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Vaccination coverage survey versus administrative data in the assessment of mass yellow fever immunization in internally displaced persons—Liberia, 2004

Gregory D. Huhn [a,*], Jennifer Brown [a], William Perea [c], Adama Berthe [d], Hansel Otero [e], Genevieve LiBeau [e], Nuhu Maksha [f], Mohammed Sankoh [g], Susan Montgomery [a], Anthony Marfin [b], Mekonnen Admassu [d]

[a] *Epidemic Intelligence Service Officer, Centers for Disease Control and Prevention, Epidemiology Program Office, Atlanta, GA 30333, USA*
[b] *Centers for Disease Control and Prevention, Division of Vector Borne Infectious Diseases, Ft. Collins, CO 80522, USA*
[c] *Medical Officer, World Health Organization, Geneva, Switzerland*
[d] *World Health Organization, Monrovia, Liberia*
[e] *Medicins Sans Frontieres-France, Monrovia, Liberia*
[f] *UNICEF, Monrovia, Liberia*
[g] *Government of Liberia, Ministry of Health, Monrovia, Liberia*

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Abstract

Yellow fever (YF) is a mosquito-borne vaccine-preventable disease with high mortality. In West Africa, low population immunity increases the risk of epidemic transmission. A cluster survey was conducted to determine the effectiveness of a mass immunization campaign using 17D YF vaccine in internally displaced person (IDP) camps following a reported outbreak of YF in Liberia in February 2004. Administrative data of vaccination coverage were reviewed. A cluster sample size was determined among 17,384 shelters using an 80% vaccination coverage threshold. A questionnaire eliciting demographic information, household size, and vaccination status was distributed to randomly selected IDPs. Data were analyzed to compare vaccination coverage rates of administrative versus survey data. Among 87,000 persons estimated living in IDP camps, administrative data recorded 49,395 (57%) YF vaccinated persons. A total of 237 IDPs were surveyed. Of survey respondents, 215 (91.9%, 95% CI 88.4–95.4) reported being vaccinated during the campaign and 196 (83.5%, 95% CI 78.6–88.5) possessed a valid campaign vaccination card. The median number of IDPs living in a shelter was 4 (range, 1–8) and 69,536 persons overall were estimated to be living in IDP camps. Coverage rates from a rapid survey exceeded 90% by self-report and 80% by evidence of a vaccination card, indicating that the YF immunization campaign was effective. Survey results suggested that administrative data overestimated the camp population by at least 20%. An emergency, mop-up vaccination campaign was avoided. Coverage surveys can be vital in the evaluation of emergency vaccination campaigns by influencing both imminent and future immunization strategies.

Keywords: Yellow fever; Vaccination; Internally displaced persons; Epidemic; Liberia

1. Introduction

Yellow fever (YF), a vaccine-preventable viral hemorrhagic disease, causes infection in approximately 200,000 persons annually and is responsible for an estimated 30,000 deaths per year [1]. The vast majority of disease and mortality occurs within the YF belt (latitude 15° north to 10°

* Corresponding author. Present address: Rush University Medical Center, Division of Infectious Diseases, 600 S. Paulina St., Suite 140 AC.FAC, Chicago, IL 60612, USA. Tel.: +1 312 942 5862 (O); +1 773 252 0449 (R); fax: +1 312 942 8200.
E-mail address: Gregory_Huhn@rush.edu (G.D. Huhn).

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south) in Sub-Saharan Africa [1]. In West Africa, the virus is transmitted in three cycles – a sylvatic cycle in which transmission occurs between forest-dwelling mosquitoes and non-human primates, an intermediate cycle in which transmission occurs between mosquitoes and both non-human primates and humans in moist savanna areas of Africa, and an urban cycle where it can cause large epidemics [1]. Urban cycle epidemics develop from anthroponotic, also known as human-to-human, transmission in which humans serve as the sole host reservoir of the peridomestic *Aedes aegypti* mosquito vector. Urban epidemics occur when anicteric but viremic persons who are not yet severely ill travel from jungles and savannas to cities where they infect local *A. aegypti* mosquitoes, a species that is abundant in urban areas and in areas where humans store water. When YF is identified in any setting, the likelihood that it resulted from human-to-human transmission or its possible introduction into an urban setting must be rapidly assessed to determine the need for emergency vaccination.

