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# The Transmission Pattern of Smallpox in Eastern Mali \*

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## *Introduction*

The administrative cercle of Ansongo, Mali, lies in the eastern part of the country along the descending portion of the great Niger Bend. It covers 70,000 square kilometers of scrub bush and semi-desert and has an estimated population of 60,000 inhabitants, most of whom live along the banks of the river. The population of Ansongo is comprised of three major ethnic groups, the sedentary Songhoi farmers who live in large villages along the river and the Tuareg and Peul nomadic herdsmen who live in seasonal camps along the river bank or next to water holes.

In January, 1967, an eight-year-old male from the village of Lellehoi in Ansongo journeyed to the town of Tillaberi in the Niger Republic. At the time there was a serious smallpox epidemic in Tillaberi. On the eighth of February he came down with fever and on the 18th of February his family took him back up river by canoe into Mali, arriving in their home village on the 19th. By the time they left Tillaberi the child had broken out with a smallpox rash. During the journey, the family spent most of their nights along isolated stretches of the river bank, but on two occasions they spent the night in a village. On the 16th they went ashore into the Malian village of Hounkoum, the child sleeping on a straw mat outside of the house of a family where there were three male children, ages 4, 6 and 8. All three subsequently developed smallpox. On the 17th, the family went ashore into the village of Kounsoum where the five-year-old male child of the family with whom they passed the night later developed smallpox. Over the next six months smallpox spread from the index case to a total of 144 other persons in a six-village area along a fifty-kilometer stretch of the Niger River. The information contained in this report was gathered during several field visits made to Ansongo during the months of June, July and August. Variola virus was cultured by the Vesicular Disease Laboratory of the Center for Disease Control, Atlanta, Georgia, from scab specimens obtained from three cases.

## *The Epidemic*

The course of the outbreak is depicted in the epidemic curve shown in Figure 1. In the six villages where cases appeared, the dates of onset of illness were recorded in Arabic by the village chiefs. During the field investigations these dates were confirmed through interviews with families in which the cases occurred and can be assumed to be fairly accurate. The majority of cases (87)

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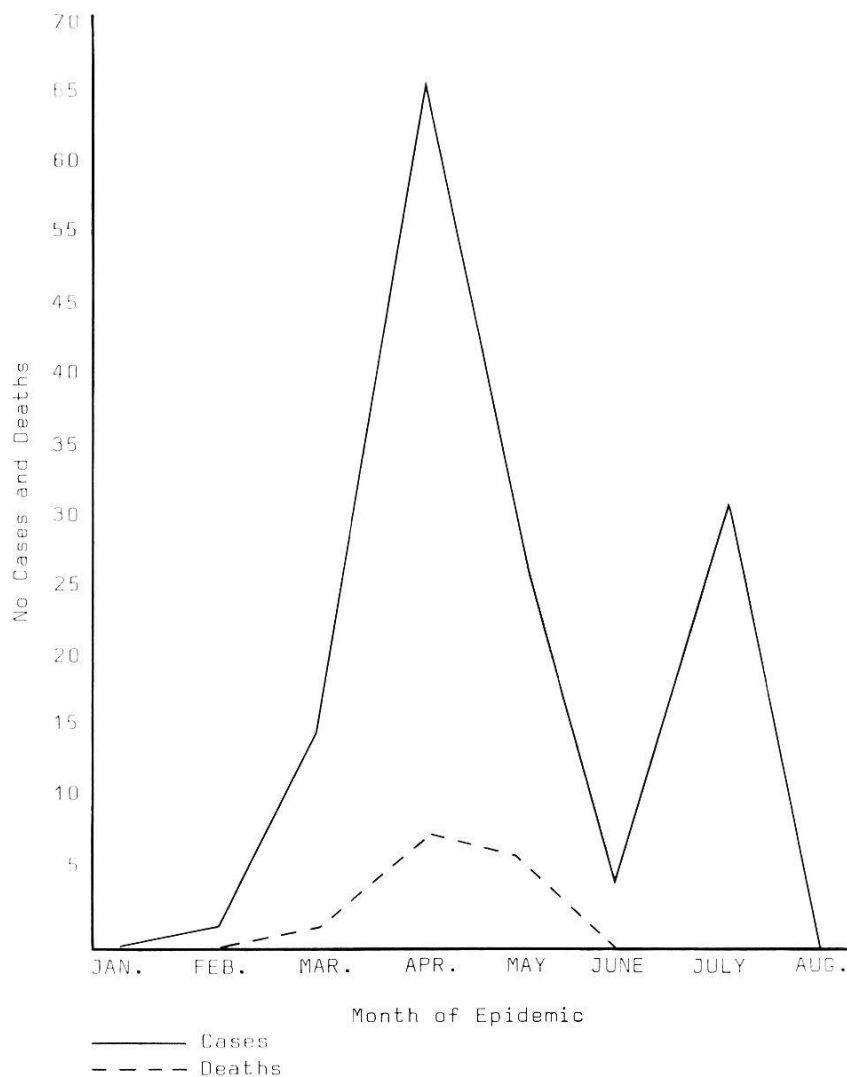
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occurred in the home village of the index case, Lellehoi where the epidemic reached a peak during the month of April when 54 cases were registered (Graph I). In 1967 Lellehoi had 897 censused inhabitants, approximately half of whom lived on the right bank of the Niger. The remainder lived on a large island close to the right bank and on the left bank of the river. All of the cases occurred among the inhabitants of the right bank and the island.

