4 and was most similar to MV detected in the UK in 2009. The rash became typical for measles on 12 March and measles-specific IgM resulted positive in another blood sample on 13 March, while IgG was still negative. In the following days the patient's condition worsened and he developed pneumonia. He was discharged from hospital on 19 March fully recovered. In the last specimens taken on that day the IgM titre became lower and specific IgG antibodies appeared (Table).

The patient came to Slovenia with his family in the evening of the day before he was admitted to the hospital. He had no contact with local people as he and his family were sleeping in a caravan. He did not know if he had been vaccinated against measles. According to his statement he was a member of the Irish Traveller community [4] and originating from Limerick, Ireland where an outbreak of measles was ongoing in early 2010.

On 24 March the NIPH was notified of another suspected case of measles (Patient 2) in a healthcare worker who had been in contact with the index case at his admission. The patient had fever, sore throat, muscle aches, vomiting, photophobia, but no typical rash (only a few papulae in the face). At first she was classified as a probable case of measles. She reported to have been vaccinated at least once (as she was born after 1971 she was supposed to have received two doses). Serum specimens taken on 23 and 25 March were tested with ELISA. Both were negative for IgM and positive for IgG antibodies (400 IU/mL). A throat swab taken on 24 March tested negative for measles with PCR. An archived serum sample taken from this patient six months earlier showed the same titre of measles-specific IgG (400 IU/mL) as in the current sera.

Patient 2 was ruled out as a case of measles and therefore was not part of this cluster. Serological evidence (IgG) indicated that the patient was fully protected against measles after being vaccinated as a child, probably with two doses, and her symptoms and signs must have been due to a different viral infection.

Another suspected case (Patient 3) was notified on 1 April in a healthcare worker involved in the care of the index case. According to her self-reported vaccination status she was vaccinated once and was thus allowed to care for Patient 1. When in contact with patients she was always wearing a mask. She was tested for immunity to measles on 16 March (together with other staff members exposed to the index case at his admission) and was found IgG-negative. Nevertheless, she was not excluded from work. She was not vaccinated against measles at that time because she had mild conjunctivitis and herpes labialis (already on 15 March).

On 23 March Patient 3 reported fever, cough and coryza. She noticed a few papulae on her neck and forehead on

TABLE

Patients notified to the National Institute of Public Health of Slovenia as suspected measles cases, Slovenia, March 2010 (n=4)

Patient	Status/case classification	Sex, age	Onset of illness	Laboratory results (date of sample taken)
1	Index case, confirmed	Male, 19	11 March	IgG neg, IgM neg (11 March)IgG neg, IgM pos (13 March) IgG pos, IgM pos (19 March) PCR pos (11 March) Genotype D4
2	Not confirmed, excluded	Female, 30	23 March	IgG pos, IgM neg (23 March) IgG pos, IgM neg (25 March) PCR neg (23 , 24 and 25 March)
3	Secondary case, confirmed	Female, 39	23 March	IgG neg (16 March) IgG pos, IgM borderline (27 March) PCR neg (8 April)
4	Secondary case, confirmed	Male, 54	23 March	IgM pos, IgG pos (1 April) PCR pos (1 April) Genotype D4

25 and 26 March and some abdominal papulae on 27 March. A sample taken on 27 March resulted positive for measles-specific IgG (8,800 IU/mL) and borderline for IgM. She stayed at home for a week from 29 March to 2 April. Throat swab and urine specimens taken on 8 April were PCR-negative (Table).

On 2 April, NIPH was notified of a man in his 50s (Patient 4) diagnosed with measles at CID on 1 April. He had visited his physician on 23 March with high fever and malaise. As his condition did not improve he returned on 30 March and was referred to CID due to high gamma glutamyltransferase levels, high levels of C-reactive protein and elevated liver transaminase levels, where he presented on 31 March. Measles was suspected on 1 April, when a typical rash appeared. He had noticed the rash on his neck already on 30 March but not payed attention to it. It was assumed from his age that he was not vaccinated against measles and he did not recall having had the disease as a child. The diagnosis was confirmed by serology (positive IgM and IgG) and by positive PCR of the throat swab taken on 1 April. Genotyping was performed at the RKI and showed 100% agreement with the sequence from the MV of Patient 1 (Table).

Between 12 and 21 March (after the isolation of Patient 1), this patient had been visiting twice a day a relative who was hospitalised on the same ward as the index case. He did not travel during or shortly before the incubation period and had no known contact with measles cases. He lives with his wife who had measles in childhood; other members of the family were vaccinated against measles according to the vaccination programme.

