Centers for Disease Control and Prevention

MMWR

Morbidity and Mortality Weekly Report

Weekly / Vol. 64 / No. 7 February 27, 2015

Transmission of Hepatitis C Virus Associated with Surgical Procedures — New Jersey 2010 and Wisconsin 2011

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Incidents of health care–associated hepatitis C virus (HCV) transmission that resulted from breaches in injection safety and infection prevention practices have been previously documented (*1,2*). During 2010 and 2011, separate, unrelated, occurrences of HCV infections in New Jersey and Wisconsin associated with surgical procedures were investigated to determine sources of HCV and mechanisms of HCV transmission. Molecular analyses of HCV strains and epidemiologic investigations indicated that transmission likely resulted from breaches of infection prevention practices. Health care and public health professionals should consider health care–associated transmission when evaluating acute HCV infections.

An estimated 3.2 million U.S. residents have chronic HCV infections; during 2011, approximately 16,500 acute HCV infections were diagnosed. Molecular analyses of HCV strains have enhanced investigations of health care–associated transmission (*3–5*) by determining the relatedness of strains infecting persons with acute and chronic HCV infection. Two investigations of HCV infection among patients who had surgical procedures highlight the potential for HCV contamination of medications or equipment, which can result in transmissions that are difficult to recognize.

New Jersey Investigation

On March 9, 2010, a female health care worker (patient A) underwent a uterine dilation and curettage procedure at the facility where she worked. On April 14, she sought care at the same facility with jaundice, anorexia, and abdominal discomfort. Laboratory test results included a positive HCV enzyme immunoassay result confirmed by a nucleic acid amplification test for HCV RNA and a serum alanine aminotransferase level of 1,681 IU/L compared with a normal level on March 3 before surgery (normal range = 7–40 IU/L). After notification on May 6, the New Jersey Department of Health (NJDOH) investigated the potential for HCV transmission during the patient's surgical procedure and other health care encounters; patient A reported no potential occupational exposure to HCV. The investigation included onsite inspection, staff interviews, records reviews, and observation of infection prevention practices.

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Review of records of all patients who had surgical procedures at the facility on March 9 before patient A's procedure revealed one patient (patient B) with an HCV infection that had been reported to NJDOH in 2006. Blood specimens collected from patients A and B were sent to the CDC for quasispecies analysis using previously described methods (*3,6,7*). Results demonstrated both patients' HCV strains were genotype 1a; 70% of chronic HCV infections are caused by genotype 1 in the United States (*8*). The specimens were clustered in genetic relatedness to one another with 100% identity and were distinct from control specimens collected from other persons with HCV infection (Figure 1). This indicated that patient B was the source of transmission to patient A.

Patients A and B had different surgeons, different procedures, and different operating rooms with different surgical equipment, but had the same anesthesiologist, who performed procedures that can result in HCV transmission. Following standard operating procedures at the facility, an anesthesiologist was assigned a cart and was responsible for its care and stocking. The anesthesiologist moved the cart and medications from patient to patient throughout the day. Medications were drawn into syringes and placed on the anesthesia cart surface during procedures. No policies or procedures regarding cleaning and disinfection of carts between patients existed. On March 9, the anesthesiologist treated patient B and immediately thereafter treated patient A. Propofol was the only medication common to both procedures. The anesthesiologist said there was no reuse of needles and syringes or reuse of single-dose vials; the number of vials used could not be verified by pharmacy records.

The facility provided a list of all patients treated by the anesthesiologist during 2005–2010. This list was matched to NJDOH reports of hepatitis B virus (HBV) and HCV infection. By considering the timing and sequence of patient procedures, 80 patients were identified who underwent surgical procedures after procedures on patients on NJDOH's list of persons with known HCV infection; those 80 patients were recommended for HCV testing. No patient had a procedure after a procedure on a patient known to have HBV infection. No additional cases of HCV infection were detected from patient testing or investigation of cases reported to NJDOH's communicable disease surveillance system

Wisconsin Investigation

On June 1, 2011, the Wisconsin Division of Public Health (WDPH) was notified of a patient with HCV genotype 4 (HCV-4) infection. HCV-4 infections typically occur in the Middle East and Africa and are not commonly documented in Wisconsin. An investigation was conducted to identify the source and determine whether the HCV-4 infection represented a novel or persistent source of exposure.

The patient (patient 1) was an adult male with a history of type 2 diabetes, hypertension, and chronic renal disease who underwent hemodialysis for approximately 1 year until he received a single transplanted kidney on May 28, 2009, at

The *MMWR* series of publications is published by the Center for Surveillance, Epidemiology, and Laboratory Services, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2015;64:[inclusive page numbers].

hospital A. Routine HCV antibody testing was conducted during outpatient visits 1 year after the kidney transplantation and annually thereafter, per the transplant facility's HCV testing protocol. Patient 1's HCV antibody test results were reported as negative on October 13, 2008, May 28, 2009, and April 27, 2010. Occasionally, persons with chronic HCV infection, including those who are immunocompromised, are persistently anti-HCV antibody negative, and detection of HCV RNA might be the only evidence of infection (*9*). On May 4, 2011, the patient's HCV enzyme immunoassay antibody test result was positive, and HCV infection was confirmed by nucleic acid amplification test.

WDPH staff members initially focused on the renal transplant procedure and contacted the United Network for Organ Sharing for donor information. The donor's nucleic acid amplification test results for human immunodeficiency virus, HBV, and HCV were negative at the time of organ procurement. Hospital A received the single kidney for transplantation into patient 1. The United Network for Organ Sharing informed WDPH that the donor's liver and second kidney were procured and shipped to hospital A to be transplanted into another patient (patient 2).

Patient 2 was a middle-aged male with a history of liver failure resulting from chronic HCV-4 infection, chronic renal disease requiring hemodialysis, and insulin-dependent diabetes. On May 28, 2009, patients 1 and 2 had received organ transplants simultaneously in adjacent operating rooms. CDC's quasispecies analysis of HCV-4 strains detected in blood specimens obtained from patients 1 and 2 revealed 100% identity. Laboratory and epidemiologic evidence indicated that patient 2, not the organ donor, was the likely source of patient 1's HCV-4 infection (Figure 2).

To determine hospital care points common to patients 1 and 2 and possible modes of HCV transmission, WDPH conducted medical record reviews, onsite visits, interviews with hospital employees, and case-finding efforts. Investigation areas included the surgical intensive care unit, medical unit, inpatient dialysis unit, and related operating rooms. Organ management protocols and surgical procedures were reviewed.

The two patients' hospital stays overlapped only during May 28–June 4, 2009, when they occupied rooms in nonadjoining areas of the surgical intensive care unit; separate health care teams were assigned to each patient. One nursing assistant likely performed vital sign assessments for both patients but did not perform invasive procedures. Multidose insulin vials were used during the two patients' hospitalizations. However, the multidose vials remained in the medication room where doses were drawn with new needles and syringes each time and then administered in patients' rooms. Pharmacy records indicated one possible occasion during which insulin from the same vial might have been administered to both patients. No insulin pens were used. On the day of surgery, patients 1 and 2 received hemodialysis in separate rooms in the inpatient dialysis unit and from different dialysis machines. Patient 2 was dialyzed first, 90 minutes before patient 1. Dialysis staff described how they conducted glucose testing and illustrated the correct steps for cleaning and disinfecting glucometers. No breaches in infection control practices were identified that might explain HCV transmission.

