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14. ABSTRACT Chikungunya virus is a mosquito borne arbovirus in the genus <i>Alphavirus</i> . In humans, infection with chikungunya virus causes a painful but self-limiting febrile illness that is often associated with a maculopapular rash and polyarthrititis. The virus can cause encephalitis, long-term (>3 months) arthritis, and rarely death. There is no commercially available vaccine or antiviral treatment for chikungunya; however, experimental vaccines are under development, and the U.S. military was involved in vaccine development in the 1990s. Chikungunya epidemics are often significant because most infected people become symptomatic (72%–97%) and large portions of the population can be sick at the same time. Prior to 2013, the majority of the population of the New World had never been exposed to chikungunya and had no immunity to the virus. In recent years, U.S. military bases in the Caribbean and worldwide have been on alert for cases. The island nation of Curaçao had notified the Pan American Health Organization of more than 1,800 cases of chikungunya by February 2015, with up to 20,000 reported in local media (i.e., up to 13% of the population). The epidemic of chikungunya extended to several active duty personnel located at the U.S. Forward Operating Location, 429 th Expeditionary Operations Squadron in Curaçao. Based on reported cases, the outbreak was the largest single cluster of chikungunya cases in USAF active duty personnel to date. This report describes a case series and discusses the significance of this disease in the Americas and diagnostic challenges when other arboviruses such as dengue are present.					
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Case Series: Chikungunya and Dengue at a Forward Operating Location

Will K. Reeves, PhD; Natasha M. Rowe, MD (Maj, USAF); Richard K. Kugblenu, MPH; Cheryl L. Magnuson, DVM, MPH (Maj, USAF)

Chikungunya virus is a mosquito-borne arbovirus in the genus *Alphavirus*. In humans, infection with chikungunya virus causes a painful but self-limiting febrile illness that is often associated with a maculopapular rash and polyarthritides.¹ The virus can cause encephalitis, long-term (>3 months) arthritis, and rarely death.² There is no commercially available vaccine or antiviral treatment for chikungunya; however, experimental vaccines are under development and the U.S. military was involved in vaccine development in the 1990s.³ Chikungunya epidemics are often significant because most infected people become symptomatic (72%–97%) and large portions of the population can be sick at the same time.^{4,5} Prior to 2013, the majority of the population of the New World had never been exposed to chikungunya and had no immunity to the virus.⁵ The first modern epidemic of chikungunya in the Americas began in late 2013, and there were more than 1 million suspected cases by the end of 2014.⁶

In recent years, U.S. military bases in the Caribbean and worldwide have been on alert for cases. The island nation of Curaçao had notified the Pan American Health Organization of more than 1,800 cases of chikungunya by February 2015, with up to 20,000 reported in local media (i.e., up to 13% of the population).^{6,7} In addition, all four serotypes of dengue viruses circulate in the Americas, including the Caribbean, and the clinical presentation of dengue fever can be confused with that of chikungunya.⁸ The mosquito vectors of dengue and chikungunya viruses in the Caribbean are the same species, *Aedes albopictus* and *Aedes aegypti*.

The U.S. Forward Operating Location (FOL), 429th Expeditionary Operations Squadron, is based in Curaçao, a tropical island nation in the Caribbean located approximately 50 miles north of the coast of Venezuela. The FOL operations include U.S. Air Force (USAF) and U.S. Navy active duty personnel. The epidemic of chikungunya extended to several active duty

personnel located at the FOL. Based on reported cases, the outbreak was the largest single cluster of chikungunya cases in USAF active duty personnel to date. This report describes a case series and discusses the significance of this disease in the Americas and diagnostic challenges when other arboviruses such as dengue are present.

Between November 2014 and January 2015, six active duty USAF personnel from the FOL presented with signs and symptoms compatible with chikungunya and dengue fever. Chikungunya can be diagnosed by polymerase chain reaction (PCR), virus isolation, or detecting IgM antibodies in patient serum. Serum samples from all patients were tested for chikungunya and dengue IgM at a local hospital in Curaçao. All six personnel were male; none required hospitalization or evacuation to the U.S. All patients lived in a modern hotel leased by the Department of Defense (DoD). The majority of the duty day for the patients was neither outdoors nor in a mosquito prone location. Patients were given acetaminophen for pain management.

Patient 1

The first reported case from the FOL was a 37-year-old male who presented at the clinic on 7 November 2014 with a fever of 100.6°F (38.1°C). Signs and symptoms included headache, body rash, muscle fatigue, chills, dyspnea, nausea and vomiting, and lightheadedness. He was administered acetaminophen for his elevated temperature and for pain management. Serum was drawn and sent for laboratory testing. Results were negative for dengue but positive for chikungunya IgM on 21 November. The serologic confirmation took more than 2 weeks and the patient was able to return to duty after a few days of rest.

Patient 2

On 8 November 2014, a 24-year-old patient presented at the clinic with a general

feeling of malaise, chills, and fatigue. No elevated temperature was noted. He had a rash on his torso in the following days. Serum was drawn and it tested negative for dengue but positive for chikungunya IgM.

