Epidemiol. Infect. (2009), **137**, 1593–1601. © Cambridge University Press 2009
doi:10.1017/S0950268809002520 Printed in the United Kingdom

Outbreak of measles and rubella in refugee transit camps

I. K. KOUADIO[1], A. K. KOFFI[2], H. ATTOH-TOURE[3], T. KAMIGAKI[1] AND H. OSHITANI[1]*

[1] *Department of Virology, Tohoku University Graduate School of Medicine, Sendai, Japan*
[2] *Department of Health Policy Science, Tokyo Medical and Dental University Graduate School of Medical and Dental Science, Tokyo, Japan*
[3] *Department of Research and Training, National Institute of Public Hygiene, Abidjan, Côte d'Ivoire*

(*Accepted 4 March 2009; first published online 20 April 2009*)

SUMMARY

In 2004, concurrent measles and rubella outbreaks occurred in four camps hosting 2767 Liberian refugees in Côte d'Ivoire. Sixty rash and fever cases were identified. From 19 January to 23 February 2004 (weeks 8–13), measles IgM testing showed that 61·1% were positive. The highest incidence rate (18·5%) of measles was observed in children aged <9 months. Ninety-three percent of children aged between 6 months and 15 years received a measles vaccine during week 13, but the rash and fever cases continued to occur. This prompted a systematic test for both measles and rubella IgM antibodies. Rubella IgM testing revealed 74·0% positive cases between 14 February and 25 April (weeks 11–21). The highest incidence rate (3·88%) of rubella was found in children aged between 5 and 15 years. Supplemental immunization with a measles-mumps-rubella (MMR) vaccine was conducted during week 20. This study illustrates the importance of testing for both measles and rubella in outbreaks of rash and fever in refugee settings.

Key words: Measles, outbreak, refugee, rubella, surveillance.

INTRODUCTION

Measles is an acute viral disease. Although a vaccine has been available since 1959 [1], measles still remains an important cause of morbidity and mortality in children, particularly in developing countries [2–4]. In 2000, measles was estimated to have been responsible for the deaths of 777 000 children worldwide, representing about half of the deaths attributed to vaccine-preventable diseases [5]. Measles outbreaks have been reported in refugee and emergency settings [6–8] due to mass population displacement, high population density and low vaccination coverage [9, 10]. For the regional elimination of measles, the World Health Organisation (WHO) and the United Nations International Children's Emergency Fund (UNICEF) advise attaining a high routine vaccination coverage of >90% in every community and ensuring that all children have a second opportunity for measles immunization [11]. Although there are effective measles control strategies [12, 13], case-fatality rates as high as 34% have been reported in refugee settings, while similar rates in stable populations are around 1% [14, 15]. In refugees and internationally displaced populations, WHO and UNICEF recommend vaccinating children aged

* Author for correspondence: Professor H. Oshitani, M.D., Ph.D., MPH, Department of Virology, Tohoku University Graduate School of Medicine, Sendai, Japan.
(Email: oshitanih@mail.tains.tohoku.ac.jp)

between 6 months and 14 years with a coverage >95%; however, they also advise that the age group to be targeted during such a campaign should be determined based on the local epidemiology of the disease [12]. They also recommend that improvements in case management and surveillance are made to reduce morbidity and mortality associated with this disease.

Rubella is also a viral disease that occurs worldwide with a seasonal pattern and cyclic epidemics every 5–9 years. It is normally a mild disease that occurs in childhood; however, infection during early pregnancy can cause congenital rubella syndrome (CRS) characterized by multiple defects, particularly cardiac, cerebral, ophthalmic and auditory. Differential diagnosis of measles and rubella without laboratory confirmation can be difficult, because both diseases have similar clinical symptoms [16]. Fewer than half of developing countries have introduced rubella immunization into their national immunization programmes [17]. Rubella vaccines for childhood immunization are used only in the private sector in many countries, including regions where rubella is not a formal part of the immunization programmes [18]. WHO recommends the elimination of rubella and CRS by universally vaccinating infants and young children using measles-rubella (MR) or measles-mumps-rubella (MMR) vaccines, implementing surveillance, and ensuring immunity in women of child-bearing age [18].

Regional conflicts can lead to the displacement of large populations into temporary settlements or camps. The overcrowded and rudimentary shelters, and the inadequate safe water and sanitation increase the risk of infectious disease proliferation [19]. A number of studies on measles have been conducted; however, few have investigated disaster and displaced populations associated with the disease. The present study describes the epidemiology of concurrent measles and rubella outbreaks in Côte d'Ivoire transit camps (TCs) for Liberian refugees during 2003–2004. It also describes the investigation and experience of a diseases surveillance team (DST) that provided advice to decision makers and public health officials throughout the surveillance and outbreak investigation.