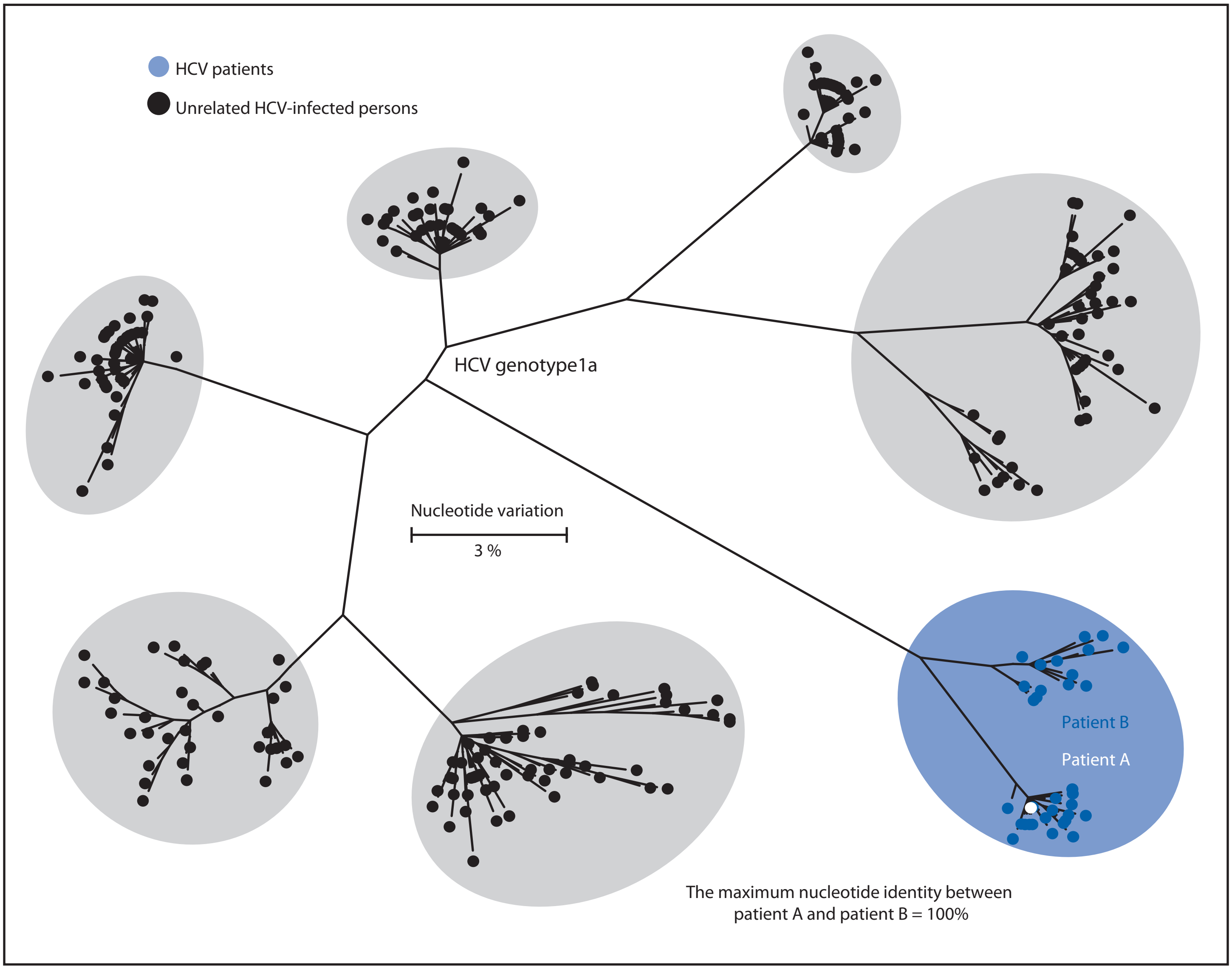
The surgical records review identified one person (surgeon 2) common to both transplant operations; all other members of the surgical teams were different. Patient 2's transplant operation (liver and left kidney) was begun by the primary surgeon (surgeon 1). Surgeon 2 assisted on patient 2's liver transplantation. After patient 2's liver transplantation, surgeon 2 degowned, degloved, and left the surgical area; surgeon 2 completely changed surgical attire and rescrubbed for patient 1's kidney transplant.

Review of the handling of donated organs indicated the liver and kidney for patient 2 were shipped separately from the kidney for patient 1. Upon arrival at hospital A, patient 2's kidney was placed on a standard kidney perfusion machine. When patient 1's kidney arrived later that day, both kidneys were perfused on the same machine in the operating room. Patient 2 had the first transplant operation. After patient 2's liver was transplanted and after examining both kidneys, surgeon 1 selected the kidney to be transplanted, removed it from the perfusion machine, and placed it on the surgical field. The perfusion machine with the remaining kidney was then moved to the adjacent operating room where the kidney was transplanted into patient 1.

The Wisconsin Electronic Disease Surveillance System was searched to determine whether other HCV infections were associated with patient 1 or patient 2 or the hospital. None of the following had reported HCV infections: 162 patients hospitalized in the same units during the same period as patients 1 and 2, 10 patients who had received dialysis on the same day as the transplantation, and 124 patients who had surgical procedures at hospital A during May 28–29.

Although the precise mechanism of HCV transmission is undetermined, investigators concluded that the likely transmission venue was one surgical suite where convergence of the following events occurred and might have resulted in breaches of infection control: two kidneys were concurrently attached to the same perfusion machine; the perfusion machine was used in a blood-rich environment in patient 2's operating room and then moved to patient 1's operating room without cleaning or disinfection; and the kidneys were transplanted into different patients.

FIGURE 1. Phylogenetic tree of the E1-HVR1 genomic region of hepatitis C virus (HCV) specimens from two patients and six randomly selected unrelated controls infected with HCV genotype 1a, indicating that patient B was the likely source of patient A's infection — New Jersey, 2010*

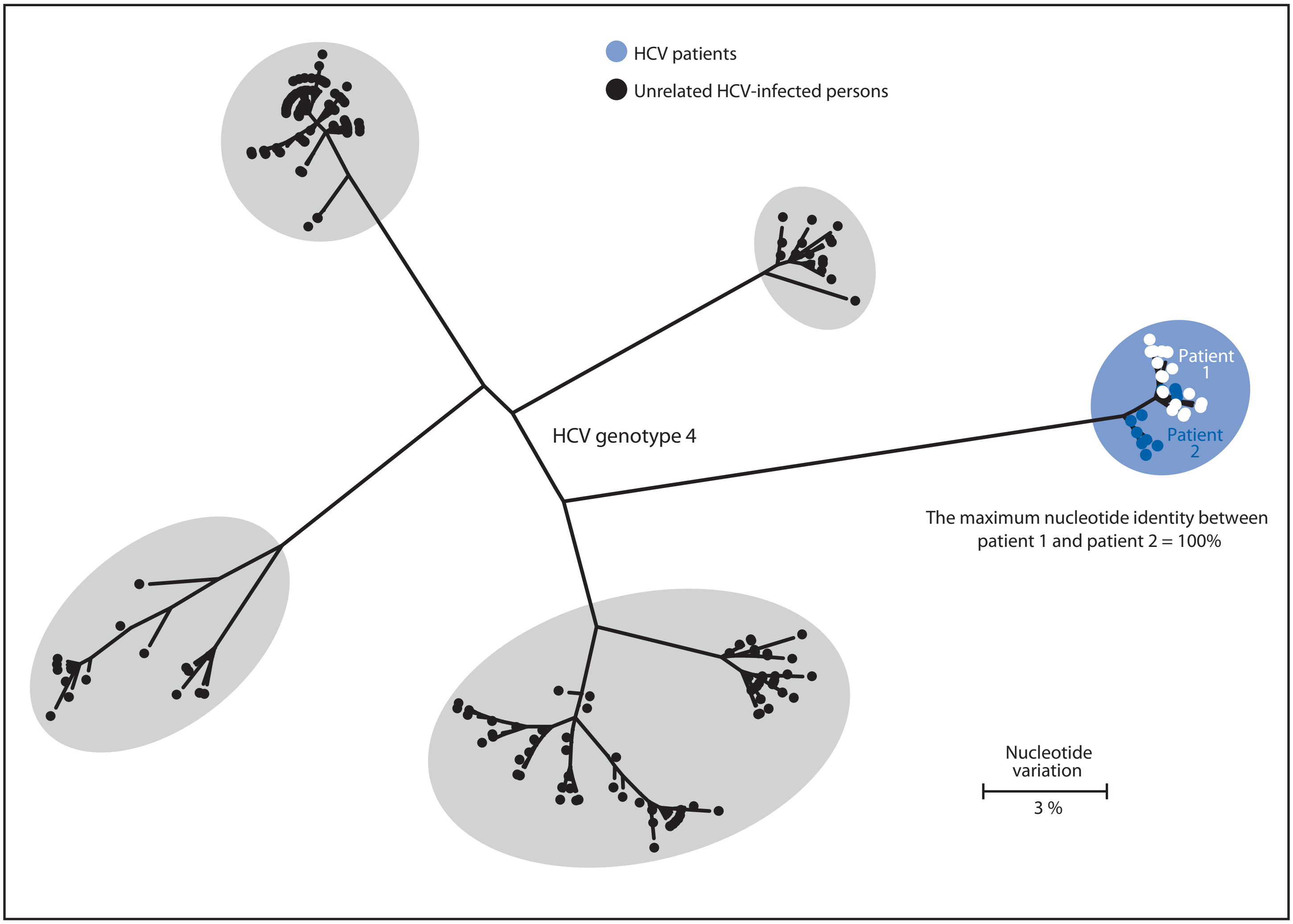


* This maximum likelihood dendrogram was created by using the general time reversible model. Each branch represents a different viral sequence, and small distances between branches suggest genetic relatedness. The size of each oval represents the diversity of HVR1 quasispecies sequences from that specimen or group of specimens. Only unique sequence patterns are shown in the tree. For patient A, there were five total sequences; all were identical. For patient B, there were 46 total sequences, including 33 that were unique.

Discussion

Occurrence of these two unrelated cases of health care–associated HCV infection highlights the importance of hepatitis C surveillance and investigations of possible health care transmission. During both investigations, public health authorities suspected health care transmission after reports of a single case of HCV infection, and results of quasispecies analysis provided key information for the epidemiologic investigations and helped confirm that health care exposures were responsible. Although data were limited, available evidence did not indicate an outbreak in either instance. The definitive mode of HCV transmission was not established, but both investigations highlight the probable role of contaminated equipment and supplies in bloodborne disease transmission. During both events, facility staff members transported potentially contaminated items from one procedure room to another.

