Effect of mass measles vaccination on numbers of measles cases: A hospital experience

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Background. Low measles vaccine coverage has been a characteristic of child health indices in Uganda. A countrywide mass measles vaccination of children from 6 months to 15 years old was undertaken in October 2003 and again in October 2006.

Objective. To describe the effect of mass measles vaccination on the number of measles cases admitted to Mulago Hospital, Kampala, Uganda.

Methods. The study involved a review of documents including ward admission books, patients' case notes, discharge summaries, measles surveillance records, and laboratory reports. Measles cases admitted during the study period were identified by using the World Health Organization (WHO) clinical case definition of measles during epidemic times but, during non-epidemic periods, the case definition had to be supported by positive testing for measles antibodies. The number of measles cases admitted before and after each mass vaccination was documented.

Results. Prior to mass measles campaigns, the mean number of measles cases admitted to Mulago Hospital was 120 per month. Seventy-three per cent of the patients were between 9 and 60 months of age. Two weeks after a campaign, the number of measles cases started falling. Four months after each of the mass campaigns, only a few mild measles cases presented; and, for 2 years subsequently, there were no cases severe enough to warrant hospital admission. The number of measles deaths dropped by 54% and 62%, after the first and second mass immunisations, respectively.

Conclusion. Mass measles vaccinations appear to significantly reduce the number of measles cases admitted to Mulago Hospital. However, the retrospective nature of the study and the lack of serological confirmation of the diagnosis of measles might have introduced bias. The results need confirmation by means of prospective studies.

Measles is an exanthem, caused by an RNA virus of the genus *Morbillivirus* and the family Paramyxovirus.[1] Measles is one of the oldest childhood diseases; the first written record goes back to the 10th century.[2] The introduction of an effective vaccine has brought measles under reasonable control in the many countries where vaccination coverage is high, and the disease usually occurs only as occasional epidemics among schoolchildren.[3-5] However, in developing countries, measles is still one of the top killers of children.[6-8] Sustained (endemic) occurrence of measles and unclear epidemic outbreaks have been noted in places where there is an influx of susceptible (non-immunised) individuals from rural areas.[3] Periodic mass measles vaccination has been recommended as a cost-effective means of disease control.[9]

According to the Uganda National Expanded Program of Immunization (UNEPI), measles vaccine is administered to children at 9 months, and at first medical contact thereafter.[10]

In Uganda, only two-thirds of children <5 years are vaccinated against measles;[11] i.e. one-third remains vulnerable. One of the reasons for the low vaccination coverage in Uganda is the low level of female education.[11] Persistent failure of routine coverage led the Ugandan Ministry of Health, WHO and United Nations Children's Fund (UNICEF) to introduce mass measles vaccination of all children between 6 months and 15 years – first in October 2003 over a 3-day period, and secondly in October 2006, also over 3 days. Apart from the low vaccination coverage in Uganda, the effectiveness of measles vaccine in Kampala was found to be 74%,[12] definitely lower than that expected (>95%) under optimum conditions.[2] It follows that even if 100% vaccination coverage were achieved, a small percentage of children who received the measles vaccine would not develop immunity against measles. Over time, the vulnerable proportion of children grows, creating conditions for a measles outbreak when a case occurs in the community. Passive immunity against measles protects in early infancy but tends to wane after 9 months of age, and sometimes earlier.[13]

The diagnosis of measles is clinical when measles prevalence is high, but requires serological verification in situations of low prevalence.[14] The clinical case definition comprises: fever, a generalised morbiliform skin rash, cough, conjunctivitis or coryza. Other viral diseases may present with signs similar to those of measles; these include: Parvovirus B19, rubella, human herpesvirus 6, Epstein-Barr virus and cytomegalovirus.[15] A child who has suffered from measles sometimes presents to the hospital with complications of measles when the case-defining features have faded. Such a presentation is referred to as post-measles syndrome, a condition of immunosuppression and debility[16] with features of malnutrition, pneumonia, diarrhoea or other infections. A demonstration of high anti-measles immunoglobulin M (IgM) in serum confirms the diagnosis of measles in a patient with post-measles syndrome.

After the first mass measles vaccination in October 2001, when a vaccination coverage of 105% was achieved, it was noted that the measles incidence dropped by 39%, measles admissions by 60%, and measles deaths by 63% in Uganda.[17] A surveillance system was established in the country, Mulago Hospital being one of the sentinel sites. The aim of the measles surveillance was to document all cases of measles in children seen in the hospital by line listing of, and submitting blood from, suspected cases to the Uganda Virus Institute for serological diagnosis of measles using the Elisa test for measles IgM antibodies. However, the data in this study were collected retrospectively and were not from a prospective surveillance.

Objective

The study was intended to describe the effect of mass measles vaccinations on the number of measles cases admitted to Mulago Hospital in Kampala, Uganda.