MATERIALS AND METHODS

Background, location and population

Since 1995, West Africa has been the region most affected by conflicts in Africa [19]. Internal conflicts in Liberia, Sierra Leone, Guinea–Bissau, Guinea, Côte d'Ivoire, Nigeria, Togo and the Casamance Province of Senegal, have resulted in the displacement of millions of people with significant adverse effects on human health [20]. Côte d'Ivoire is located in West Africa and is bordered by Liberia to the west. Since 1989, about 70 000 refugees have fled from Liberia to Côte d'Ivoire to escape civil war. They were transferred from the western border areas of Tabou and San Pedro (Fig. 1*a*) where most of them had been living in large camps or villages, to TCs in Abidjan. The refugees were to be resettled in the USA in 2003–2004 by the International Organization for Migration. A total of 5427 Liberian refugees were distributed into 19 TCs in four municipalities: 13 TCs in Cocody, three in Abobo, two in Koumassi and one in Marcory (Fig. 1*b*). Compared to normal refugee camps, these TCs had better overall living conditions. Food, clean water and toilet facilities were available, and there was a health unit in each TC supported by two non-governmental organizations (NGOs). Yobou, Biabou, Palmeraie and Eucalyptus TCs were cramped and often overcrowded. Several family groups were living together and sharing rooms and toilets with less than optimal sanitary conditions. Residents of these TCs often visited other TCs. In addition, Biabou and Yobou were continually receiving new refugees. The outbreak of rash and fever started on 19 January 2004. This was 4 days after the first case was detected in the border area prior to the arrival of new refugees at the TCs. Measles and rubella vaccines had not been given to any refugees in the camps prior to outbreaks occurring in Yobou, Biabou, Palmeraie and Eucalyptus TCs (Fig. 1*b*). Therefore our analysis includes a total of 2767 Liberian refugees living in the four affected TCs.

Study and surveillance period

To minimize the potential for the refugees to transmit infectious diseases in camps and during the resettlement process, a DST was established. The aim of the DST was to perform active surveillance in order to detect cases in the early phase and to take timely control action. We documented the results of measles and rubella surveillance from 1 December 2003 (week 1) to 28 June 2004 (week 30). During this period, the DST, consisting of medical doctors and nurses, performed daily surveillance in each TC. Cases were also reported from the health unit established in each camp. A suspect measles case was defined as a refugee,