FIGURE 2. Phylogenetic tree of the E1-HVR1 genomic region of hepatitis C virus (HCV) specimens from two patients and four randomly selected unrelated controls infected with HCV genotype 4, indicating that patient 2 was the likely source of patient 1's infection — Wisconsin, 2011*



* This maximum likelihood dendrogram was created by using the general time reversible model. Each branch represents a different viral sequence, and small distances between branches suggest genetic relatedness. The size of each oval represents the diversity of HVR1 quasispecies sequences from that specimen or group of specimens. Only unique sequence patterns are shown in the tree. For patient 1, there were 25 total sequences, including 15 that were unique. For patient 2, there were 51 total sequences, including 11 that were unique.

After the NJDOH investigation, the New Jersey facility revised its policies and procedures regarding assigning, stocking, and cleaning anesthesia carts. Pharmacy tracking of medication vials was instituted to more accurately document the anesthesiologist's use of each vial for each patient. All anesthesiologists were required to attend infection prevention training regarding standard precautions, injection safety, and bloodborne pathogen transmission. At the Wisconsin hospital, officials purchased a second kidney perfusion machine to eliminate the need to simultaneously perfuse multiple kidneys on the same machine.

Continuing training of all patient-care personnel and review of policies and procedures to ensure that equipment and supplies within and between procedure rooms are adequately cleaned and disinfected are important measures to optimize infection control and injection safety practices in health care settings. These cases illustrate the importance of partnerships and communication between public health and health care professionals to ensure that basic infection control and injection safety practices are optimized wherever health care is delivered.

What is already known on this topic?

Hepatitis C virus (HCV) transmission documented in health care settings has been primarily a result of unsafe injection practices including reuse of needles, fingerstick devices, and syringes, and other breaches in infection control.

What is added by this report?

Two separate occurrences of health care–associated HCV transmission likely resulted from breaches of infection prevention practices during surgical procedures. In one case, two patients received injectable propofol from the same medication cart; in the other, two patients received kidneys that had been perfused on the same machine. Molecular analyses of HCV strains helped epidemiologic investigators identify the source of transmission.

What are the implications for public health practice?

Health care and public health professionals should consider health care–associated transmission when evaluating acute HCV infections. Health care professionals should adhere to recommended standard precautions and infection control protocols to prevent transmission of bloodborne pathogens.

Acknowledgments

Laura Taylor, PhD, New Jersey Department of Health. Ryan Anderson, Wisconsin Division of Public Health. New Jersey and Wisconsin local health departments and hospital staff. Guo-liang Xia, Yury Khudyakov, Division of Viral Hepatitis, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, CDC. Joseph Perz, Division of Healthcare Quality Promotion, National Center for Emerging and Zoonotic Infectious Diseases, CDC. Kristine M. Bisgard, Michael Paul Reid, C. Kay Smith, Division of Scientific Education and Professional Development, Center for Surveillance, Epidemiology, and Laboratory Services, CDC.

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CDC Grand Rounds: Preventing Youth Violence

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Youth violence occurs when persons aged 10–24 years, as victims, offenders, or witnesses, are involved in the intentional use of physical force or power to threaten or harm others. Youth violence typically involves young persons hurting other young persons and can take different forms. Examples include fights, bullying, threats with weapons, and gang-related violence. Different forms of youth violence can also vary in the harm that results and can include physical harm, such as injuries or death, as well as psychological harm. Youth violence is a significant public health problem with serious and lasting effects on the physical, mental, and social health of youth. In 2013, 4,481 youths aged 10–24 years (6.9 per 100,000) were homicide victims (*1*). Homicide is the third leading cause of death among persons aged 10–24 years (after unintentional injuries and suicide) and is responsible for more deaths in this age group than the next seven leading causes of death combined (Figure) (*1*). Males and racial/ethnic minorities experience the greatest burden of youth violence. Rates of homicide deaths are approximately six times higher among males aged 10–24 years (11.7 per 100,000) than among females (2.0). Rates among non-Hispanic black youths (27.6 per 100,000) and Hispanic youths (6.3) are 13 and three times higher, respectively, than among non-Hispanic white youths (2.1) (*1*). The number of young persons who are physically harmed by violence is more than 100 times higher than the number killed. In 2013, an estimated 547,260 youths aged 10–24 years (847 per 100,000) were treated in U.S. emergency departments for nonfatal physical assault–related injuries (*1*).

Data from death certificates and emergency departments help communities understand and prevent youth violence but reflect only part of the problem. According to CDC's 2013 Youth Risk Behavior Survey, one in four high school students reported being in at least one physical fight in the past year, and 17.9% reported that they carried a weapon (gun, knife, or club) at least once in the past 30 days (*2*). Youth violence also occurs in schools and harms students' ability to participate fully in school life. In 2013, 19.6% of high school students reported being bullied at school in the past year, 6.9% said they were threatened or injured with a weapon on school property in the past year, and 7.1% reported missing at least 1 day of school in the past 30 days because they felt unsafe either at school or on their way to or from school (*2*).

Youths who are victims of violence are at greater risk for many other physical and mental health problems and other difficulties, including smoking, obesity, high-risk sexual behavior, depression, academic difficulties, and suicide (*3–5*). The impact of youth violence extends beyond the young perpetrators and victims to affect entire communities. Each year, youth homicides and nonfatal physical assault-related injuries result in an estimated $19.5 billion in combined medical and lost productivity costs (*1*). Violence can increase health care costs, decrease property values, and disrupt social services (*6*).

This is another in a series of occasional MMWR *reports titled CDC Grand Rounds. These reports are based on grand rounds presentations at CDC on high-profile issues in public health science, practice, and policy. Information about CDC Grand Rounds is available at http://www.cdc.gov/about/grand-rounds.*

Evidence-Based Youth Violence Prevention

Youth violence is not inevitable. It is preventable. Research supported by CDC and other groups has identified many approaches that contribute to significant reductions in youth violence and other risk behaviors and significant cost savings (*7,8*). Most effective prevention approaches work by modifying individual-level (e.g., problem-solving, communication, anger management skills) or relationship-level (e.g., parental supervision, consistent discipline, and communication skills) factors. A growing body of research shows the prevention potential of approaches that modify community-level factors (e.g., physical environments, norms about violence).

Universal school-based prevention programs are the most common approach to youth violence prevention. In general, these programs change how youths think and feel about violence and develop skills to avoid violence and resolve disputes nonviolently. These programs are designed to reach all students in a given school or grade. A systematic review of 53 studies by the Community Preventive Services Task Force (Community Guide) found a median reduction in violent behavior of 15% (*9*). These programs can be effective in different school environments, regardless of socioeconomic status, crime rate, or predominant ethnicity of students. One example is Life Skills Training, a 30-session curriculum that teaches students self-management and social skills (*8*). Life Skills Training has resulted in lower rates of violence, delinquency, and other high risk behavior. In the state of Washington, cost-benefit analyses suggest a savings of $11.58 for each dollar spent on Life Skills Training (*10*).

Parenting and family-focused strategies also have been extensively researched. These prevention approaches provide caregivers with support and teach communication, problem-solving, monitoring, and behavior management skills (*8*). Some are designed for youths with known histories of difficulties (e.g., chronic offenders, abuse victims) and include intensive services to address individual, family, school, and community factors that contribute to violence and delinquency. One example is therapeutic foster care for chronically delinquent juveniles, which involves placing at-risk youths with specially trained foster families for several months to provide a structured environment and intensive services. The Community Guide reviewed this approach and found it to reduce violent crime by 71.9% among participants when compared with youths in standard group residential treatment facilities and to have net benefits of $20,351 to $81,664 per youth (*9*).

