Outbreak of Marburg Hemorrhagic Fever Among Miners in Kamwenge and Ibanda Districts, Uganda, 2007

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Marburg hemorrhagic fever was detected among 4 miners in Ibanda District, Uganda, from June through September, 2007. Infection was likely acquired through exposure to bats or bat secretions in a mine in Kamwenge District, Uganda, and possibly human-to-human transmission between some patients. We describe the epidemiologic investigation and the health education response.

Marburg hemorrhagic fever (MHF) is an acute, severe febrile illness caused by Marburg virus (MARV; family, Filoviridae). After an incubation period of up to 21 days (typically 5–10 days), a sudden onset of fever, headache, and myalgia develops; hemorrhagic signs ensue within 6–8 days after onset [1]. The resulting small vessel damage and multisystem organ failure can be fatal. MHF outbreaks are rare, resulting from human exposure to a presumed zoonotic reservoir [2], and are frequently amplified by secondary person-to-person transmission through contact with infectious body fluids and tissues [3]. Case-fatality rates for large MHF outbreaks have ranged from 20% to 90% [4]; the largest and deadliest outbreak occurred in northern Angola in 2005, with 374 cases and a case-fatality rate of 88% [5].

On 13 July 2007, the Uganda Ministry of Health (MoH) was notified of a suspected case of viral hemorrhagic fever in a miner from Kamwenge District who was hospitalized and died in Kampala. A second miner who had been in contact with him was also hospitalized with suspected viral hemorrhagic fever. This report describes the epidemiologic investigation conducted by the MoH in collaboration with the Centers for Disease Control and Prevention (CDC), World Health Organization (WHO), and Médecins sans Frontières. The initial response was followed by an information campaign by the Ugandan MoH and the Uganda Wildlife Authority.

THE STUDY

The MoH convened a Marburg Task Force comprising government ministries, nongovernmental organizations, and international partner organizations. An initial investigation revealed that both patients had worked at Kitaka mine in Ibanda District and had lived in a tent camp in the Kibale forest reserve surrounding the mine. The tunnel mine was the roosting site of thousands of bats. The remaining miners reported working in the mine using little to no personal protective equipment (PPE), with use of only gloves, gum

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boots, and occasionally hard hats reported; no one reported use of masks, respirators, or goggles. Kitaka mine was operated from 1953 until the mid-1970s by a commercial mining company, at which point the commercial operation ceased but local residents could access open passages in an unofficial capacity. From September through December 2006, another commercial mining operation reopened this mine, employing workers to expand tunnels prior to the start of mining operations. On 6 August 2007, at the recommendation of the Marburg Task Force, the Ugandan Department for Geological Survey and Mines officially closed Kitaka mine and a local miner was hired to help ensure that mine access was restricted.

A suspected case of MHF was defined as having an acute onset of fever with either 3 or more nonspecific symptoms or unexplained bleeding at any time since 21 June 2007. A probable case was defined as a suspected case with a history of 1 of the following in the 3 weeks prior to fever onset: travel to an area where an MHF case had occurred; direct contact with bodily fluids from a person or animal with probable or confirmed MHF; or work in a laboratory or animal facility handling MARV. A confirmed case was defined as a suspected or probable case with laboratory evidence of recent MARV infection by virus isolation antigen-detection enzyme-linked immunosorbent assay (ELISA), anti-MARV immunoglobulin M (IgM) or immunoglobulin G (IgG), immunohistochemistry, or reverse-transcription polymerase chain reaction (RT-PCR) and sequencing [6, 7].

Three confirmed cases of MHF were identified with onset occurring in June–July 2007; a fourth case occurred in September 2007 after closure of the mine. All 4 patients were male, were aged 22–29 years, and worked at Kitaka mine. The index case patient (patient 1), aged 29 years, presented to hospital A in Kampala on 7 July with a 3-day history of fever, chills, headache, and arthralgia. Three days after admission, he continued to be febrile and began vomiting. On 13 July, he developed confusion, seizures, hematemesis, and hematochezia, and died later that day. A blood sample collected on 13 July was sent on 23 July to CDC for testing. MARV was detected by RT-PCR and subsequently by virus isolation (isolate no. 200702854) and ELISA (Table 1).

Contact tracing revealed that 2 of patient 1's co-workers (patients 2 and 3) were ill prior to the onset of his illness. Patient 2, aged 23 years, presented to a health center in Kamwenge District on 21 June with fever, headache, arthralgia, and vomiting; he was transferred to hospital B in Ibanda District the next day, where he developed apparent seizure activity. Patient 2 was discharged on 29 June but had persistent weakness and dizziness and was transported overnight to hospital C in Kampala District on 1 July. He recovered and was discharged on 9 July.

Patient 3, aged 22 years, developed fever, arthralgia, and headache in early June and traveled to a health center in Kampala for treatment. Both patients 2 and 3 tested positive for anti-MARV IgG by ELISA (Table 1). All 3 patients lived in the same tent in the mining camp. Patients 1 and 3 had provided care to patient 2 during his transportation to hospitals B and C.