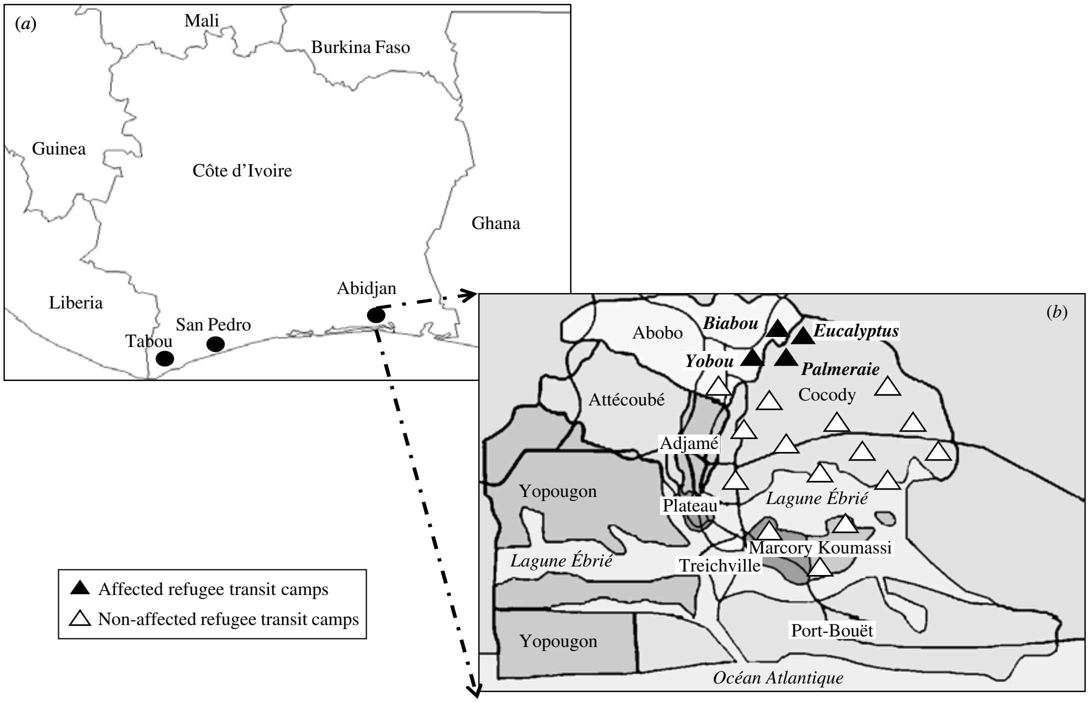

Fig. 1. (*a*) Map of Côte d'Ivoire: Liberian refugees lived in border-country area of Tabou and San Pedro in large camps or villages before being convoyed to Abidjan transits camps (TCs). (*b*) Distribution of the 19 TCs hosting Liberian refugees in Abidjan: the four affected TCs (Biabou, Yobou, Eucalyptus, Palmeraie) were located in two municipalities (Abobo and Cocody).

identified by the DST or a camp health unit, who had a generalized maculopapular rash and high-grade fever ($\geqslant 38$ °C). There was no separate clinical case definition to detect rubella. The same case definition for measles was also used to detect rubella cases. An active-case search was conducted family-by-family and each person was checked and screened individually based on family lists. For those people that were absent, follow-up was done over the next days to ensure that there were no unreported cases. A standardized questionnaire was used to collect information from patients, including demographical, epidemiological and clinical information from the camps. If suspect cases of infectious diseases were detected and reported, further investigations were conducted immediately. A meeting was held every day after the surveillance activities to share updates on the situation in the camps, to discuss suspect cases reported, and to make further decisions. Appropriate actions were taken for suspected cases, including isolation, laboratory confirmation, and treatment. When necessary, affected camps were placed in quarantine and scheduled flights for refugee resettlement were postponed. Every case was reported and investigated immediately. All resulting data was kept and maintained in a comprehensive database established by the DST. The information was disseminated during a weekly coordination meeting held at the United Nations High Commissioner for Refugees office in Abidjan and included all partners in the project. This active and comprehensive surveillance system was established and maintained throughout the surveillance period (December 2003 to June 2004).

Laboratory confirmation and case management

Blood specimens from the cases were collected and transported to the Institut Pasteur in Côte d'Ivoire for measles IgM detection by Enzygnost-EIA (Dade Behring, Germany) from 19 January 2004 (week 8). Laboratory testing for rubella IgM (Enzygnost-EIA) and IgG (Microwell-ELISA; Abbott, USA) was reported from 14 February 2004 (week 11). All confirmed cases were monitored and the patients were treated at the TCs or at the health department until they recovered. A measles control and prevention education programme was also provided to families whenever a case was detected. Families were encouraged to adopt certain principles, e.g. bringing sick children to the health facility for treatment, bringing healthy children for immunization and separating sick children from the others in order to reduce the risk of transmission. Mothers were educated to continue feeding and breastfeeding to prevent their children from developing vitamin A deficiency.

Vaccination campaign

In response to the outbreaks, two mass vaccination campaigns targeting children aged between 6 months and 15 years were held at all TCs. The outbreak started from week 8. Once the decision to vaccinate was approved, a vaccination team was established to plan and conduct the vaccination campaign. The team included personnel from the DST, the local health official and health officers from a local NGO. Social mobilization in camps was undertaken by involving the refugees' community leaders in their social activities. The measles vaccination campaign was conducted from 26 February to 4 March 2004 (week 13) and targeted children aged between 6 months and 15 years. A meeting was held every day at the end of the vaccination activities to review progress and address problems arising. The second vaccination campaign was conducted from 13 to 20 April 2004 (week 20) using MMR vaccines.

Data analysis

Demographical and epidemiological data as well as laboratory results were recorded using Microsoft Excel 2000 (Microsoft, USA) and analysed with Epi-Info version 6 (Centers for Disease Control and Prevention, USA) software.

RESULTS

Refugee population characteristics

Biabou and Yobou TCs were the most populated with 1365 (49·3 %) and 773 (27·9 %) residents, respectively. The majority of the population was male (54·6 %). The age range was 0–102 years and the mean age was 23 years. There were 402 (14·4 %) children aged <5 years and 37·7 % aged <15 years. In total, 60 rash and fever cases were identified during the surveillance period (weeks 1–30).