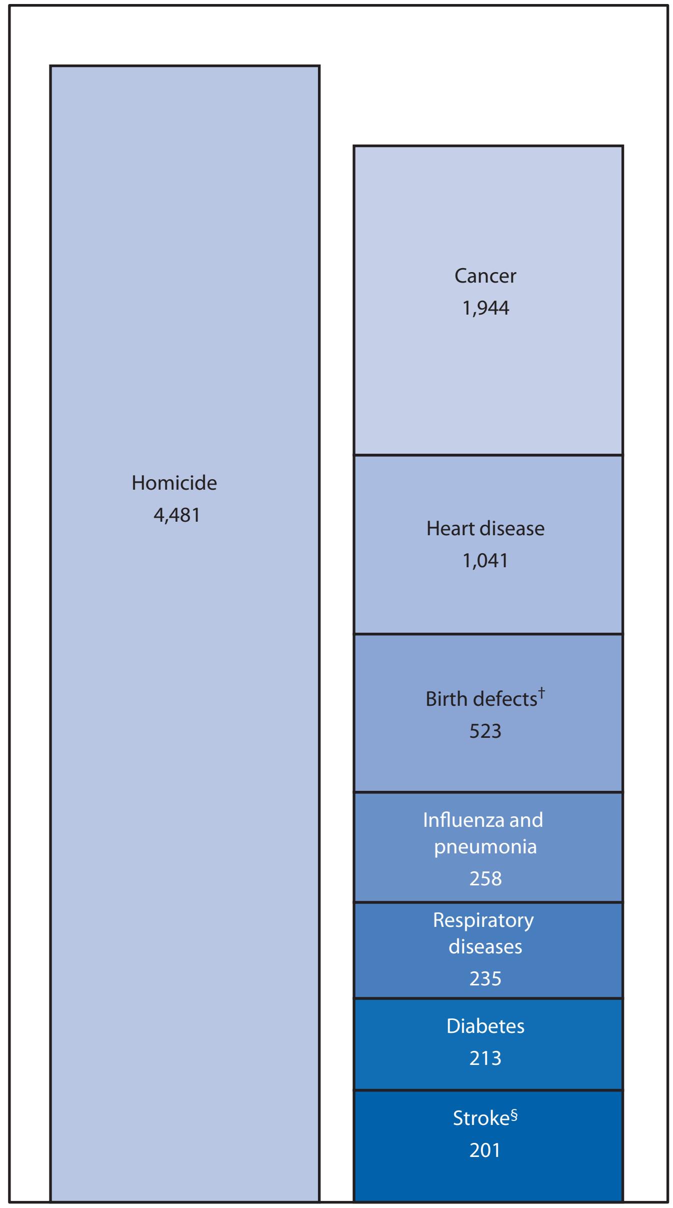
Economic, policy, and violence prevention strategies that address community-level factors are emerging. One promising approach is business improvement districts, which are public-private partnerships that invest resources in local services and activities (e.g., street cleaning, security, adding parks and other green spaces) to increase the appeal and use of an area. A CDC-supported evaluation of 30 business improvement districts in Los Angeles found a 12% drop in robberies, an 8% drop in violent crime, and substantial economic benefits (e.g., savings from the decline in robbery alone offsetting implementation costs) (*11*). Growing research suggests other community-level approaches, such as street outreach and mobilization activities (e.g., Ceasefire and Safe Streets), can result in significant reductions in youth violence (*8*).

Challenges to Preventing Youth Violence

Many communities are not aware of, or are unable to take advantage of, the strategies known to reduce youth violence. CDC's Striving to Prevent Youth Violence Everywhere (STRYVE) initiative strengthens community capacity and collaboration to strategically select and implement evidence-based strategies (*7*,*12*). STRYVE resources are designed to help communities identify and access evidence-based youth violence prevention programs, policies, and practices. Examples of resources used by STRYVE and other CDC youth violence technical assistance activities include CDC's *Preventing Youth Violence: Opportunities for Action* and its companion guide, CDC's *STRYVE Online Strategy Selector Tool*, and the Office of Juvenile Justice and Delinquency Prevention's *Model Programs Guide* (*8*,*12*,*13*).

No one program, practice, or policy can address all the factors that contribute to youth violence. Research conducted by

FIGURE. Third leading cause of death (homicide) among persons aged 10–24 years compared with the fourth through tenth leading causes of death in the same age group — United States, 2013*



* Does not include the two leading causes of death among persons aged 10–24 years in 2013: unintentional injuries (12,394 deaths) and suicide (5,264).
† Congenital anomalies.
§ Cerebrovascular diseases.

CDC's Youth Violence Prevention Centers (YVPCs) shows that a comprehensive prevention approach that includes multiple strategies to address individual, relationship, and community-level risk factors is critical. For example, work by the Chicago YVPC demonstrates that comprehensive public health approaches can have a broader reach and more sustained effects than the implementation of a single prevention program.

Preliminary data suggest that between 2010 and 2013 there was a 50% decline in homicides in a Chicago community using comprehensive strategies (e.g., Schools and Families Educating Children, GREAT Families, and Ceasefire) (*14*). The decline in homicides and other outcomes (e.g., violent crime) was the result of the synergistic effect of all the implemented strategies and not the result of a single strategy (*14*).

Collaboration between governmental and nongovernmental groups can facilitate sustained preventive action. Government partners at federal, state, and local levels include justice, education, labor, social services, medical and mental health, and public health and safety. Community partners, such as businesses, youth-serving organizations (e.g., YMCA and Boys and Girls Clubs), and faith-based institutions as well as community residents are also critical. Additionally, young persons offer important perspectives. For example, young persons play an integral role in the prevention approaches implemented by CDC's STRYVE-funded Houston Health Department and its partners. Surveys with youths and conducted by youths demonstrated that Houston youths felt disconnected from their community and neighbors, wanted to find ways to improve their community, and had few structured out-of-school activities (*14*). Houston partners used this information, other data sources, and CDC technical assistance to develop a comprehensive prevention plan. They selected evidence-based approaches, such as Youth Empowerment Solutions (e.g., structured opportunities for youth to work with adults and organizations to change social and physical environments) and principles of Crime Prevention through Environmental Design (e.g., maintenance and management of community space such as parks and increased lighting), to enhance the ability of neighborhood organizations to engage youth in violence prevention activities.

Another surmountable challenge is a tendency for communities to wait to intervene following violence rather than proactively preventing it from starting. Partners from the Department of Justice are increasingly focusing on the need for a collaborative, comprehensive approach that includes prevention. Robert L. Listenbee, Administrator of the Office of Juvenile Justice and Delinquency Prevention, stresses that communities cannot arrest their way out of the problem of youth violence and notes that a broader, more nuanced approach is required (*14*). Most youths in the juvenile justice system have been exposed to trauma (e.g., abuse and community violence), thus a part of reducing youth violence is providing these youths with services to help them recover. Judicial, medical, and social interventions that are implemented after youth violence occurs can help stop violence from continuing or progressing by addressing or ameliorating some of the consequences of violence (e.g., physical and mental trauma) that might increase the likelihood violence could occur again (*8*). Although important, these responses are not sufficient because they do not stop violence before it starts. Some interventions even increase the risk for subsequent violence. For example, the Community Guide systematic review of the transfer of juvenile offenders to adult criminal courts showed this strategy resulted in a 34% increase in rearrests for violent crimes (*9*). Primary prevention must be part of the collection of approaches communities use. Multi-agency collaborations, such as the National Forum on Youth Violence Prevention, are more commonly noting that youth violence is a public health problem and not just a law enforcement issue (*15*). Youth violence can be addressed by encouraging communities to use a data-driven, balanced approach that includes prevention, intervention, enforcement, and community reintegration following detention strategies (*15*).

Public Health Role in Preventing Youth Violence

Preventing youth violence has far reaching benefits for health, safety, and economic development. The prevention of youth violence can lower morbidity and mortality from injuries and has the potential for reducing risks for other health problems, such as alcohol and substance abuse, obesity, and chronic diseases, and can result in cost savings for the justice, education, and health care systems. Public health professionals have a clear responsibility to help reduce the health burden of youth violence. With its emphasis on a science-driven approach, the public health sector brings a clear focus on prevention and the promotion of population-wide health, safety, and well-being. The public health community has the skills and expertise to collect and analyze relevant data, select and implement comprehensive prevention strategies, and organize and integrate efforts of diverse partners to successfully address the complex health issues of youth violence (*8*).

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Rapid Intervention to Reduce Ebola Transmission in a Remote Village — Gbarpolu County, Liberia, 2014

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As late as September 14, 2014, Liberia's Gbarpolu County had reported zero cases of Ebola virus disease (Ebola) (*1*). On October 25, the Bong County Health Team, a local health department in the Liberian Ministry of Health and Social Welfare (MOHSW), received confirmation of Ebola in a man who had recently left Geleyansiesu, a remote village of approximately 800 residents, after his wife and daughter had died of illnesses consistent with Ebola. MOHSW requested assistance from CDC, the World Health Organization, and other international partners to investigate and confirm the outbreak in Geleyansiesu and begin interventions to interrupt transmission. A total of 22 cases were identified, of which 18 (82%) were laboratory confirmed by real-time polymerase chain reaction. There were 16 deaths (case-fatality rate = 73%). Without road access to or direct telecommunications with the village, interventions had to be tailored to the local context. Public health interventions included 1) education of the community about Ebola, transmission of the virus, signs and symptoms, the importance of isolating ill patients from family members, and the potential benefits of early diagnosis and treatment; 2) establishment of mechanisms to alert health authorities of possibly infected persons leaving the village to facilitate safe transport to the closest Ebola treatment unit (ETU); 3) case investigation, contact tracing, and monitoring of contacts; 4) training in hygienic burial of dead bodies; 5) active case finding and diagnosis; and 6) isolation and limited no-touch treatment in the village of patients unwilling or unable to seek care at an ETU. The findings of this investigation could inform interventions aimed at controlling focal outbreaks in difficult-to-reach communities, which has been identified as an important component of the effort to eliminate Ebola from Liberia (*2*).