An alert was issued on 13 March through the Early Warning and Response System (EWRS) following the diagnosis of the index case. On 2 April the NIPH informed paediatricians and general practitioners about the outbreak through regional epidemiologists; information about measles cases was also published at NIPH website. Guidance for healthcare workers was prepared; an algorithm for the management of measles cases was published on the NIPH website (http://sm146.slohosting.com/Planet/?ni=150&pi=5&_5_Filename=1246.pdf&_5_MediaId=1246&_5_AutoResize=false&pl=150-5.3.).

Discussion

We describe a nosocomial cluster in a highly vaccinated population of Slovenia. Different manifestations of measles were observed, depending on the vaccination status of the patients.

Fortunately, measles in the index case was suspected even before the typical clinical picture appeared. Thus, control measures could have been implemented in time. However, despite this, transmission to two individuals occurred in the hospital setting. The index case was placed in a single room with anteroom in droplet isolation. No air condition was in place. All healthcare workers who were exposed to the index case at admission were tested for immunity against measles and offered vaccination if measles-specific IgG test was negative, but they were not excluded from work. Documented evidence of measles vaccination was not available for all healthcare workers.

It is obvious that Patient 3 was infected by the index case. As she reported to be vaccinated once, but tested negative for measles-specific IgG, she should have been considered a vaccine failure case (primary or secondary) Nevertheless, she was not excluded from work despite her susceptibility and exposure history. The observed rapid IgG antibody response could have been due to secondary immune response [5,6]. Rising measles-specific IgG in the absence of IgM in vaccinated cases has been described before [7]. Due to clinical presentation (mild measles) and antibody dynamics, Patient 3 was classified as a case of measles due to vaccine failure. According to some authors, most measles cases in a highly vaccinated population represent vaccine failure and are vaccine-modified cases with a lower transmission potential [8,9]. Although it is not very clear whether individuals with a mild illness who do not display the full range of clinical signs of measles are capable of transmitting the virus to susceptible persons, early detection of measles cases especially in healthcare workers is important so that appropriate infection control measures can be implemented in time to reduce the risk of nosocomial transmission.

It is not clear how Patient 4 was infected. To our knowledge, he had no direct contact with the index case. It is not very probable that Patient 3 was the source of infection because the illness in both cases was reported to start almost simultaneously. There is a possibility of indirect transmission from the index case.

In case of suspected measles in a hospital setting it is important to identify susceptible staff (without evidence of vaccination with two doses or laboratory evidence of immunity) who should be excluded from contact with suspected cases. Screening of immunity should be considered. Only staff with documented measles immunity should provide care to a suspected measles case.

Conclusion

This small outbreak clearly demonstrated the importance of implementing all appropriate control measures in healthcare settings. In addition, high measles vaccination coverage and strong surveillance remain critical to prevent future outbreaks.

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Notes

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Austria

Mitteilungen der Sanitätsverwaltung
Bundesministerium für Gesundheit Familie und Jugend, Vienna.
Monthly, print only. In German.
http://www.bmgfj.gv.at/cms/site/thema.html?channel=CH0951

Belgium

Vlaams Infectieziektebulletin
Department of Infectious Diseases Control, Flanders.
Quarterly, print and online. In Dutch, summaries in English.
http://www.infectieziektebulletin.be

Bulletin d'information de la section d'Epidémiologie
Institut Scientifique de la Santé Publique, Brussels
Monthly, online. In French.
http://www.iph.fgov.be/epidemio/epifr/episcoop/episcoop.htm

Bulgaria

Bulletin of the National Centre of Infectious and Parasitic Diseases, Sofia.
Print version. In Bulgarian.
http://www.ncipd.org/

Cyprus

Newsletter of the Network for Surveillance and Control of Communicable Diseases in Cyprus
Medical and Public Health Services, Ministry of Health, Nicosia
Biannual, print and online. In Greek.
http://www.moh.gov.cy

Czech Republic

Zpravy CEM (Bulletin of the Centre of Epidemiology and Microbiology)
Centrum Epidemiologie a Mikrobiologie Státního Zdravotního Ústavu, Prague.
Monthly, print and online. In Czech, titles in English.
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Denmark

EPI-NEWS
Department of Epidemiology, Statens Serum Institut, Copenhagen.
Weekly, print and online. In Danish and English.
http://www.ssi.dk