Measles

Up to week 13, 11/18 samples (61·1 %) tested for measles IgM antibody, were positive. A total of 58 blood samples were tested for measles IgM antibody during the surveillance period, of which 11 (19·0 %) were positive (Table 1). The serologically confirmed measles cases were reported from Eucalyptus, Biabou and Yobou TCs with Eucalyptus having the highest incidence rate (4·05 %). The mean age for the confirmed measles cases was 3·8 years and ranged from 5 months to 11 years. The highest incidence rate (18·5 %) was reported in children aged <9 months (Table 2). The cases included eight females and three males. The measles outbreak lasted for 6 weeks, from 19 January to 23 February (weeks 8–13), without any particular peak (Fig. 2). The first vaccination campaign was conducted from 26 February to 4 March 2004 (week 13), using only the measles vaccine. This vaccination campaign was implemented 6 weeks after the outbreak started. Most (92·9 %) of the target population (6 months–15 years) were vaccinated. The vaccination coverage was lowest (88·2 %) in the specific group of children aged <9 months (Table 3). Eucalyptus TC had a coverage of 82·1 % which was the lowest of the TCs (Table 3). No serologically confirmed measles cases were detected from the remaining suspected cases following this immunization campaign (Fig. 2).

Table 1. *Clinical sample details of measles and rubella cases of Liberian refugees in transit camps in Abidjan, 1 December 2003–28 June 2004*

		Measles		Rubella	
Weekly Evolution (week no.)	Rash and fever	Blood sample tested	Measles positive	Blood sample tested	Rubella positive
1–7	0	0	—	0	—
8	1	1	1/1	0	—
9	3	3	3/3	0	—
10	1	1	1/1	0	—
11	6	5	3/5	5	1/5
12	3	3	2/3	2	0/2
13	5	5	1/5	4	2/4
14	5	5	0/5	4	2/4
15	6	5	0/5	4	4/4
16	3	3	0/3	3	3/3
17	1	1	0/1	1	1/1
18	10	10	0/10	8	8/8
19	7	7	0/7	7	7/7
20	7	7	0/7	6	5/6
21	2	2	0/2	2	1/2
22–30	0	0	0	0	0
Total	60	58	11/58	46	34/46

https://doi.org/10.1017/S0950268809002520 Published online by Cambridge University Press

Table 2. *Serologically confirmed cases of measles and rubella in Liberian refugees aged <15 years in transit camps in Abidjan, 2003–2004*

Population	No.	Rash and fever cases	Serologically confirmed measles(+)/ incidence rate	Serologically confirmed rubella(+)/ incidence rate
Age range				
0–<9 months	27	6	5 (18·5 %)	0 (0·00 %)
9 months–<1 year	35	0	0 (0·00 %)	0 (0·00 %)
1–<5 years	340	15	2 (0·59 %)	9 (2·65 %)
5–<15 years	645	39	4 (0·62 %)	25 (3·88 %)
Total	1047	60	11 (1·05 %)	34 (3·25 %)
Transit camps				
Biabou	448	23	1 (0·22 %)	16 (3·57 %)
Yobou	314	27	4 (1·27 %)	15 (4·78 %)
Eucalyptus	148	8	6 (4·05 %)	1 (0·68 %)
Palmeraie	137	2	0 (0·00 %)	2 (1·46 %)
Total	1047	60	11 (1·05 %)	34 (3·25 %)

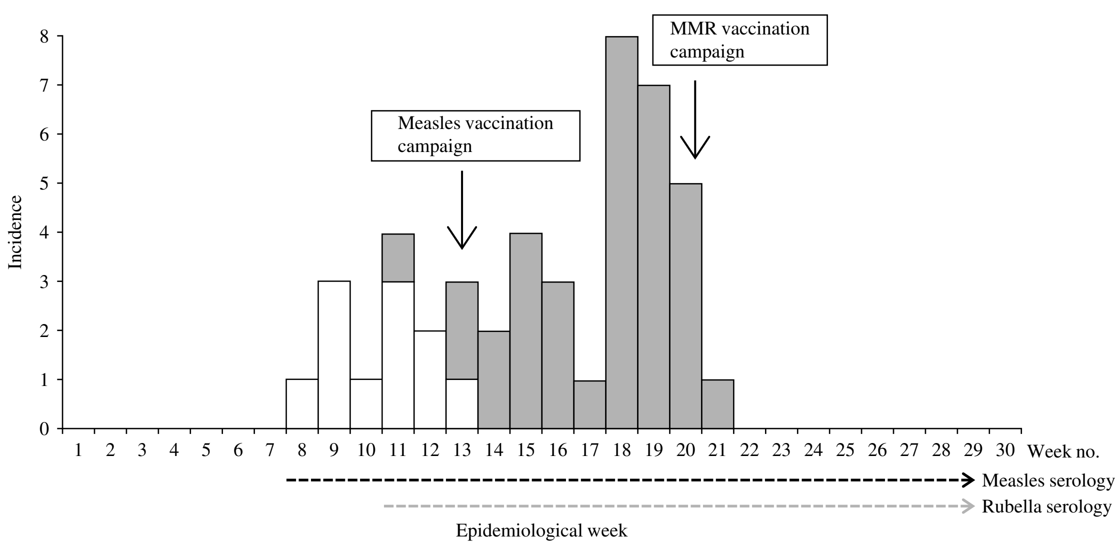

Fig. 2. Weekly evolution of serologically confirmed cases of measles (□) and rubella (■) in the affected transit camps (1 December 2003 to 28 June 2004).