The second largest number of cases (36) appeared in the village of Monzonga (population 1,000), twenty-five kilometers upstream from Lellehoi. The first case in this village appeared in March in a two-year-old male who had visited the family of the index case in Lellehoi. The same month four other cases appeared among his siblings and in June another in another sibling. The outbreak did not move out of this single family unit until July when thirty cases occurred in several families living close to the home of this index family. All of the cases in Monzonga were among unvaccinated children less than ten years of age. This July outbreak in Monzonga is depicted in Graph I.

In Hounkoum smallpox appeared in the three children with whom the index case had spent the night of the 16th of February. A fourth case appeared in March in a child who had known contact with the first three and three of his contacts contracted the disease in April. There were a total of seven cases in Hounkoum among unvaccinated children less than ten years of age. In Kounsoum



*Graph I*

where the index case spent the night of the 17th of February the first case appeared in March in a five-year-old male who spent the night sleeping near the index case. During the month of April eleven other cases occurred in unvaccinated children less than ten years of age. In the village of Golea there was one case in a 40-year-old male who had visited Lellehoi in April, spending the night with a family whose children had smallpox. In Tabango two cases occurred in June in unvaccinated children less than ten years of age who had known contact with smallpox cases in Lellehoi.

Contact between all of the six villages involved in this epidemic was continuous throughout the six-month period. Although many persons with smallpox were isolated in straw huts on the edge of each village, curious children often entered the isolation camps and had easy access to those cases which were not isolated. During the prodromal phase of the illness, patients were visited regularly by relatives, but once the rash appeared they tended to stay away. Children, however, continued to visit their friends who were sick with smallpox in spite of the precautions taken by their parents.

At the outset of the outbreak, variolation was practiced in the villages of Lellehoi and Monzonga. A detailed description of this practice has been presented in another report (1). It was difficult to evaluate the role variolation played in the transmission pattern since those variolated also had had intimate contact with active cases of smallpox.

The existence of the outbreak became known to the medical authorities late in the month of June. In July, a mass vaccination campaign was undertaken in the entire cercle of Ansongo which effectively terminated transmission.

#### *Epidemiological Characteristics*

Table 1 presents the age and sex distribution of cases and deaths in the six villages area and the age specific death/case ratios. A higher number of cases were seen in females in all age groups. Of the 145 cases, 128 (88.3%) occurred among children less than fourteen years of age. No cases were seen in the age group above forty five years. The overall fatality rate was 8.2%. A vaccination scar survey of 201 inhabitants of Lellehoi revealed the presence of old scars in 28.8% of the assessed population. Among children less than fifteen years of age, only 16.6% had old vaccination scars whereas among those above this age, 46.8% had visible scars (Table 2). All of the 145 cases of smallpox occurred among unvaccinated individuals.

