Epidemiol. Infect., Page 1 of 5. © 2006 Cambridge University Press
doi:10.1017/S0950268805005716 Printed in the United Kingdom

Exploring the time to intervene with a reactive mass vaccination campaign in measles epidemics

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(*Accepted 18 October 2005*)

SUMMARY

The current WHO policy during measles outbreaks focuses on case management rather than reactive vaccination campaigns in urban areas of resource-poor countries having low vaccine coverage. Vaccination campaigns may be costly, or not timely enough to impact significantly on morbidity and mortality. We explored the time available for intervention during two recent epidemics. Our analysis suggests that the spread of measles in African urban settings may not be as fast as expected. Examining measles epidemic spread in Kinshasa (DRC), and Niamey (Niger) reveals a progression of smaller epidemics. Intervening with a mass campaign or in areas where cases have not yet been reported could slow the epidemic spread. The results of this preliminary analysis illustrate the importance of revisiting outbreak response plans.

INTRODUCTION

Although global incidence has been significantly reduced through vaccination, measles remains an important public health problem. This disease remains the leading vaccine-preventable killer of children worldwide, and is estimated to have caused 614000 global deaths in 2002 with 50% of these occurring in sub-Saharan Africa [1]. The persistence of measles in many African countries indicates the need to further investigate the dynamics of measles epidemics in these areas as well as our approach to epidemic control.

On declaring a measles epidemic, the question of whether to conduct a mass campaign is almost always raised. The current World Health Organization (WHO) recommendations [2], based on a literature review of measles outbreaks from 1963 to 1995 [3], emphasize case management rather than mass vaccination interventions. This is for two main reasons: (1) measles spreads too rapidly within urban areas to allow sufficient time for implementation of a mass vaccination campaign; and (2) as a result of the lost time, the number of prevented cases is low, and thus the resulting cost per prevented case is high [2, 3]. The recommendations conclude that there is insufficient evidence either for demonstrating the positive impact of a reactive vaccination campaign or the usefulness of such a strategy [2]. The WHO recommendations suggest that reactive vaccination campaigns, if implemented, should focus only on areas where infection has not yet occurred, or in closed populations such as those in refugee or military camps, or schools.

There have been few documented successful reactive mass vaccination campaigns in low-vaccination coverage contexts. One such intervention occurred in rural Peru in 1993 [4]. The intervention, targeting all non-measles cases between 6 months and 15 years over a period of approximately 1 week, was

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conducted 35 days after the first cases became ill. There were only two cases reported after the end of the intervention, both in children under 6 months [4]. Its success was attributed to two principal factors. First, before the outbreak, a large proportion of the population was susceptible because of the geographical characteristics of the health district. This meant that prior exposure, whether to measles or vaccination, was unlikely. Second, the households in the village were dispersed, leading to slower transmission.

There may be important lessons from the control strategy applicable to African urban centres where epidemics often occur. In two recent measles outbreaks, one in the city of Kinshasa, Democratic Republic of Congo (DRC) (2002–2003) (population $\sim$5 000 000) and one in the city of Niamey, Niger (2003–2004) (population $\sim$750 000), the medical non-governmental organization Médecins sans Frontières (MSF) documented outbreaks of lengthy duration, suggesting a more complex spatial-temporal spread than previously recognized. The countrywide measles vaccination coverage estimate for DRC prior to the outbreak was 45% and for Niger 64% [5]. The populations of these cities were not distributed evenly and there was limited internal mobility within the city (no public transportation and certain areas having limited mobility due to non-navigable roads). Once measles cases have been identified in one location, the time to intervene in the rest of the city needs to be explored, especially while observing outbreaks lasting more than 20 weeks in each context. A rapidly deployed mass vaccination campaign might have slowed down the spread of the epidemic, but how much time is actually available to intervene with an effective reactive vaccination campaign?

Although some research has been conducted on the spatial-temporal dynamics of measles epidemics in resource-poor settings, research focuses on the most effective routine vaccination strategies, rather than vaccination as an epidemic response option [6–8]. The aim of this research was to explore the amount of time available for intervention with a mass vaccination campaign.

METHOD

We used surveillance data on previously reported cases of measles from Kinshasa and Niamey. Data for the epidemic in Kinshasa comprised of weekly reported cases to the Ministry of Health for the 35 health districts in Kinshasa from January 2002 to February 2003. For the epidemic in Niamey, data comprised of weekly reported measles cases to public health centres and hospitals from November 2003 to July 2004, aggregated for the three communes (districts) in Niamey. Data from Kinshasa was collected prospectively from the beginning of the epidemic. Data was collected retrospectively from public health centres in Niamey for the first 3 months of the outbreak and prospectively until July 2004. For both investigations, the WHO clinical case definition for measles was used. At the beginning of both outbreaks, 10 cases were laboratory confirmed through detection of measles-specific IgM antibodies by the ministries of health of both DRC and Niger. Details on both epidemics have been described elsewhere [9–11]. We considered the first district (in Kinshasa) or commune (in Niamey) where cases were reported to be the index district. The epidemic was considered to have spread to a district if there were two consecutive weeks during which at least one case had been reported.

