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An outbreak of yellow fever with concurrent chikungunya virus transmission in South Kordofan, Sudan, 2005

L. Hannah Gould[a,*], Magdi S. Osman[b], Eileen C. Farnon[a], Kevin S. Griffith[a], Marvin S. Godsey[a], Said Karch[c], Basimike Mulenda[d], Amgad El Kholy[e], Francesco Grandesso[f], Xavier de Radiguès[f], Maria-Emanuela Brair[g], Sylvie Briand[d], El Sadig Mahgoub El Tayeb[b], Edward B. Hayes[a], Herve Zeller[h], William Perea[d]

[a] *Division of Vector-Borne Infectious Diseases, National Center for Zoonotic, Vector-Borne and Enteric Diseases, Centers for Disease Control and Prevention, Fort Collins, CO, USA*
[b] *Sudan Federal Ministry of Health, Khartoum, Sudan*
[c] *Agence Régionale de Démoustication, Aulnay Sous Bois, France*
[d] *World Health Organization, Geneva, Switzerland*
[e] *NAMRU-3, Cairo, Egypt*
[f] *Epicentre, Paris, France*
[g] *World Health Organization, Khartoum, Sudan*
[h] *Institute Pasteur, Lyon, France*

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Summary From September through December 2005, an outbreak of hemorrhagic fever occurred in South Kordofan, Sudan. Initial laboratory test results identified IgM antibodies against yellow fever (YF) virus in patient samples, and a YF outbreak was declared on 14 November. To control the outbreak, a YF mass vaccination campaign was conducted and vector control implemented in parts of South Kordofan. Surveillance data were obtained from the Sudan Federal Ministry of Health. Clinical information and serum samples were obtained from a subset of patients with illness during the outbreak. Nomads, health personnel and village chiefs were interviewed about the outbreak. Mosquitoes were collected in 11 villages and towns in North and South Kordofan. From 10 September to 9 December 2005 a total of 605 cases of outbreak-related illness were reported, of which 45% were in nomads. Twenty-nine percent of 177 patients seen at clinics in Julud and Abu Jubaiyah had illness consistent with YF. Five of 18 unvaccinated persons with recent

* Corresponding author. Present address: Division of Foodborne, Bacterial, and Mycotic Diseases, Centers for Disease Control and Prevention, 1600 Clifton Road MS D-63, Atlanta, GA 30333, USA. Tel.: +1 404 639 3373; fax: +1 404 639 3535.
E-mail address: lgould@cdc.gov (L.H. Gould).

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illness and 4 of 16 unvaccinated asymptomatic persons had IgM antibodies to YF virus. IgM antibodies to chikungunya virus were detected in five (27%) ill persons and three (19%) asymptomatic persons. These results indicate that both chikungunya and YF occurred during the outbreak.
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1. Introduction

In October 2005, the Sudan Federal Ministry of Health (FMOH) was notified of 23 cases of hemorrhagic illness, including seven fatalities, in the state of South Kordofan. The patients had all been treated at Habila Hospital in Dilling locality, and presented with illness characterized by fever, severe headache and backache. Approximately half of the patients had hemorrhagic signs, including gingival bleeding, epistaxis, hematemesis and melena. Nearly 15% had jaundice. Using a dengue virus (DENV) rapid strip test, IgM antibodies against DENV were detected in five (45%) of 11 blood samples submitted to the Sudan National Public Health Laboratory. On the basis of these results, FMOH and the WHO began investigation and control of a suspected outbreak of dengue fever (DF).

Initial investigations by FMOH, WHO and the South Kordofan Ministry of Health found that the epidemic was focused in the Kortala area of Dilling locality. The majority of patients were nomads of the Shanabla tribe, and there did not appear to be any clustering of illness within families or transmission to health care workers. Further serologic testing conducted at the Naval Medical Research Unit-3 (NAMRU-3, Cairo, Egypt) found IgM antibodies against yellow fever virus (YFV) in 13 (34%) of 38 serum samples, and chikungunya virus (CHIKV) was isolated from two samples at the Centers for Disease Control and Prevention, Fort Collins, CO, USA. On 14 November, FMOH officially declared an outbreak of yellow fever (YF) (WHO, 2006) and on 27 November a YF mass vaccination campaign was launched in South Kordofan. The outbreak was declared over on 20 December 2005 (WHO, 2006). In response to a request from FMOH, an international, multidisciplinary team coordinated by WHO's Global Alert and Response Network (GOARN) carried out additional epidemiologic and entomologic investigations to confirm the cause and further describe the outbreak.

2. Materials and methods

2.1. Description of the area

South Kordofan is located in south-central Sudan, has a land area of approximately 190 843 km^2, and a population of 1.6 million persons. The state is divided into 10 localities: Abeyi, Abu Jubaiyah, As Salam, Dilling, En Nuhud, Ghebeish, Kadugli, Lagawa, Rashad and Talodi. The outbreak mainly affected residents of Abu Jubaiyah, Dilling, Kadugli, Rashad and Talodi localities. South Kordofan is primarily savannah, with the Nuba Mountains (460—910 m elevation) comprising small, isolated ranges throughout the state. Travel within South Kordofan is difficult and limited, especially during the rainy season. The rainy season is from mid-May through October, with the total annual rainfall ranging from 600 to 900 mm. Locations only a couple of kilometers apart may vary significantly in the amount of rainfall received, and may have marked differences in microclimate (Kirk, 1941).

The population of South Kordofan consists primarily of subsistence farmers, and many families own farm animals, including cattle and goats. Several nomadic tribes migrate seasonally across the state. The health care infrastructure is rudimentary or non-existent, and much of the population relies on traditional medical practices. A large YF outbreak occurred in the Nuba Mountains in 1940, infecting over 15 000 persons (Kirk, 1941). YF vaccination has not been introduced into the routine immunization schedule, and before this outbreak the population of South Kordofan had not been vaccinated against YFV.

2.2. Case definitions and surveillance methods

Surveillance data were obtained from the FMOH sentinel surveillance system. Cases were reported using a DF/dengue hemorrhagic fever (DHF) case definition (PAHO, 2000) until the YF outbreak was declared on 14 November after which a YF case definition was adopted. A case of suspected YF was defined as an acute onset of fever, followed by jaundice within 2 weeks, and accompanied by either hemorrhage or death within 3 weeks of onset. A case of confirmed YF was defined as a suspected case confirmed by laboratory testing or epidemiologically linked to another confirmed case. Confirmatory laboratory tests included detection of anti-YFV IgM antibodies, a $\geq$4-fold change in serum IgG titer between acute and convalescent serum samples, isolation of YFV in blood, or detection of YFV antigen in tissues by immunohistochemistry. In order to account for changes in case definition and analyze data from the entire outbreak, we defined a case of outbreak-related illness as any patient with acute onset of fever, hemorrhage or jaundice reported to FMOH during September—December 2005.

Daily surveillance reports were obtained from hospitals and medical clinics. There were 12 sentinel reporting sites in South Kordofan at the start of the outbreak; this was expanded to 42 sites to increase reporting capacity during the outbreak. Reports submitted through the surveillance system included the patient's name, age, sex, residence status (nomad vs permanent resident) and village of residence. Clinical data included date of hospital admission, date of symptom onset, outcome and symptoms (i.e. presence or absence of fever, jaundice and hemorrhage).