Investigation Results

On September 16, a girl aged 10 years (source patient) attending school in Kakata, Margibi County, returned to Geleyansiesu (southeastern Gbarpolu County, bordering Bong County) (Figure 1), a remote village accessible only by canoe and several hours walking. It was reported by the community that the aunt with whom the source patient resided had recently died of an illness consistent with Ebola. The child became ill on September 18 and was cared for by her

FIGURE 1. Aerial view of the village of Geleyansiesu — Gbarpolu County, Liberia, November 9, 2014

Photo/Kim A. Lindblade

stepmother (aged 37 years) before dying on September 27 in Geleyansiesu. At least 13 village residents in addition to the stepmother participated in her burial, none of whom contracted Ebola. The stepmother experienced symptoms consistent with Ebola on October 8, and became the only known patient with infection attributable to the source patient. The severely ill stepmother was carried in a hammock stretcher by at least nine persons from Geleyansiesu to a nearby town to seek medical care; she died on October 11. One of the hammock carriers, her husband (aged 39 years), traveled to a quarantine center for Ebola patient contacts in Gbarnga, Bong County, along with seven family members who had not participated in her transport. Eight of the carriers returned to Geleyansiesu, and none became ill with Ebola. The husband experienced symptoms including fever, vomiting, and diarrhea beginning on October 24 and was transported to the Bong County ETU (Bong ETU) on October 25, where he tested positive for Ebola virus. He recovered and was discharged on November 12; none of the seven immediate family members staying with him in the quarantine center became ill.

On October 30, MOHSW, Gbarpolu County, and Bong County, CDC, and other international partners conducted a brief overnight assessment visit to Geleyansiesu. The purpose of the visit was to determine whether there was ongoing transmission in the village and gather situational information to mount a coordinated public health response, which was complicated by the difficult access to the community. During the visit, team members educated the community about the signs and symptoms of Ebola and the importance of early identification and treatment, along with the options for diagnosis and treatment at the Bong ETU. Although information provided by the community did not suggest any current cases or contacts of the previously identified cases in the village, they did report two recent deaths on October 27 (of farmer A) and October 28 (of farmer B). Farmer A was reported to have died of an injury, whereas farmer B's death was unexplained. At the time, neither could be linked epidemiologically to the two previous cases. Despite the lack of evidence of ongoing transmission, a Bong county health official was stationed at the closest point to the community accessible by vehicle (Saint Paul River crossing) to provide mobile telephone updates to the county health team and to arrange safe transport to the ETU for any patients walking out of the community.

On November 3, seven ill Geleyansiesu residents departed the village on foot and were later admitted to the Bong ETU; all tested positive for Ebola virus on November 4, and five died. Each of these seven patients was an immediate family member (two wives and five children) of farmer A or farmer B. Preparations were immediately begun by MOHSW and partners for a full investigation and public health response. Before the investigation could be launched, six additional Geleyansiesu residents were admitted to the Bong ETU; all tested positive for Ebola virus, and five died. Four of these six patients had visited or cared for farmer A after his reported injury or had helped prepare his body for burial; they had not received training on safe burial practices. One of the six was linked to farmer B, whereas the epidemiologic link of one could not clearly be determined.

Investigators returned to the village during November 9–11 to complete case investigations, find and monitor contacts, and conduct active house-to-house case finding. Using MOHSW case definitions, described previously (*3*), three probable cases and three suspected cases in the village were identified along with 20 contacts. Investigators provided technical assistance to families and local community health volunteers to isolate and treat patients with oral rehydration solutions and facilitate safe evacuation to the Bong ETU for those willing and able to walk out to the ambulance. One of the patients with a probable case of Ebola left to seek diagnosis and treatment at the Bong ETU and tested negative; another died in the village on November 11. One patient with a suspected case went to the Bomi County community care center (*4*), tested positive, and died. An international partner collected samples on November 11 for the remaining persons with suspected and probable cases, including one post-mortem, and confirmed three cases, all among contacts of farmer A. A clinical partner established isolation tents in the village and was prepared to provide no-touch care to the two remaining cases, but both declined treatment and isolation outside their homes.

On November 19, the clinical partner organization attempted to return to the village to reassess contacts and identify any new cases, but left because of resistance from a group of residents. A meeting with the Gbarpolu County health team and the district's paramount chief (ranking traditional leader) led to successful reentry into the village on November 29 by MOHSW, CDC, and other partners. During follow-up interviews, it was determined that farmer B had cared for the stepmother of the source patient while she was ill; farmer A had been absent from the village during the weeks before his symptom onset, indicating there were likely two separate Ebola introductions into the village. No new cases were identified during the visit, and both of the previously identified confirmed patients had recovered.

During September 18–November 6, a total of 22 Ebola cases (18 confirmed, two probable, and two suspected) were identified in Geleyansiesu, for an estimated attack rate of 28 cases per 1,000 residents (Figure 2). A total of 16 of the cases were fatal. Median age of patients was 34 years, and six patients (27%) were aged <18 years; 13 (59%) were male (Table). Fifteen of 22 patients were hospitalized at an ETU

What is already known on this topic?

Persons with Ebola virus disease (Ebola) can travel with the infection and spark outbreaks in remote areas. These outbreaks can cause large numbers of illnesses and deaths in the absence of public health interventions to find, isolate, and treat persons with Ebola.

What is added by this report?

In October 2014, CDC, the Liberian Ministry of Health and Social Welfare, and other partners investigated an outbreak in a remote community of Liberia, accessible only by canoe and foot, to confirm the outbreak and begin public health interventions. Although there were delays, ambulance support was established to help those patients who managed to walk out of the community reach an Ebola treatment unit; this intervention removed many patients from the community and contributed to the resolution of the outbreak.

What are the implications for public health practice?

Lessons learned from this outbreak were employed in the planning and interventions for subsequent outbreaks in isolated Liberian communities, improving response times and helping to shorten the course of the outbreak.

FIGURE 2. Number of suspected, probable, and confirmed Ebola virus disease cases, by date of symptom onset — village of Geleyansiesu in Gbarpolu County, Liberia, September 18–December 20, 2014

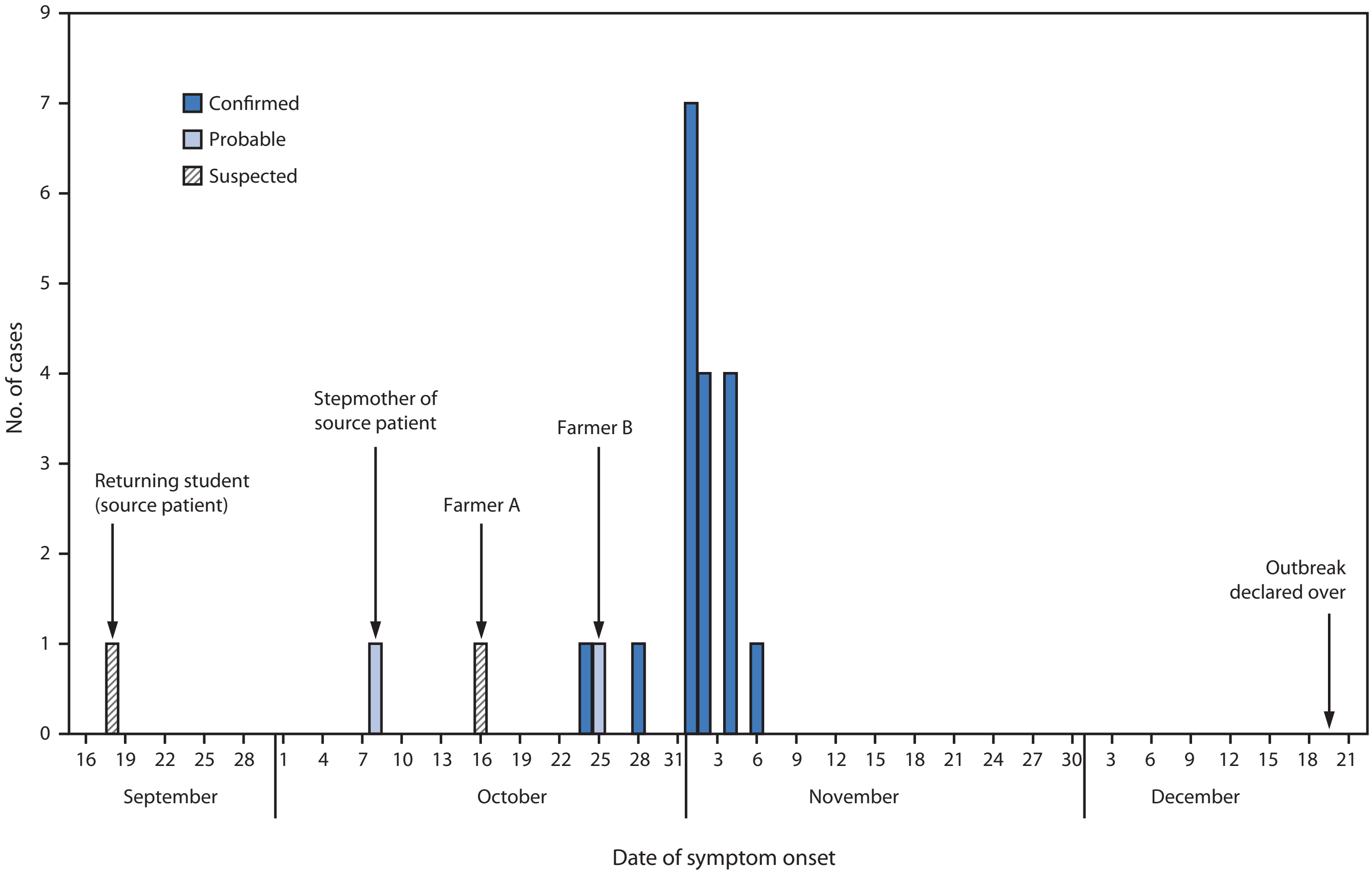

TABLE. Number and percentage of patients with Ebola virus disease (N = 22), by selected characteristics — village of Geleyansiesu in Gbarpolu County, Liberia, September–November 2014

Characteristic	No.	(%)
Male	13	(59)
Aged <18 yrs	6	(27)
Case status		
Confirmed	18	(82)
Probable	2	(9)
Suspected	2	(9)
Hospitalized	15	(68)
Outcome		
Dead	16	(73)
Recovered	6	(27)

or community care center, and 18 had a diagnostic test for Ebola completed; samples for 15 were collected at an ETU or community care center, and three were collected in the village. Among those who were hospitalized, the median interval between reported symptom onset and admission to an ETU was 2 days (mean = 3.4 days; range = 2–8 days). Although the patients who became symptomatic before the initial investigation on October 30 generated an average of three secondary cases, no secondary cases were produced by any of the patients who became symptomatic after October 30. On December 20, 21 days after full recovery of the last patient, the outbreak was declared to be over.