Patient 4, aged 25 years, had onset of weakness and chills on 14 September. On 21 September he presented to a health center in a suburb of Kyebando, located on the outskirts of Kampala, with fever, headache, arthralgia, anorexia, and hematemesis. Two weeks prior, he entered the mine without PPE, despite being aware of the ongoing public health response and having been hired to restrict access to the mine following its official closure. He was transferred to hospital C in Kampala, and MARV infection was confirmed by virus isolation (isolate no. 200703648), RT-PCR, and in convalescent samples by anti-MARV IgG (Table 1). Sequencing of viral isolates from patients 1 and 4 showed 20% divergence at the nucleotide level, indicating that the 2 cases represented separate introductions and were not epidemiologically linked [8]. Some of the sequences obtained from the original bat (*Rousettus aegyptiacus*) specimens and isolated viruses from the same bats, sampled during the following ecological investigation, matched very closely to the unique sequence of the viruses isolated from the 2 patients [8].

We performed close monitoring of health workers and contact tracing in all districts to which the 4 patients had traveled from June through September 2007. Contacts were evaluated for fever and other symptoms for 21 days after last contact. Of 267 contacts identified, 161 were able to be located and followed up; 83 contacts (73 in Kamwenge and Ibanda districts; 10 in Kampala District) provided blood samples for testing. During the 21-day incubation period, 24 (15%) and 3 (2%) of the 161 contacts developed fever and bleeding, respectively; none of the contacts had evidence of MARV infection by antigen-detection, IgM, or IgG ELISA. Active surveillance for new cases continued in the affected districts for an additional 21 days. No additional cases were identified.

The number of MARV infections in this outbreak was limited, although the risk of MHF exists as long as people without PPE enter mines or caves inhabited by bats in areas where MARV infection is endemic. There are no reasons to believe that MARV exists only in Kitaka mine. The movements of fruit bats are partly regulated by food abundance and availability of spaces in the roosting areas. Some proportion of the population migrates to other colonies on a seasonal basis [9]. This risk of MARV being spread by bats was emphasized by the subsequent identification of 2 cases of MHF in tourists visiting the Python cave in nearby Queen Elizabeth National Park [10–12]. In the weeks following this cluster of cases, Kitaka mine was officially closed and the owner decided to destroy the residing bat population by fumigation and by closing the access to discourage recolonization by bats from other locations. Educational campaigns that targeted communities living around bat-inhabited caves and mines,

Table 1. Results of Marburg Virus–Specific Test Results of 4 Patients With Marburg Hemorrhagic Fever in Uganda, 2007

Patient, date of symptom onset, date of sample collection	Days after symptom onset	Titer			RT-PCR	Virus isolation
		MARV antigen detection ELISA[a]	Anti-MARV IgM ELISA	Anti-MARV IgG ELISA[b]		
1						
4 July 2007						
13 July 2007	9	4	Negative	Negative	Positive	MARV
2						
21 June 2007						
1 August 2007	41	Negative	Negative	400	…	…
22 August 2007	62	…	Negative	400	…	…
29 August 2007	69	…	Negative	400	…	…
3						
10 June 2007						
1 August 2007	52	Negative	Negative	400	…	…
22 August 2007	73	…	Negative	400	…	…
29 August 2007	80	…	Negative	400	…	…
17 November 2007	160	…	Negative	400	…	…
4						
14 September 2007						
21 September 2007	6	Negative	Negative	Negative	Positive	MARV
24 September 2007	7	Negative	Negative	Negative	Positive	…
5 October 2007	20	Negative	Negative	1,600	Negative	…

NOTE. ELISA, enzyme-linked immunosorbent assay; IgG, immunoglobulin G; IgM, immunoglobulin M; MARV, Marburg virus; RT-PCR, reverse-transcription polymerase chain reaction.

[a] For antigen detection, titers of >2 are considered to be positive.

[b] For IgG ELISAs, titers of ≥400 are considered to be positive.

wildlife workers, and tourist groups were established in Uganda by the MoH, the Wildlife Authorities, and the Tourist Board with the support of CDC. A letter explaining the potentials risks of entering any bat-inhabited cave was sent by the MoH to the Association of Uganda Tour Operators. Posters and leaflets were designed in English and local languages and distributed to target populations. Health messages were posted on MoH and CDC Web sites. In recognition of the economic impact of the tourism industry in the parks and specifically Queen Elizabeth Park, it was decided that the site would be redeveloped for bat observation while protecting the health of the visitors. The park rangers received bat ecology and MHF-related education training. A viewing platform was erected at a safe distance to allow visitors to see the cave and the bats from a covered structure during the day, when bat movements in and out of the cave are limited. Educational signage concerning the ecology of bats, the environment, and MARV was posted in the campground, on the trail, and in the platform. All signs included specific warnings of the potential for the bats to carry MARV.

CONCLUSIONS

This outbreak was limited to 4 confirmed case patients, all of whom were male miners with regular contact with bats or their secretions. The association of MHF with mines and caves is likely related to exposure to bats in a confined space [2, 3]. Considering the incubation period, it also remains possible that all 4 cases had separate introductions. However, person-to-person transmission may have occurred sequentially from patient 3 to patient 2 to patient 1, although patient 3's symptoms were mild, which makes it unlikely that he transmitted the infection to either patient 1 or patient 2. Without acute-phase samples from patients 2 and 3, it is impossible to prove both the timing and the source of their infection. Although the 2005 MHF outbreak in Angola included a significant number of cases from nosocomial transmission [5], our contact tracing revealed no evidence of health care–associated infection. Barrier nursing and infection control are known to be the most critical ways to prevent secondary transmission.

Surveillance for hemorrhagic fever, rapid testing of suspected cases, institution of infection control measures, and education of the community, health care workers, and other stakeholders are critical to prevent and contain individual cases and outbreaks of MHF.

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