Rubella

Up to week 13, 3/11 samples (27·3 %) tested for rubella IgM antibody, were positive. A total of 46 samples were tested during the entire surveillance period, of which 34 (74·0 %; 18 females, 16 males) were positive (Table 1). Confirmed rubella cases were reported from four camps, Biabou, Yobou, Eucalyptus and Palmeraie (Table 2). The highest incidence rate was reported in Yobou (4·78 %). The mean age of confirmed cases was 6·7 years and ranged from 1 to 14 years with the highest incidence rate in children aged between 5 and 14 years of age (Table 2). The rubella outbreak lasted for 11 weeks, from 14 February to 25 April 2005 (weeks 11–21). A peak was observed during week 18 with six cases reported in Yobou (Fig. 2). A supplementary MMR immunization campaign was conducted during week 20 with a reported coverage of 66·9 %. The highest coverage (94·1 %) was reported for children aged <9 months, and coverage in the Palmeraie camp (85·2 %) was the highest (Table 3).

Eucalyptus had reported the highest incidence rate of measles (4·05 %), and the lowest incidence rate of

Table 3. *Summary of the two mass-vaccination campaigns targeting Liberian children aged 6 months–15 years in transit camps in Abidjan between March and April 2004*

	Biabou		Yobou		Eucalyptus		Palmeraie			
	Pop. target	Pop. vaccinated	Pop. target	Pop. vaccinated	Pop. target	Pop. vaccinated	Pop. target	Pop. vaccinated	Total pop. target	Total pop. vaccinated
First vaccination campaign using measles vaccine										
Age range										
6–<9 months	9	9	6	4	0	0	2	2	17	15 (88·2 %)
9 months–<1 year	8	8	5	4	1	0	3	3	17	15 (88·2 %)
1–<5 years	226	212	51	46	39	39	30	27	346	324 (93·6 %)
5–15 years	383	368	128	118	83	62	80	78	674	626 (92·9 %)
Total	626	597 (95·4 %)	190	172 (90·5 %)	123	101 (82·1 %)	115	110 (95·7 %)	1054	979 (92·9 %)
Second vaccination campaign using MMR vaccine										
Age range										
6–<9 months	9	8	6	6	0	0	2	2	17	16 (94·1 %)
9 months–<1 year	9	4	5	1	1	0	3	3	18	8 (44·4 %)
1–<5 years	226	128	51	36	39	23	30	24	346	211 (61·0 %)
5–15 years	383	242	128	109	83	51	80	69	674	471 (69·9 %)
Total	627	382 (60·9 %)	190	152 (80·0 %)	123	74 (60·2 %)	115	98 (85·2 %)	1055	706 (66·9 %)

rubella (0·68 %). From weeks 11–13, both measles and rubella cases were detected in refugees (Fig. 2). No fatality was reported during this investigation.

DISCUSSION

We documented concurrent measles and rubella outbreaks that occurred in 2004 in four TCs for Liberian refugees in Côte d'Ivoire. Measles and rubella are endemic in many countries in sub-Saharan Africa where vaccination coverage is usually low [21–25]. There are a variety of risk factors for the spread of measles and rubella in displaced populations, which include poor vaccination coverage in countries affected by conflicts [11], international spread of these diseases that occurs during mass migration and high refugee population densities in camps [19]. During the resettlement process, refugees may spread the measles virus to other international travellers [26] thus facilitating the re-introduction of measles into countries where it had been previously eliminated [27].

This outbreak occurred initially in Liberian refugees who were convoyed into TCs in Abidjan from large camps in border-country areas from where the index case was detected. They were not vaccinated upon arrival at the TCs and had contacted a poorly vaccinated community with unknown vaccination status. Ninety-seven percent of the total rash and fever cases were reported from Biabou, Yobou and Eucalyptus TCs, which continually accepted newly convoyed refugees. A continuous flow of new refugees might facilitate the introduction of these diseases [10]. Existing guidelines advise early vaccination of refugees upon arrival at camps [28]. The TCs were located in close proximity to each other and the frequent visits that occurred among them may have also contributed to the increased disease incidence.