Discussion

During late 2014, multiple outbreaks in remote areas of Liberia were sparked as a result of travelers from affected areas (such as Monrovia) returning to their rural homes. Geleyansiesu is accessible only by a combination of foot and canoe travel, and during this outbreak response, challenges were encountered that have been identified in other rural Liberian counties (*5*), including poor transportation and communication infrastructure. These challenges, in addition to instances of community resistance to outside intervention, likely delayed and complicated the public health response. A multidisciplinary team including domestic and international partners supported the community in responding to the outbreak, which was effectively controlled with interventions including education about Ebola and establishment of a communication plan to alert health authorities to potential cases and to arrange safe ambulance transportation to an ETU. Rapid response teams can initiate interventions to quickly interrupt Ebola virus transmission, even in remote areas. Flexible support networks, including onsite options for nonambulatory persons and transportation support to link patients to treatment centers, could help limit transmission in remote communities.

Acknowledgments

Sampson Dolo, David Vourjoloh, US Peace Corps. Gebru Gebrukrstos, Moses Jerunlon, World Health Organization. Gerald Ferguson, Bong County Health Team. Gbarpolu County Health Team. International Medical Corps. Samaritan's Purse. Abisseh M. Pitta, Global Communities.

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Community Quarantine to Interrupt Ebola Virus Transmission — Mawah Village, Bong County, Liberia, August–October, 2014

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On September 30, 2014, the Bong County health officer notified the county Ebola task force of a growing outbreak of Ebola virus disease (Ebola) in Mawah, a village of approximately 800 residents. During September 9–16, household quarantine had been used by the community in response to a new Ebola infection. Because the infection led to a local outbreak that grew during September 17–20, county authorities suggested community quarantine be considered, and beginning on approximately September 20, the Fuamah District Ebola Task Force (Task Force) engaged Mawah leaders to provide education about Ebola and to secure cooperation for the proposed measures. On September 30, Bong County requested technical assistance to develop strategies to limit transmission in the village and to prevent spread to other areas. The county health team, with support from the Task Force and CDC, traveled to Mawah on October 1 and identified approximately two dozen residents reporting symptoms consistent with Ebola. Because of an ambulance shortage, 2 days were required, beginning October 1, to transport the patients to an Ebola treatment unit in Monrovia. Community quarantine measures, consisting of restrictions on entering or leaving Mawah, regulated river crossings, and market closures, were implemented on October 1. Local leaders raised concerns about availability of medical care and food. The local clinic was reopened on October 11, and food was distributed on October 12. The Task Force reported a total of 22 cases of Ebola in Mawah during September 9–October 2, of which 19 were fatal. During October 3–November 21, no new cases were reported in the village. Involving community members during planning and implementation helped support a safe and effective community quarantine in Mawah.

Investigation and Results

In late August 2014, a male student (source patient) aged 22 years from Kakata, Liberia, the seat of Margibi County, traveled 20 miles (32 km) to Bong Mine Town in neighboring Bong County. He had signs and symptoms of Ebola, including fever, vomiting, and diarrhea, and was reported to have stayed overnight with family in Bong Mine Town on August 30. On August 31, he was taken by motorbike to his mother's ancestral home in Mawah, 10 miles (16 km) by road. On September 1, he returned to Bong Mine Town, where he received home-based care for 3 days from a nurse-aid, before dying on September 4. No specimen was collected for Ebola virus testing, and he was buried in Bong Mine Town on September 6 by family members, who had not received training on safe burial practices.

The nurse-aid who provided care to the source patient in Bong Mine Town departed from there on September 3 and traveled to nearby Monokparga and Kalikata Meca, where he became ill. The nurse-aid continued to provide patient care after symptom onset, becoming the likely source of infection for a cluster of at least nine Ebola cases. Currently, no additional information is available regarding this separate cluster.

On September 9, an adult male Mawah resident who reportedly had contact with the source patient during his overnight stay in Mawah developed Ebola-like symptoms. He tested positive for Ebola virus, and later died. During September 9–16, six households of his and the source patient's contacts were quarantined in an effort to prevent transmission within the village, and to prevent spread to other areas. Six additional persons experienced onset of symptoms during September 17–20, and each later died.

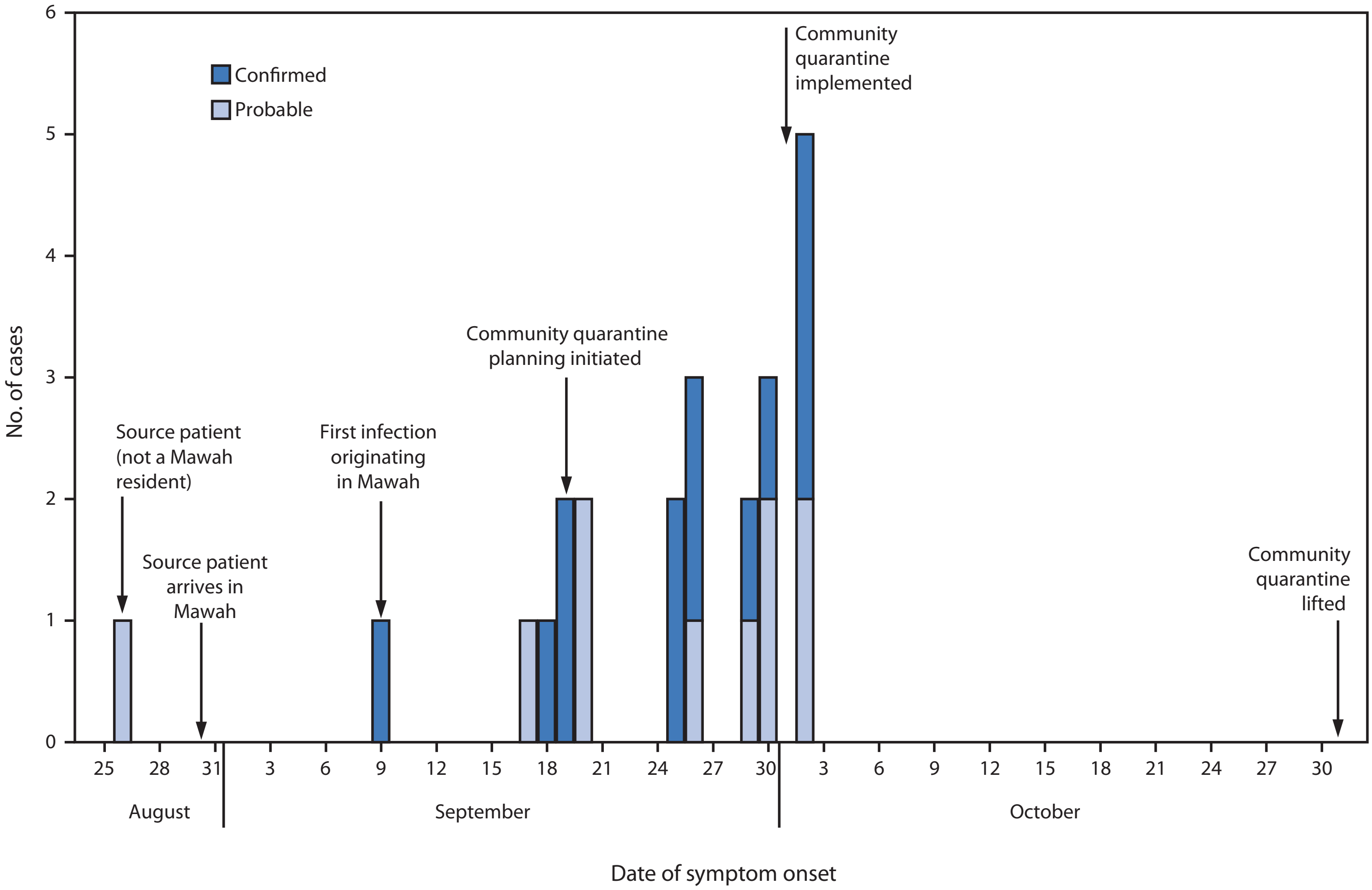
An investigation by the Task Force identified 22 incident cases of Ebola (13 confirmed and nine probable) in Mawah (Figure 1), resulting in 19 deaths during September 9–October 2. Seven of the patients were female, and the median age was 44 years. A total of 160 contacts were identified.