*Table 1.* Age and sex of smallpox cases and deaths, Ansongo, Mali, February–August, 1967

Age	Male	Female	Total	Deaths	Case fatality rate (deaths per 100 cases)
Less 1	1	2	3	1	33.3
1–4	17	21	38	3	7.8
5–14	38	49	87	3	3.4
15–44	7	10	17	5	34.7
45+	0	0	0	0	0
Total	63	82	145	12	8.2

Table 2. Vaccination status of residents of Lellehoi village, Ansongo, July, 1967

Age	Total assessed	Vaccination scar present	No vaccination scar present, no history of vaccination	History of vaccination, no scar present
Less 1	15	0	15	0
1-4	46	0	46	0
5-14	59	20	39	0
15-44	53	21	31	1
45+	28	17	8	3
Total	201	58 (28.8%)	139 (69.1%)	4 (1.9%)

### Discussion

Smallpox was introduced into a population which was fairly susceptible as evidenced by the low percentage of old vaccination scars. It is of note that the majority of cases were seen among the most susceptible segment of this population, those below fifteen years of age, of whom only 16.6% had old vaccination scars. This same group also had a greater exposure to active cases than adults because they did not observe any precautions nor make an effort to avoid those ill with smallpox. In spite of the generally susceptible nature of this population, it required five months for the disease to reach its total level of 145 cases in a limited geographic area. As the index case made his way up the river, he spread the disease to those households with which he had intimate contact. The secondary cases in the villages of Kounsoum and Hounkoum occurred among children with whom the index case had spent the night. In the home village of the index case the first three secondary cases were seen among children who lived in the house next to that of the index case. Spread to the villages of Monzonga, Golea and Tabango took place when susceptibles entered the household of a smallpox case in Lellehoi. This data suggests that spread took place at the household level where contact through the use of common eating and drinking utensils and sleeping quarters is the rule rather than through casual contact. In previous epidemics in Mali it has been noted that smallpox is not highly contagious disease and that for transmission to occur intimate contact is necessary (2). HENDERSON & YEKPE found in Dahomey that smallpox was not a highly contagious disease and that prolonged and repeated contact was required for transmission among susceptibles (3).

In the present epidemic the first secondary cases were seen in households into which the index case entered and spent approximately twelve hours resting on a straw mat in front of the doorway. During this period he used common drinking and eating utensils. The first secondary case in the village of Monzonga occurred in a child who had visited the house of the index case in Lellehoi for less than a day and the same was true for the first cases in Golea and Tabango. It is a debatable point whether one can consider such contact to be prolonged. Certainly it was not repeated. In all instances transmission took place when susceptibles entered infected households, ate, drank or slept there. An important inference in this observation is that persons such as travelers, nomads and merchants who act as smallpox vectors in this part of the world can transmit the disease through the intimate contact they have with local sedentary popu-

lations. As seen in this outbreak such intimate contact occurs at the household level. However, it can also take place in weekly markets and other groupings of populations where people spend as many as ten hours in close physical contact, eating and drinking from common containers and engaging in the continuous holding of hands which is socially accepted custom. The role of markets in this epidemic was minimized because that segment of the population which supported the epidemic, that is the children below fifteen years of age, do not as a rule attend markets in this area of the country.

The absence of smallpox cases from the quarter of Lellehoi situated on the left bank of the river is striking. Population movements across the river tend to be from the right bank to the left and it is infrequent for those people living on the left bank in Lellehoi to cross over to the other side. The reasons given for this were that people traveling overland by road must cross over to the left side where the road is located and that all of the major villages and markets are situated on the left bank. In crossing over to the left bank, inhabitants of the right bank do not generally enter the quarter of Lellehoi situated on that side since it is about a mile upstream from where the crossing point is located. These factors made for minimal contact between the populations of either side of the river in Lellehoi.

Prior to the implementation of mass vaccinations in the month of July, the epidemic curve for the village of Lellehoi had already begun to fall. It is likely that transmission would have stopped shortly in this village without any vaccination effort due to the lack of a sufficient level of susceptibles. Transmission in the entire area was finally stopped through a mass vaccination campaign.

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