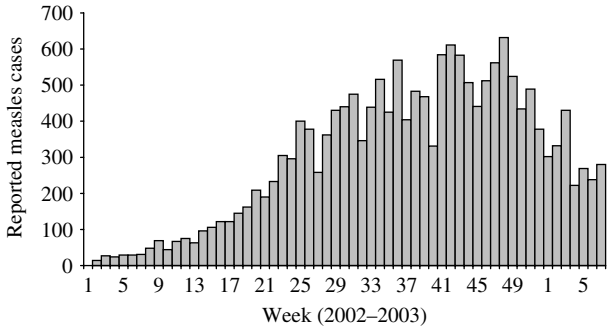

Fig. 1. Reported measles cases in Kinshasa, Democratic Republic of Congo (January 2002–February 2003).

RESULTS

An increase in measles cases was reported in Kinshasa beginning in January 2002 with cases reported throughout the entire year and throughout 2003 (Fig. 1). In total, 17 624 measles cases were reported. The overall attack rate was 0·35% (17 624/5 032 222). Within health districts a median of 414 cumulative cases were reported (range 65–1550). Within 1 week the epidemic spread to two other health districts, and to six health districts during the next 3 weeks, with 10 health districts reporting cases after 6 weeks. Of the remaining health districts, cases did not appear for a mean of 9 weeks later (median 7 weeks) (Fig. 2).

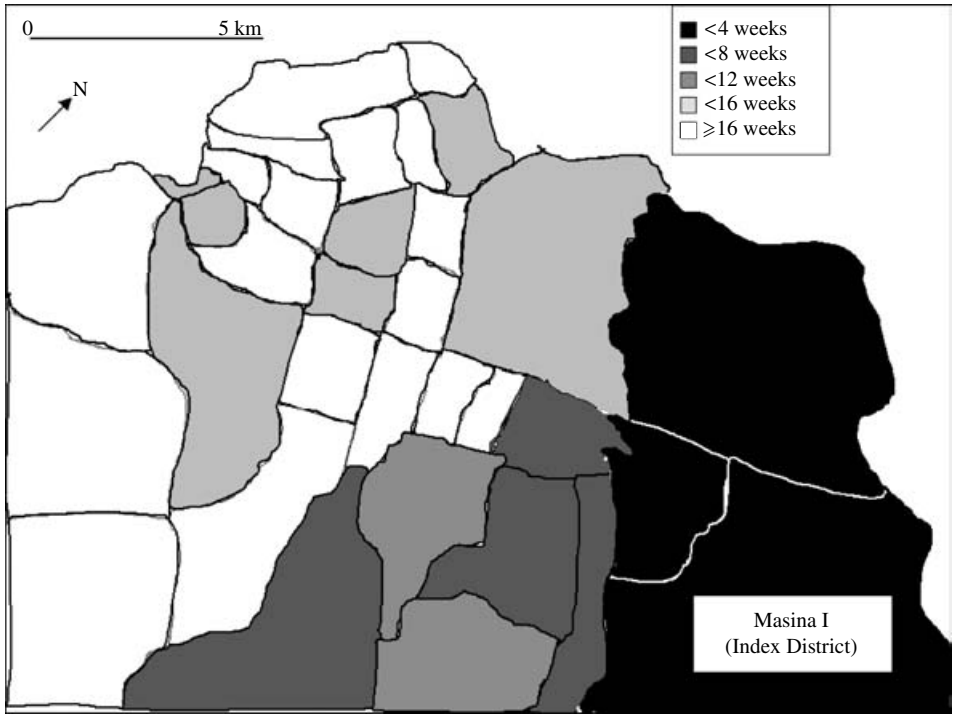

Fig. 2. Map displaying the spatial and temporal progression of reported measles cases in 35 health districts of Kinshasa, 2002–2003. Health districts are coded by the number of weeks cases are first reported (defined as when there are two consecutive weeks with at least one case reported) from the index district in 4-week increments beginning with darker shading and progressing to lighter shading.

The measles epidemic in Niamey started in November 2003 (defined by a sharp increase in reported cases over a period of 3 weeks) with peak cases reported in March 2004. The epidemic began to subside by the end of April 2004. In total, the epidemic lasted 30 weeks. Between November 2003 and July 2004, a total of 10 880 cases were reported. The overall attack rate reached 1·4% (10 880/769 454). At the commune level, 5789 cases were reported in commune 1, 3598 cases in commune 2, and 587 cases in commune 3 (Fig. 3).