Public Health Response

Because of the increase in cases, on approximately September 20, the county health officer suggested that the Task Force chair (TFC), a local physician, consider community quarantine as an additional measure. After multiple meetings with the village chief and elders to provide information on Ebola and its transmission, and inclusion of the paramount chief (ranking traditional leader) in the Task Force, the TFC proposed a community quarantine period of 21 days, consisting of the following measures:

1) Restrictions on residents leaving Mawah (e.g., checkpoint at access road),
2) Prohibition of nonresidents entering Mawah (e.g., road checkpoint),

FIGURE 1. Number of probable and confirmed Ebola virus diseases cases, by date of symptom onset — village of Mawah in Bong County, Liberia, August 26–October 31, 2014



3) Regulation of local river crossings, and
4) Closure of two local markets.

Local leaders expressed two main concerns relating to the proposal. First, the measures would leave the village without important food and income sources because residents fish in the St. Paul River and rice fields are on the opposite bank. Leaders agreed it was prudent to regulate cross-river traffic, but were concerned that residents' livelihoods would suffer if fishing grounds and fields were off-limits, and if markets were closed. Second, community leaders were concerned that the proposed measures would limit residents' access to basic medical services. A clinic normally operated in Mawah, but it had closed recently, leaving a clinic in a neighboring village as the only remaining option within walking distance.

Community quarantine was instituted on October 1 and presented the community and the Task Force with challenges. For example, the reopening of the clinic and food delivery were delayed by approximately 1 week while county and international partners requested and coordinated the needed personnel and resources. During the first week of October, the Task Force requested support to address issues relating to medical care and food. To reopen the medical clinic, Bong County paid a nurse to manage the clinic 2 days per week, and an international nongovernmental organization provided three support staff, which allowed services to resume on October 11. The nurse was provided a noncontact infrared thermometer and was instructed to avoid providing care to persons with symptoms consistent with the case definitions for suspected or probable Ebola, but rather to seek support in arranging for safe ambulance transport. Partners in Bong County contacted the World Food Programme, which on October 12 delivered a 45-day ration of rice, corn, beans, and lentils, and assisted village leaders with distribution. During the quarantine, members of the Task Force visited the village at least twice per week to provide psychosocial support for affected families, with special emphasis on survivors and those with family members receiving treatment in an Ebola treatment unit. The TFC worked with local leaders to arrange regulated cross-river transport so residents could access fields for harvest. The crossing was open to farmers each morning, closed during the middle of the day, and then reopened each evening to allow return. Hand hygiene supplies were placed at the crossing, and two canoe pilots were identified to provide the only river crossing services. Canoes not belonging to approved pilots were chained to trees (Figure 2). Pilots were instructed to deny transport to symptomatic persons and to asymptomatic nonresidents (e.g., persons attempting to reach a market). After the safe transport of symptomatic persons to an Ebola treatment unit during October 1–2, and institution of community quarantine, Mawah had no newly reported cases for the remainder of the quarantine period, which was extended by 10 days as a precautionary measure and concluded on October 31.

Discussion

Community quarantine is controversial, and implementation requires careful consideration of the balance between public health and individual rights (*1*). Potential secondary consequences, including insufficient access to food and medical care, are important considerations. Although no causal conclusions can be drawn from the Mawah experience about the effectiveness of community quarantine, it illustrated a number of issues that must be addressed in such situations.

First, community leaders needed to be convinced that the disease was real. During the current Ebola epidemic, earning community trust and confidence in response efforts has at times been challenging (*2*). In Mawah, community members might only have been willing to accept the proposed quarantine after witnessing the devastating effect Ebola had on the village. Second, a trusted local leader with health expertise and an understanding of the culture acted as a liaison between community leaders and district health authorities. Communities might benefit from formal integration of traditional leaders into outbreak response planning, and could consider offering both traditional and political leaders opportunities to provide feedback before decisions are made relating to proposed public health interventions. Third, local leaders worked to ensure that basic needs (e.g., food, medical, and psychosocial) were met for the duration of the quarantine period. In this situation, support was provided by the county and international nongovernmental organizations. In other low-resource settings, or in areas with small populations, a similar approach might be necessary to ensure that community needs are met if community quarantine is determined to be an effective approach to interrupting Ebola virus transmission. Finally, the appropriate isolation of sick persons and comprehensive contact tracing remain essential components of an Ebola response, irrespective of decisions on community quarantine.

FIGURE 2. Most community canoes were chained to trees for the duration of the community quarantine period — village of Mawah in Bong County, Liberia, 2014

Photo/David J. Blackley

What is already known on this topic?

Community quarantine can be controversial and logistically difficult to implement.

What is added by this report?

During September–October 2014, multiple partners responded to an outbreak of Ebola virus disease (Ebola) in the village of Mawah in Bong County, Liberia; county officials proposed community quarantine. Local traditional leaders were integrated into response planning and raised concerns about availability of medical care and food. Community quarantine was implemented, and local, national, and international partners arranged to reopen a local clinic, deliver food, and provide psychosocial support. After removal of symptomatic patients and implementation of community quarantine, Mawah reported no new Ebola cases.

What are the implications for public health practice?

Community quarantine in a low-resource setting can restrict access to critical goods and services. Involving local leaders during planning and implementation can help ensure community needs are met. Isolation of ill persons and contact tracing remain essential components of an Ebola response, irrespective of decisions on community quarantine.

Acknowledgments

Bong County Health Team. Fuamah District Ebola Task Force. CDC Liberia field team. World Food Programme. US Peace Corps Liberia staff.

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Implementation of Ebola Case-Finding Using a Village Chieftaincy Taskforce in a Remote Outbreak — Liberia, 2014

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On October 16, 2014, a woman aged 48 years traveled from Monrovia, Liberia, to the Kayah region of Rivercess County, a remote, resource-poor, and sparsely populated region of Liberia, and died on October 21 with symptoms compatible with Ebola virus disease (Ebola). She was buried in accordance with local tradition, which included grooming, touching, and kissing the body by family and other community members while it was being prepared for burial. During October 24–November 12, eight persons with probable and 13 with confirmed Ebola epidemiologically linked to the deceased woman had onset of symptoms. Nineteen of the 21 persons lived in five nearby villages in Kayah region; two, both with probable cases, lived in neighboring Grand Bassa County (Figure). Four of the confirmed cases in Kayah were linked by time and location, although the source case could not be determined because the patients had more than one exposure.