Methods

The study was a retrospective review of measles cases admitted to Mulago Hospital, which is Uganda's national referral and teaching hospital for the Faculty of Medicine of Makerere University. The hospital is in Kampala, and its catchment area includes the outskirts of the city and other parts of Uganda. Kampala comprises 5 administrative divisions, each served by a health centre and several private health facilities. Each of these carries out on-site vaccination and, to a varying extent, vaccination in outlying parts of their catchment areas. Children <5 years constitute 30% of Kampala's population. There are a number of slums in Kampala, with high population densities and poor living conditions.

All paediatric measles cases brought to Mulago Hospital are first seen in the acute care unit (ACU) for evaluation. Children with complicated measles strains are admitted to the hospital's isolation ward, while non-complicated cases are managed on an out-patient basis. The isolation ward has 20 beds, and children with measles are usually admitted for an average of 5 days. During non-epidemic periods, this ward is used for other medical conditions.

We reviewed the measles hospital admission records for a year preceding the mass measles campaign of 2003 and the subsequent 5 years. The sources of information included: ACU records, ward admission books, patients' case notes, discharge summaries, measles surveillance records and laboratory reports. Cases were recorded consecutively as they were identified in the hospital records.

Before mass measles vaccinations and during epidemics, a measles case was defined according to the WHO/Integrated Management of Childhood Illnesses (IMCI)[18] criteria as any child who presented with fever (by history, feeling hot, temperature ≥37.5°C), general skin rash and either cough, runny nose or red eyes at the time of presentation to Mulago Hospital, or within the previous 3 months. After mass measles vaccination, measles was defined as any suspected case of measles according to the WHO/IMCI criteria. Confirmatory serological tests were reported if they had been requested in the case notes.

Data for each identified case were recorded in a pre-coded questionnaire, and included age, sex, dates of admission and discharge, complications and outcome. Data were reported using absolute numbers of cases seen; percentages were used where appropriate.

Permission to perform the study was obtained from the Mulago Hospital ethics and research committee.

Results

We reviewed the records of measles cases admitted to Mulago Hospital from January 2002 to December 2006. All the reviewed records enabled us to make clinical diagnoses; none of them was excluded from the final analysis. In 2002, 1 460 measles cases were admitted; 721 were boys and 701 girls. During that year, the records showed a range of 84 - 166 admissions (mean 120) each month (Fig. 1). Patients' ages ranged between 2 and 171 months. The most commonly affected age group was that of 9 - 60 months (73%) – the target group for routine vaccination. Twenty-seven per cent of the measles patients were either older or younger than the age group targeted for routine vaccination (Fig. 2). Patients came from all 5 divisions of Kampala District, with the central division contributing the lowest number.

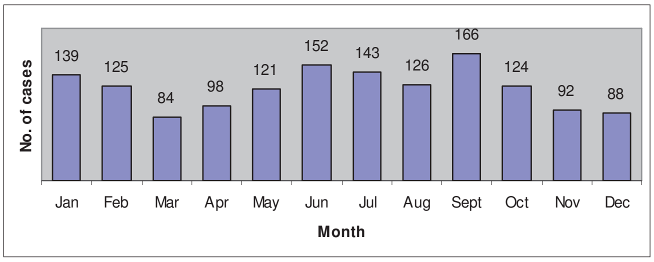

Fig. 1. Paediatric measles cases (N=1 460) admitted to Mulago Hospital in 2002.

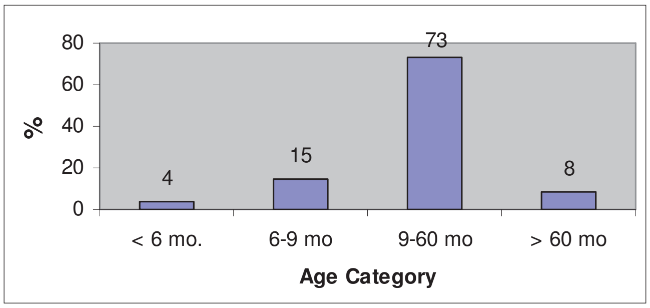

Fig. 2. Age distribution of measles cases admitted to Mulago Hospital in 2002.

After the mass measles campaign of October 2003, the number of measles cases admitted to Mulago Hospital dropped significantly (Fig. 3). Within 2 weeks of the mass vaccination, a fall in the number of measles cases became apparent. Between 26 October and 26 November 2003, there was a 50% drop in measles cases admitted to the hospital (from 90 to 48 cases) compared with each of the preceding months of the year.

The distribution of measles according to age did not change significantly within 3 months after a mass vaccination; all age

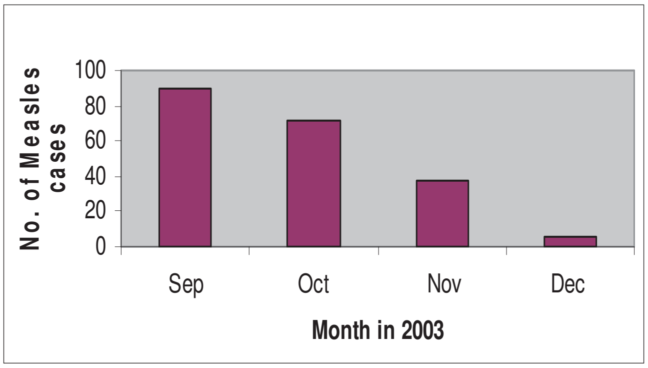

Fig. 3. Measles cases just before and after mass vaccination in October 2003.

groups were still represented, with the 9 - 60-month group predominating.