WHO reported that MMR vaccine coverage in 2004 was only 49 % in Côte d'Ivoire and 42 % in Liberia [29]. Camps were located within the city of Abidjan and Liberian refugees had close contact with the neighbouring Ivorian community. Therefore, future interventions should include a simultaneous MMR immunization campaign that is instituted in refugee camps and in surrounding communities as a common effort between international NGOs and local public health authorities. Similar to other studies, most of the measles cases (5/11, 45·5 %) were detected in children aged <9 months [1, 30–32], suggesting that measles vaccine should be provided for this age group in such populations [12]. Furthermore, a second dose of measles vaccine should be given at age 9 months due to the increased likelihood of primary vaccination failure in younger children in whom maternal antibodies are retained [33]. This outbreak did not include older measles cases although they have been identified in other investigations [10, 34].

Most of the rubella cases (25/34, 73·5%) occurred in children aged 5–14 years. This contrasts with studies from African countries that report rubella is more likely to occur early in life and that >80% of children are immune by age 10 years [35]. In Turkey, rubella antibodies were present in 38% of children aged 1–4 years [36]. The preponderance of rubella in young children in this study may be due to the limited exposure to infection of refugees who usually live in remote areas. In many developing countries, as well as in disaster situations, there are a limited number of laboratories that can serologically confirm a disease. Because measles may present with symptoms similar to many other exanthematous diseases (including rubella), and diagnoses are often made based on clinical data alone, there is an increased risk of misdiagnosis. In fact, a high percentage of suspected measles cases are identified as rubella in countries considered to be in a measles-elimination phase [16].

In our investigation, serological testing performed up to week 13 resulted in a higher positive rate for measles IgM (61·1% positive) than for rubella IgM (27·3% positive). As a result, the decision to immunize only against measles was made because the vaccine was readily available and much cheaper than the MMR. Following this immunization campaign, there were no further confirmed measles cases in the remaining patients with rash and fever, but there were an increasing number of confirmed rubella cases. A second vaccination campaign was conducted 2 months later using MMR. Subsequently, there were no further confirmed cases of measles or rubella. If rubella had been serologically confirmed at an earlier stage, together with measles, then the rubella outbreak might have been controlled earlier. This may have led to the appropriate decision to vaccinate initially with MMR in order to terminate the rubella and measles outbreaks. Our study highlights the significance of early laboratory testing for both measles and rubella to confirm the nature of a rash and fever. It also suggests that the MMR vaccine should be given priority in disaster and refugee situations and also in areas with limited laboratory resources. In this case, it may have been more cost-effective to test for measles and rubella earlier, prior to the vaccination campaign [37]. WHO also advise that measles control activities can be used as an opportunity to pursue control of rubella through the use of MR or MMR vaccines [18].

The active and comprehensive surveillance in combination with laboratory testing for measles enabled the detection of the measles outbreak at an early stage. However, the lack of laboratory testing for rubella did not permit early detection of concurrent measles and rubella outbreaks. WHO recommends that coverage >94% is required to prevent an outbreak of measles in displaced populations [12]. In the present study, the measles and rubella outbreaks were successfully controlled after two mass vaccination campaigns targeting children aged from 6 months to 15 years. The outbreak of measles was controlled after the first vaccination campaign with a monovalent measles vaccine (vaccine coverage of 92·9%) while the rubella outbreak was controlled after the second vaccination campaign with a combined MMR vaccine (vaccination coverage of 66·9%). The WHO and UNICEF joint statement for measles mortality reduction in complex emergencies recommends the vaccination of all children aged between 6 months and 14 years plus vitamin A supplementation during emergencies [12]. As a minimum, children aged from 6 months to 4 years must be vaccinated, while vaccine availability, funding, human resources and local epidemiology may influence the target age group [12]. None of the refugees were vaccinated in camps before the outbreak occurred, and the implementation of both vaccination campaigns was delayed. The measles vaccination campaign was implemented 6 weeks after confirmation of the measles outbreak. Trained personnel, vaccines, cold chain equipment and other supplies (syringes, needles, record cards) were not available at the start of the outbreak. There were also a number of administrative and logistical issues to be addressed before the vaccination campaigns began. Even during the campaigns, there were still some obstacles such as lack of cold chain equipment and shortage of vaccines. Measles vaccinations should be given a high priority in emergency relief programmes. Trained personnel, vaccines, cold chain equipment, and other supplies should be available as soon as at-risk individuals begin to gather in camps [38]. Our study indicated that the highest incidence rate of measles was in children aged <9 years (18·5%), but the vaccination coverage (first vaccination campaign) in this specific group was the lowest (88·2%). This is below WHO recommendations. Therefore, based on surveillance data, it will be necessary to prioritize and increase measles vaccination coverage in this age group, particularly in displaced populations. These outbreaks were particularly marked because of the absence of fatalities. This might be due to the active-case-finding approach which functioned quite well by increasing detection, reporting and treating patients at an early stage. Existing studies have documented high case-fatality rates in disaster and refugee settings [4, 6]; in particular, a rate as high as 33% was reported in Ethiopian refugees in Sudanese camps [15]. The involvement of families, community leaders and community health workers from the refugee population, was important in establishing effective surveillance and in mobilizing resources. Moreover, the systematic serological surveillance for both measles and rubella, even though it began late, enabled confirmation of the nature of the second outbreak (i.e. rubella), and implementation of appropriate actions. The present study has presented some interesting aspects of measles and rubella epidemiology in refugee settings and has provided insight for future response and control of outbreaks. However, further research is needed to develop indicators for early warning and surveillance systems in disaster and refugee settings