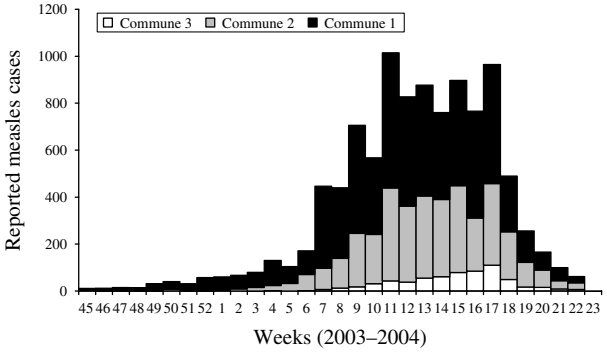

Fig. 3. Reported measles cases in Niamey, Niger (November 2003–July 2004) by commune.

DISCUSSION

The prolonged duration of these two epidemics suggest that there may have been enough time for early intervention with a mass vaccination campaign in Kinshasa or Niamey. Although halting a measles epidemic entirely may be neither realistic nor feasible, the goal of a reactive vaccination intervention after the start of an epidemic in an index area would be to reduce transmission in other parts of the city, which have either not yet been affected or are in an even earlier stage. MSF routinely estimates that 15 days of preparation are required from the decision to perform a mass vaccination campaign and the first dose delivered [12]. During the Niamey epidemic, a vaccination intervention occurred 24 weeks after the beginning of the outbreak targeting 50% of children aged between 6 and 59 months, regardless of vaccination status. For this intervention, 56·9% of children between the ages of 6 and 59 months [84 563 (doses delivered)/148 595 (children between 6–59 months)], regardless of their vaccination status, were vaccinated at health centres in 1 week. This reinforcement activity demonstrates the feasibility of intervening during an

epidemic within a short time and had the intervention occurred earlier in the epidemic it might have averted a significant number of cases. If the intervention had occurred before cases spread to commune 3 (6 weeks after cases were reported in commune 1) it is likely that many of these cases could have been averted. The same holds true for Kinshasa, where there were significant delays in reporting between health districts.

An important second step in assessing the potential success of such a campaign would be to explore patterns of movement within urban areas and to begin to determine the degree of isolation of neighbourhoods. The acquisition of geographic data, such as the boundaries of health sectors, population size and density estimates, as well as additional information on population travel between health districts, is essential in performing further analyses. Similarly, exploring other African urban environments is also a logical next step as population dynamics and the geography of these cities play a critical role in determining whether reactive vaccination interventions are appropriate.

Reported measles cases, while indicating the progress of an epidemic, are likely to underestimate its true extent. Although measles is a well-recognized illness in Kinshasa and Niamey avoiding any serious misclassification problems, only a fraction of cases are likely to be reported. It is important to point out that although measles cases are routinely underestimated in surveillance data, it is this data that would be used to determine whether a measles outbreak was occurring. That is, surveillance data is that used in practice to follow the evolution of measles epidemics in Kinshasa and Niamey and the data used for public-health decision-making. A successful outbreak response intervention depends on the ability of existing surveillance systems to report cases promptly.

Although the slow progression of these two epidemics suggests that current policies could benefit from a second look, there needs to be a public health capacity for rapid intervention with an efficacious vaccination campaign. In practice, these conditions are not necessarily met. Interventions rely on the expertise and resources available from the Ministry of Health and/or medical non-governmental organizations. Logistic constraints, available human resources, community participation, and management of injection safety are among the challenges. In reality, reactive vaccination campaigns are also likely to target all children within a city rather than just specific neighbourhoods for both ethical and logistic reasons. Our primary contribution is to provide a starting point for discussion of some of the public health policy issues surrounding mass vaccination intervention during measles epidemics and to suggest future areas of research. Important questions remain to be addressed including the age range to be targeted during a reactive vaccination campaign.

ACKNOWLEDGEMENTS

This research work was supported by Médecins sans Frontières (MSF). We thank the Ministry of Health of Niger and Democratic Republic of Congo (DRC) for their support during the outbreak investigations and the investigation teams in Niger and DRC for collecting data under difficult conditions. We also thank Dr Benoit Kebela Ilunga of the Department of Epidemiology, Ministry of Health, DRC, Dr Ali Djibo, General Director, Ministry of Public Health, Niger, Dr Bernadette Gergonne, Epicentre, and Dr Michel van Herp of MSF. We also thank A. M. C. Rose and D. L. Smith for their comments and improvements to the manuscript.

DECLARATION OF INTEREST

None.

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