Measles cases continued to arise from much the same divisions after a mass vaccination as before, with Kampala's central division producing no measles cases, Kawempe division (the most densely populated) producing the majority of cases (19), and 13 cases from outside Kampala district, out of a total of 48 cases.

No measles patients presented at Mulago Hospital in 2004 but cases re-appeared in 2005. Admitted cases increased sixfold (from 3 to 18 cases) between March and April 2006, marking a re-emergence of a measles epidemic. The epidemic of 2006 peaked after 6 months. A second mass measles vaccination was carried out in October 2006 and, like the first mass vaccination, this was followed by a rapid fall in measles admissions (Table I).

Clinically diagnosed measles cases as well as deaths reduce promptly after a campaign.

The total number of measles deaths dropped by 54% between 2002 and 2003, and by 62% 1 month after the second mass measles campaign of October 2006. The drop in measles deaths after October 2006 was followed by a flattening in the number of measles deaths at 7 per month, before dropping further (Table I).

Discussion

The review of measles cases in Mulago Hospital before mass measles campaigns shows the endemic nature of this disease in the areas served by the hospital, which is attributed to the low measles vaccination coverage. The findings of this study demonstrate how responsive an epidemic of measles is to mass measles vaccination. Within a month of a mass measles vaccination, a fall in the number of measles cases was already evident, showing that mass measles vaccination is an important public health intervention for child health, especially in countries like Uganda, where routine vaccination alone has failed to reach the 95% coverage necessary for herd immunity. The age range (6 months - 15 years) covered during a mass measles vaccination in Uganda contributed to the success. Mass measles campaigns limited to children <5 years have yielded inferior results.[19,20] The age of children at which maternal measles antibodies disappear tends to vary greatly; this explains the wide age range of measles cases seen in this review (2 - 171 months). Maternal measles antibodies present in children tend to reduce the measles vaccine's efficacy.

Epidemics tend to repeat themselves in 2-year cycles; this pattern makes them predictable and therefore allowing of preventive action. The 2-year cycle conforms with what is known of measles epidemics.[3] From our findings, it is also apparent that, by simple recording of measles cases seen in hospital after an initial containment, it is possible to detect a measles epidemic when it starts. It generally took at least 2 months before an epidemic escalated, giving time for appropriate intervention. A prompt repeat of mass vaccination should avert an epidemic. Our review shows that mass measles vaccinations quickly reduced measles fatalities, confirming earlier reports of reductions across the board in child deaths from measles.[17] Mass measles vaccination reaches a higher proportion of children who were difficult to reach than routine methods.[21,22] Periodic mass vaccination therefore should be one of the standard means to attain child health millennium goals in Uganda and other countries with similar child health challenges. Measles epidemics in camps, as have occurred in camps in northern Uganda,[23] could be prevented, or at least controlled, by mass vaccination.

During non-epidemic periods, the clinical case definition of measles becomes less specific, leading to misdiagnoses of other viral exanthems such as rubella. The clinical diagnosis of current measles infection should ideally be confirmed by serological testing. A potential bias in this study is the recording of the absolute number of measles cases without reference to

TABLE I. MEASLES ADMISSIONS AND DEATHS 2003 - 2007

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
2002	C	139	125	84	98	121	151	143	126	166	124	92	88	1 457
	D	2	4	4	13	6	11	12	10	11	4	0	1	78
2003	C	95	55	63	67	77	63	76	81	89	66	36	7	775
	D	4	4	1	4	2	6	3	3	4	2	3	0	36
2004	C	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	C	0	0	0	1	1	0	2	1	4	1	0	4	14
	D	0	0	0	0	0	0	0	0	1	0	0	0	1
2006	C	0	1	3	18	38	124	295	220	235	151	103	42	1 230
	D	0	0	2	1	2	5	12	21	21	8	7	7	86
2007	C	0	0	6	3	0	0	1	2	0	0	0	0	12
	D	0	0	0	0	0	0	0	0	0	0	0	0	0

C = Measles cases.
D = Measles deaths.

the total number of patients seen during the study periods. In addition, the data in this study were typical of its retrospective nature, with serological testing done on a few patients but with no clear prospective criteria of how they were chosen. As a result, serological results were not reported as they were difficult to interpret. Well-designed prospective studies with serological confirmation of diagnoses would better quantify the effect of mass measles vaccination.

Conclusion

Measles was endemic in Mulago Hospital before the introduction of mass measles vaccination campaigns. Clinically diagnosed measles cases as well as deaths reduced promptly after a campaign. Early detection of a new measles epidemic is possible through simple surveillance. Periodic mass measles vaccination in countries where the ordinary Expanded Programme on Immunization (EPI) vaccination persistently fails to raise vaccination coverage to community-protective levels should be studied and appropriately implemented.

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