Immunization coverage of the at-risk population is an important determinant for human-to-human transmission because the potential for an epidemic increases when there is low prevalence of neutralizing antibody to YF virus from previous vaccination or naturally acquired infection. The 17D YF vaccine is highly effective and safe; Over 400 million estimated doses have been administered worldwide, with rare reports of serious adverse events following immunization (AEFI) [2–11]. Monitoring AEFI during mass vaccination campaigns are important to ensure not only the timely identification of possible events which may signal compromised safety of the vaccine, but to detect potential programmatic errors that may occur when a large number of doses are administered over a short time period.

In Liberia, 14 years of civil war during 1989–2003 devastated much of the country's healthcare infrastructure and severely disrupted public health disease surveillance and immunization programs. On February 13, 2004, the World Health Organization (WHO) declared an outbreak of YF after laboratory confirmation of four cases. All cases had illness onset January 1–9, 2004, of which three were fatal. Two cases occurred in men aged 19 and 26 years living in densely populated internally displaced person (IDP) camps, settlements of citizens displaced from their in-country homes because of civil strife, in Salala District, Bong County, in central Liberia. Roughly 365,000 Liberians, one-sixth of the country's estimated population, had lived in IDP camps throughout the country since the end of the civil war in August 2003 [12]. Because of the potential for human-to- human transmission in overcrowded IDP camps with extension into the surrounding area, YF mass vaccination campaigns were launched in Salala District IDP camps and neighboring communities during February 26 to March 6, 2004 and March 16 to March 20, 2004.

Administrative data, a simple formula used to estimate vaccination coverage that divides the number of persons vaccinated during the campaigns by the number of vaccine-eligible persons estimated residing in the camps, indicated that, of the estimated 87,000 persons living in these camps, only 49,395 (56.8%) were immunized against YF with the 17D YF vaccine (Institute Pasteur, Dakar, Senegal) during the campaigns [13–16]. Because validation studies to determine IDP camp population size had not been performed, a coverage survey was needed to more precisely evaluate vaccination coverage after the campaigns. We report findings of a rapid vaccine coverage survey that underscores the importance of accurately estimating the population at risk for YF to assist decisions regarding future vaccination strategies.

2. Methods

The IDP camps in Salala District of Bong County were built in 2002 and administered by the Liberian government through the Liberia Refugee Repatriation and Resettlement Commission (LRRRC). Medical services were coordinated by Médecins Sans Frontières – France (MSF-F) and food was supplied by the World Food Programme (WFP). Camp shelters were uniformly designed, each measuring approximately 4 m × 5 m (Fig. 1). A census of the camps had not been performed. Instead, a WFP formula of five persons per shelter was used to estimate the camp population. All six IDP camps in the district were included in the study (Fig. 2).

2.1. Sampling method

Camp managers provided maps and registration logs of habitable shelters in each camp. Each camp was partitioned into alphabetical blocks and each shelter within each block was given a sequential integer number. Each of the 17,384 total shelters in these six camps had a unique identification that included the camp name, a block letter and a shelter number. We developed a two-stage cluster sampling design to select survey participants.

Sample size was calculated based on 5% allowable margin of error. The design effect was equal to one because one person per shelter cluster was to be randomly selected for the survey. We chose the conjectured vaccination coverage rate to be 80%, the threshold that is believed to eliminate the likelihood of human-to-human transmission [17–18]. Sample size was calculated by a standard random cluster formula [19]:

$$\frac{(t^2)(\text{design effect})(\text{coverage rate})(I - \text{coverage rate})}{(\text{margin of error})^2}$$

$$= 248\ \text{persons}[t = 1.96\ \text{for 95\% level of confidence}]$$

As a contingency for missing persons in selected shelter households, an additional 5% (12 persons) were added for a total sample size of 260.

The sum total of all shelters ($n = 17{,}384$) served as the overall denominator for the population. At the first stage, we