Finland

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Department of Infectious Disease Epidemiology, National Public Health Institute, Helsinki.
Monthly, print and online. In Finnish.
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France

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Germany

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Robert Koch-Institut, Berlin
Weekly, print and online. In German.
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Hungary

Epinfo (az Országos Epidemiológiai Központ epidemiológiai információs hetilapja)
National Center For Epidemiology, Budapest.
Weekly, online. In Hungarian.
http://www.oek.hu/oek.web?to=839&nid=41&pid=7&lang=hun

Iceland

EPI-ICE
Landlæknisembættið
Directorate Of Health, Seltjarnarnes
Monthly, online. In Icelandic and English.
http://www.landlaeknir.is

Ireland

EPI-INSIGHT
Health Protection Surveillance Centre, Dublin.
Monthly, print and online. In English.
http://www.ndsc.ie/hpsc/EPI-Insight

Italy

Notiziario dell'Istituto Superiore di Sanità
Istituto Superiore di Sanità, Reparto di Malattie Infettive, Rome.
Monthly, online. In Italian.
http://www.iss.it/publ/noti/index.php?lang=1&tipo=4

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Istituto Superiore di Sanità, Reparto di Malattie Infettive, Rome.
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http://www.epicentro.iss.it/ben

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Epidemiologijas Bileteni
Sabiedribas veselibas agentura
Public Health Agency, Riga.
Online. In Latvian.
http://www.sva.lv/epidemiologija/bileteni

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Užkreciamuju ligu profilaktikos ir kontroles centras
Center for Communicable Disease Prevention and Control, Vilnius.
Online. In Lithuanian.
http://www.ulac.lt/index.php?pl=26

Netherlands

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Rijksinstituut voor Volksgezondheid en Milieu
National Institute of Public Health and the Environment, Bilthoven
Monthly, print and online. In Dutch.
http://www.rivm.nl/infectieziektenbulletin

Norway

MSIS-rapport
Folkehelseinstituttet, Oslo.
Weekly, print and online. In Norwegian.
http://www.folkehelsa.no/nyhetsbrev/msis

Poland

Meldunki o zachorowaniach na choroby zakazne i zatruciach w Polsce
Panstwowy Zaklad Higieny,
National Institute of Hygiene, Warsaw.
Fortnightly, online. In Polish and English.
http://www.pzh.gov.pl/epimeld/index_p.html#01

Portugal

Saúde em Números
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Direcção-Geral da Saúde, Lisbon.
Sporadic, print only. In Portuguese.
http://www.dgs.pt

Romania

Info Epidemiologia
Centrul pentru Prevenirea si Controlul Bolilor Transmisibile,
National Centre of Communicable Diseases Prevention and Control, Institute of Public Health, Bucharest.
Sporadic, print only. In Romanian.
http://www.cpcbt.ispb.ro

Slovenia

CNB Novice
Inštitut za varovanje zdravja, Center za nalezljive bolezni, Institute of Public Health, Center for Infectious Diseases, Ljubljana.
Monthly, online. In Slovene.
http://www.ivz.si/index.php?akcija=podkategorija&p=89

Spain

Boletín Epidemiológico Semanal
Centro Nacional de Epidemiología, Instituto de Salud Carlos III, Madrid.
Fortnightly, print and online. In Spanish.
http://www.isciii.es/jsps/centros/epidemiologia/boletinesSemanal.jsp

Sweden

EPI-aktuellt
Smittskyddsinstitutet, Stockholm.
Weekly, online. In Swedish.
htpp://www.smittskyddsinstitutet.se/publikationer/smis-nyhetsbrev/epi-aktuellt

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England and Wales
Health Protection Report
Health Protection Agency, London.
Weekly, online only. In English.
http://www.hpa.org.uk/hpr

Northern Ireland
Communicable Diseases Monthly Report
Communicable Disease Surveillance Centre, Northern Ireland, Belfast.
Monthly, print and online. In English.
http://www.cdscni.org.uk/publications

Scotland
Health Protection Scotland Weekly Report
Health Protection Scotland, Glasgow.
Weekly, print and online. In English.
http://www.hps.scot.nhs.uk/ewr/index.aspx

Other journals

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Published four times a year in English and Russian.
http://www.epinorth.org

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"Europa" is the official portal of the European Union. It provides up-to-date coverage of main events and information on activities and institutions of the European Union.
http://europa.eu

European Commission - Public Health
The website of European Commission Directorate General for Health and Consumer Protection (DG SANCO).
http://ec.europa.eu/health/index_en.htm

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