CONCLUSION

Outbreaks of measles and rubella were detected by the DST in 2003–2004 in Liberian refugees living in overcrowded TCs in Côte d'Ivoire. This active surveillance approach contributed to the successful control of these outbreaks. However, serological testing for both rubella and measles during the early stage of an outbreak and prior to immunization remains critical. Furthermore, it is recommended that vaccination programmes be conducted with MMR rather than with measles vaccine alone, due to the potential misdiagnosis of measles and, for its advantage in the control of rubella and CRS. Routine monitoring of ongoing surveillance data must be considered in order to prioritize camps and to target population age for vaccination strategies in disaster and refugee settings.

ACKNOWLEDGEMENTS

We thank Dr Frank Guttman, Dr Ekissi Alexis, Dr Houffouet Hermann, Dr Kokora Partrice, Bini Jean Claude, Konan Tolla Jean and anonymous persons for the surveillance effort and data collection. We also thank Dr Claude de Ville de Goyet Dr Nobs Roy and Ms Karen Duong for their advice.

DECLARATION OF INTEREST

None.

REFERENCES

1. **Whittle HC, *et al.*** Effect of dose and strain of vaccine on success of measles vaccination of infants aged 4–5 months. *Lancet* 1988; **1**: 963–966.
2. **World Health Organization.** The world health report 1999: making a difference. Geneva, 1999.
3. **Mohan A, *et al.*** Measles transmission following the tsunami in population with a high one dose vaccination coverage, Tamil Nadu, India 2004–2005. *BMC Infectious Diseases* 2006; **6**: 143.
4. **Bosan AH, *et al.*** Measles mortality among Afghan refugees' children. *Pakistan Journal of Medical Research* 2002; **41**: 43.
5. **World Health Organization–United Nations Children's Fund.** Joint statement on strategies to reduce measles mortality worldwide. WHO/V and B/0.1/40, 2001. (http://www.who.int/vaccines-documents/DocsPDF01/www667.pdf). Accessed 20 February 2008.
6. **Porter JDH, *et al.*** Measles outbreaks in Mozambican refugee camps in Malawi: the continued need for an effective vaccine. *International Journal of Epidemiology* 1990; **19**: 1072–1077.
7. **Taylor WR.** Measles in Vietnamese refugee children in Hong Kong. *Epidemiology and Infection* 1999; **122**: 441–446.
8. **Tool MJ, Waldman RJ.** An analysis of mortality trends among refugees population in Somalia, Sudan and Thailand. *Bulletin of the World Health Organization* 1988; **66**: 237–247.
9. **Morley D, Martin W, Allen I.** Measles in east and central Africa. *East African Medical Journal* 1967; **44**: 497–508.
10. **Kamugisha C, Cairn KL, Akim C.** An outbreak of measles in Tanzanian refugee camps. *Journal of Infectious Diseases* 2003; **187** (Suppl. 1): 58–62.
11. **World Health Organization/United Nations Children's Fund.** Measles: mortality reduction and regional elimination strategic plan 2001–2005. WHO/V and B/01.13 March 2003 (http://www.who.int/vaccines-documents/DocsPDF01/www573.pdf). Accessed 26 March 2008.
12. **World Health Organization–United Nations Children's Fund.** Joint statement on reducing measles mortality in complex emergencies. WHO/v and B/0.4.03; 2004. (http://www.unicef.at/fileadmin/medien/pdf/Measles_Emergencies.pdf). Accessed 23 February 2008.
13. **Redd SC, Markowitz LE, Katz SL.** Measles vaccine. In: Plotkin SA, Orenstein WA, eds. *Vaccines*, 3rd edn. Philadelphia, PA: Saunders, 1999, pp. 222–267.
14. **Moore PS, *et al.*** Mortality rate in displaced and resident populations of central Somalia during 1992 famine. *Lancet* 1993; **341**: 935–938.