Patient 3

On 18 November 2014, a 43-year-old patient presented at the clinic. Onset of symptoms was reported by the patient as 14 November. The patient's temperature was normal at 98.9°F (37.1°C). The patient reported symptoms of fatigue and joint and muscle pain and he was found to have a rash on his scalp, arms, face, and trunk. Serum was drawn. He was released without duty limitations. Lab results were negative for dengue but positive for chikungunya IgM antibody.

Patient 4

On 20 November 2015, a 38-year-old patient presented at the clinic with a fever of 102.7°F (39.3°C). He complained of chills, knee and other joint pain, and fatigue. Serum was drawn and he was released with work/duty limitations. The patient's serum was positive for dengue virus IgM but not chikungunya. The patient reported being bitten by mosquitoes around the lodging area.

Patient 5

On 27 November 2014, a 24-year-old patient presented at the clinic with a fever of 102.6°F (39.2°C). His complaints included joint and muscle pain, chills, fever, body rash, and headache. Serum was drawn and the laboratory reported that he was negative for dengue but positive for chikungunya IgM. The patient was released to duty after 2 days of convalescence.

Patient 6

On 8 January 2015, a 24-year-old patient presented with complaint of general diffuse joint and muscle aches. He reported

having diarrhea, rash, headache, fever, and weakness. The patient's temperature was 99.8°F (37.7°C). Serum was drawn and the tests were positive for chikungunya IgM but negative for dengue.

During this ongoing epidemic of chikungunya, the six patients presented at the FOL clinic with a range of similar complaints associated with arboviral infections. There were five confirmed cases of chikungunya and one confirmed case of dengue. These cases in active duty personnel demonstrate the potential for similar clinical presentations of the two diseases and the difficulty in distinguishing them without serology, PCR, or virus isolation. Both the dengue case and most chikungunya cases had fever and complaints of chills, joint pain, and general malaise. Although infections with chikungunya virus are more likely to cause symptoms, infections with dengue viruses can be more serious due to the potential for hemorrhagic complications. In the U.S. Special Operations Command, up to 11% of the active duty population has been infected with dengue.⁸ Most FOLs and Forward Operating Bases have relatively modest physical facilities and staffing. Many have 100–500 active duty personnel, so even if chikungunya and dengue are not fatal, they can cause debilitating joint pain in a significant percentage of a base population.

The DoD uses a multiple layer personnel protection system to prevent insect bites and associated diseases. The guidance recommends treating uniforms with permethrin and sleeping under a treated bed net in addition to the use of a topical insect repellent.⁹ Some services have factory-treated, permethrin-impregnated uniforms; however, the USAF does not and the Airman Battle Uniform (ABU) can only be treated with a short-term treatment using a 6-ounce aerosol spray. The newer Ripstop ABU can be treated with a permanent post-production treatment, but responsibility for doing so is the wearer's. At the FOL, contractors are responsible for the control of mosquitos that are competent vectors of dengue and chikungunya virus transmission. Most patients reported that they had

not consistently used insect repellents on exposed skin.

Dengue has been an ongoing threat in the Caribbean with periodic epidemics since the 1970s.¹⁰ Now chikungunya is also a significant concern. Long-term control of dengue and chikungunya in the Americas has been difficult due to the rapid emergence of insecticide resistance and a lack of vaccines.¹¹ In addition to the ongoing threat from chikungunya, there is a potential for introduction of Mayaro virus, an *Alphavirus* from mainland South America, which causes a disease that is symptomatically similar to chikungunya and can be transmitted by *Aedes aegypti*.¹² Several other vector-borne diseases such as rickettsial infections, (e.g., *Rickettsia felis*) can also be symptomatically mistaken as dengue and have been detected among vectors collected by U.S. military operations during dengue outbreaks.¹³

The seasonality of the vectors of chikungunya and dengue in Curaçao can be expected to follow the rain patterns with the majority of mosquitoes breeding from September through March following rains. All of the patients at this FOL were seen during the rainy season. The FOL pest control operators conduct surveillance for mosquitoes and have regularly collected *Aedes aegypti* in and around the hotel where service members live (unpublished data). These mosquitoes have all been identified and tested for dengue and chikungunya viruses at the U.S. Air Force School of Aerospace Medicine but have not been positive for either virus. However, detection of virus in vectors, even during outbreaks, can be rare. The specific exposure locations for the patients in this outbreak are not known, but *Aedes aegypti* is primarily a daytime feeding mosquito.

This outbreak of mosquito-transmitted viral infections in a known endemic area emphasizes the importance of the proper and consistent use of personal protective measures against arthropod-transmitted infections. These measures include the proper wear of permethrin-treated uniforms and the consistent use of DEET- or picaridin-containing (e.g., military-issued) repellents.

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Air Force, the Department of Defense, or the U.S. Government. Distribution A: Approved for public release; distribution is unlimited. Case No. 88ABW-2015-1642, 31 Mar 2015.

Author affiliations: U.S. Air Force School of Aerospace Medicine/PHR (Dr. Reeves, Dr. Magnuson, Mr. Kugblenu); 325th Aerospace Medicine Squadron (Dr. Rowe)

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