15. **Shears P, *et al.*** Epidemiological assessment of health and nutrition of Ethiopian refugees in emergency camps in Sudan 1985. *British Medical Journal* 1987; **295**: 314–318.
16. **Ramamurty N, *et al.*** Investigation of measles and rubella outbreaks in Tamil Nadu, India – 2003. *Journal of Medical Virology* 2006; **78**: 508–513.
17. **Banatvala JE.** Rubella – could do better. *Lancet* 1998; **351**: 849–850.
18. **World Health Organization.** Outbreak news: rubella vaccine. *Weekly Epidemiological Record* 2000; **75**: 161–172.
19. **Gayer M, *et al.*** Conflict and emerging infectious diseases. *Emerging Infectious Diseases* 2007; **13**: 11.
20. **Wyndham J.** The challenges of internal displacement in west Africa. Brookings Institution–University of the Bern project on Internal displacement (http://www.fmreview.org/FMRpdfs/FMR26/FMR2639.pdf). Accessed 21 January 2009.
21. **Riddell M, Rota JS, Rota PA.** Review of the temporal and geographical distribution of measles virus genotypes in the pre-vaccine and post-vaccine eras. *Virology Journal* 2005; **2**: 87.
22. **Kouomou DW, *et al.*** Measles virus strains circulating in central and West Africa: geographical distribution of two B3 genotypes. *Journal of Medical Virology* 2002; **68**: 433–440.
23. **El Mubarak HS, *et al.*** Genetic characterization of wild-type measles viruses circulating in suburban Khartoum, 1997–2000. *Journal of General Virology* 2002; **83**: 1437–1443.
24. **Mosquera MM, Ory F, Echevarria JE.** Measles virus genotype circulation in Spain after implementation of the national measles elimination plan 2001–2003. *Journal of Medical Virology* 2005; **75**: 137–146.
25. **Lawn JE, *et al.*** Unseen blindness, unheard deafness, and unrecorded death and disability: congenital rubella in Kumasi, Ghana. *American Journal of Public Health* 2000; **90**: 1555–1561.
26. **Rota J, *et al.*** Identical genotype B3 sequences from measles patients in 4 countries, 2005. *Emerging Infectious Diseases Journal* 2006; **12**: 1779–1781.
27. **Barnett ED, Christiansen D, Figueira M.** Seroprevalence of measles, rubella, and varicella in refugees. *Clinical Infectious Diseases* 2002; **35**: 403–408.
28. **Oxfam GB.** The SPHERE Project: Humanitarian charter and minimum standards in disaster response. Oxford, UK, 1998.
29. **World Health Organization (WHO) database.** Reported estimated of immunization coverage time series (http://www.who.int/immunization_monitoring/en/globalsummary/timeseries/tscoveragebcg.htm). Accessed 8 May 2008.
30. **Ministry of Health of Kenya and the World Health Organization.** Measles immunity in the first year after birth and the optimum age for vaccination in Kenyan children. *Bulletin of the World Health Organization* 1977; **55**: 21–30.
31. **Loenig WEK, Coovadia HM.** Age-specific occurrence rate of measles in urban, peri-urban and rural environments: implication for time of vaccination. *Lancet* 1983; **127**: 788–794.
32. **Taylor WR, *et al.*** The importance of measles in children under nine months in urban Africa. *American Journal of Epidemiology* 1988; **127**: 788–794.
33. **Aaby P, *et al.*** Overcrowding and intensive exposure as determinants of measles mortality. *American Journal of Epidemiology* 1984; **120**: 49–63.
34. **Coronado F, *et al.*** Retrospective measles outbreak investigation: Sudan, 2004. *Journal of Tropical Pediatrics* 2006; **52** (Suppl. 5): 329–334.
35. **Gomwalk NE, Ahmad AA.** Prevalence of rubella antibodies on the African continent. *Reviews of Infectious Diseases* 1989; **11**: 116–121.
36. **Aksit S, *et al.*** Rubella seroprevalence in an unvaccinated population in Izmir: recommendations for rubella vaccination in Turkey. *Pediatric Infectious Diseases Journal* 1999; **18**: 577–580.
37. **Medecin sans Frontiere (MSF).** *Refugee Health: An Approach to Emergency Situations*. London: Macmillan Education Ltd, 1997.
38. **Toole MJ, *et al.*** Measles prevention and control in emergency settings. *Bulletin of the World Health Organization* 1989; **67** (Suppl. 4): 381–388.