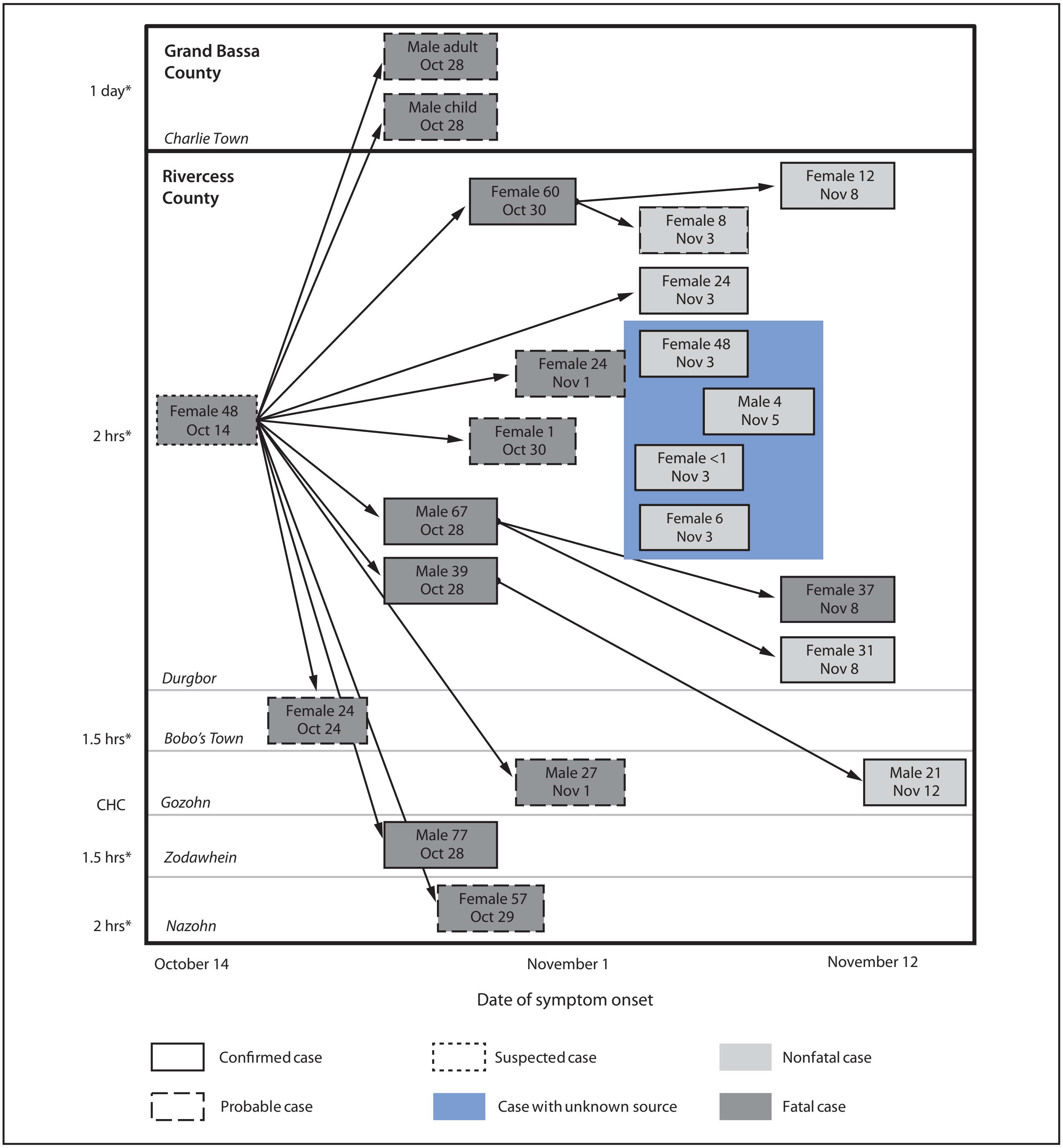
On November 9, the Rivercess County Health Team requested assistance from CDC, Médecins Sans Frontières, the World Health Organization, and other partners to assess area needs and guide response efforts. Initial public health actions from November 11 to November 17 included health promotion messaging, rapid construction and staffing of a temporary isolation and treatment facility, and an investigation that included case finding, area mapping, and interviews with village leaders and community representatives. Village leaders reported that some known contacts had fled to the surrounding forest, raising concerns that Ebola might have been transmitted to surrounding villages. Many of these villages lack cellular phone connectivity and are only reachable by footpaths through dense forest. In addition, movement between neighboring village communities is common and is unrestricted by administrative boundaries, which facilitates the possibility of wide dispersion of contacts who might not all be included in contact listing. For these reasons, traditional contact tracing (*1*) was determined to be inadequate to stop transmission. This report describes a novel system to supplement contact tracing by quickly identifying potential cases among villages in a remote area with limited infrastructure.

An active surveillance network was created by working with community leadership to establish village-to-village communication relays that could, with minimal additional investment of resources or training, rapidly overcome the obstacle to outbreak control that was posed by the lack of means of communication and transportation in the remote area. The Kayah region is a chiefdom containing 37 villages with approximately 5,000 persons, led by a council of village chiefs. The CDC and county health team requested a meeting with the council of chiefs, as well as representatives of men, women, youths, and elders of the community, to hear their concerns, identify needs, and to engage them as partners in social mobilization to sensitize the community to the urgency of outbreak control, and to overcome resistance to Ebola messaging and measures to prevent transmission. Following this meeting, the chiefs and community members expressed a high level of enthusiasm for participating in the Ebola response in a concrete and visible way as members of a Chieftancy Task Force, and contributed to the design of the surveillance system.

Capitalizing on existing political and public health structures, the county health team and CDC created a process for active case-finding at the village level and reporting of cases and deaths to the district health team. The Kayah chiefdom includes a single health clinic, and is organized into four community health clusters of five to 14 neighboring villages per cluster. Each cluster is represented by a community health committee in the principal (largest and most accessible) village of the cluster. Within each cluster a maximum of 2 hours of walking was required to reach the nearest village or cellphone-accessible area. All cases in Rivercess County occurred in the Gozohn community health cluster. In each of the 11 villages in this cluster, Task Force members identified a person (when available, this was a general community health volunteer, a village member trained in general community health issues) to perform a daily survey of all village households to identify persons who were feeling unwell for any reason and any deaths from any cause. Special attention was paid to subjective fever, severe body pain or weakness, or gastrointestinal symptoms, the most common early signs and symptoms of Ebola (*2*). A report of any of these findings was transmitted daily to a community health committee representative, either by telephone or in person.

Reports from the villages were expected at least every 2 days, even if zero cases or deaths were detected. A simple log of reports was kept by the community health committee representative and the district health team to identify villages with

FIGURE. Ebola cases epidemiologically linked to the death of a woman aged 48 years, by patient's sex, age in years, and date of symptom onset — Rivercess and Grand Bassa counties, Liberia, October 14–November 12, 2014



* Approximate walking distance from Gozohn, the location of the community health committee (CHC) that serves the affected villages in Rivercess County.

missed reports and record basic details of positive reports. The district health team followed up each alert with case investigation or triage, as appropriate. Missed reports were followed up by reestablishing contact with the village by telephone or in person, as needed.

Surveillance was implemented on November 17 in Gozohn village. It was expanded to the rest of the Gozohn community health cluster on November 20, and continued until 21 days following the last possible exposure to a person with confirmed or suspected Ebola in the community, a total of 16 days. There was a high level of acceptance by village surveillance volunteers and community members. Reports were filed from all 11 villages every 2 days; one suspected case and one death were detected, both of which were determined not to be Ebola by laboratory test or verbal autopsy, respectively. Following cessation of daily reporting, village and community health cluster representatives expressed interest in scaling down the system to continue passive reporting of suspected Ebola cases. Widespread prominent display of Ebola health promotion posters on houses and in common areas suggested that active participation by village leadership and community representatives was helping to raise awareness and acceptance of Ebola prevention messaging.

This system could be easily used or adapted for use in other remote areas where there is concern about active Ebola transmission and unidentified contacts, and where local geography and lack of communication and transportation infrastructure impede case-finding and contact tracing from a more central administrative level (e.g., district or county level). Adequate performance of the system can be measured using indicators such as the number of missed reports and the number of cases that are only detected from other sources (e.g., patients admitted to an Ebola treatment unit or cases reported directly to the district or county surveillance teams). In addition, if implemented on a scale that includes multiple community health clusters and larger population sizes, a well-performing system should detect all-cause mortality in the surveillance catchment area of at least the baseline crude death rate for Liberia, up to one per 10,000 population per day, the expected crude mortality rate in complex humanitarian emergency settings (*3*).

Acknowledgment

Bernadette Gergonne, Médecins Sans Frontières.

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Update: Ebola Virus Disease Epidemic — West Africa, February 2015

Incident Management System Ebola Epidemiology Team, CDC; Guinea Interministerial Committee for Response Against the Ebola Virus; World Health Organization; CDC Guinea Response Team; Liberia Ministry of Health and Social Welfare; CDC Liberia Response Team; Sierra Leone Ministry of Health and Sanitation; CDC Sierra Leone Response Team; Viral Special Pathogens Branch, National Center for Emerging and Zoonotic Infectious Diseases, CDC

On February 24, 2015, this report was posted as an MMWR *Early Release on the* MMWR *website (http://www.cdc.gov/mmwr).*

CDC is assisting ministries of health and working with other organizations to end the ongoing epidemic of Ebola virus disease (Ebola) in West Africa (*1*). The updated data in this report were compiled from situation reports from the Guinea Interministerial Committee for Response Against the Ebola Virus, the Liberia Ministry of Health and Social Welfare, the Sierra Leone Ministry of Health and Sanitation, and the World Health Organization.

According to the latest World Health Organization update on February 18, 2015 (*2*), a total of 23,253 confirmed, probable, and suspected cases of Ebola and 9,380 Ebola-related deaths had been reported as of February 15 from the three West African countries (Guinea, Liberia, and Sierra Leone) where Ebola virus transmission has been widespread and intense. Total case counts include all suspected, probable, and confirmed cases, which are defined similarly by each country (*3*). Because of improvements in surveillance, the number of cases reported in recent weeks might overestimate the number of Ebola cases in some areas because nonconfirmed cases are included in the total case counts. Sierra Leone reported the highest number of laboratory-confirmed cases (8,212), followed by Liberia (3,149) and Guinea (2,727). During the week ending February 14, a daily average of 11 confirmed cases were reported from Sierra Leone, fewer than one from Liberia, and seven from Guinea. The areas with the highest numbers of confirmed cases reported during January 25–February 14 were the Western Area and Port Loko (Sierra Leone) and Forecariah (Guinea) (Figure). Guinea saw an increase in confirmed cases over the past 3 weeks. This might reflect improved surveillance and case reporting because of increased access to previously inaccessible communities.

The latest updates on the ongoing Ebola epidemic in West Africa, including case counts, are available at http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/index.html. The most up-to-date infection control and clinical guidelines for the Ebola epidemic in West Africa are available at http://www.cdc.gov/vhf/ebola/hcp/index.html.

Acknowledgments

World Health Organization. Geospatial Research, Analysis, and Services Program, CDC. Situational Awareness Team, Office of Public Health Preparedness and Response, CDC.

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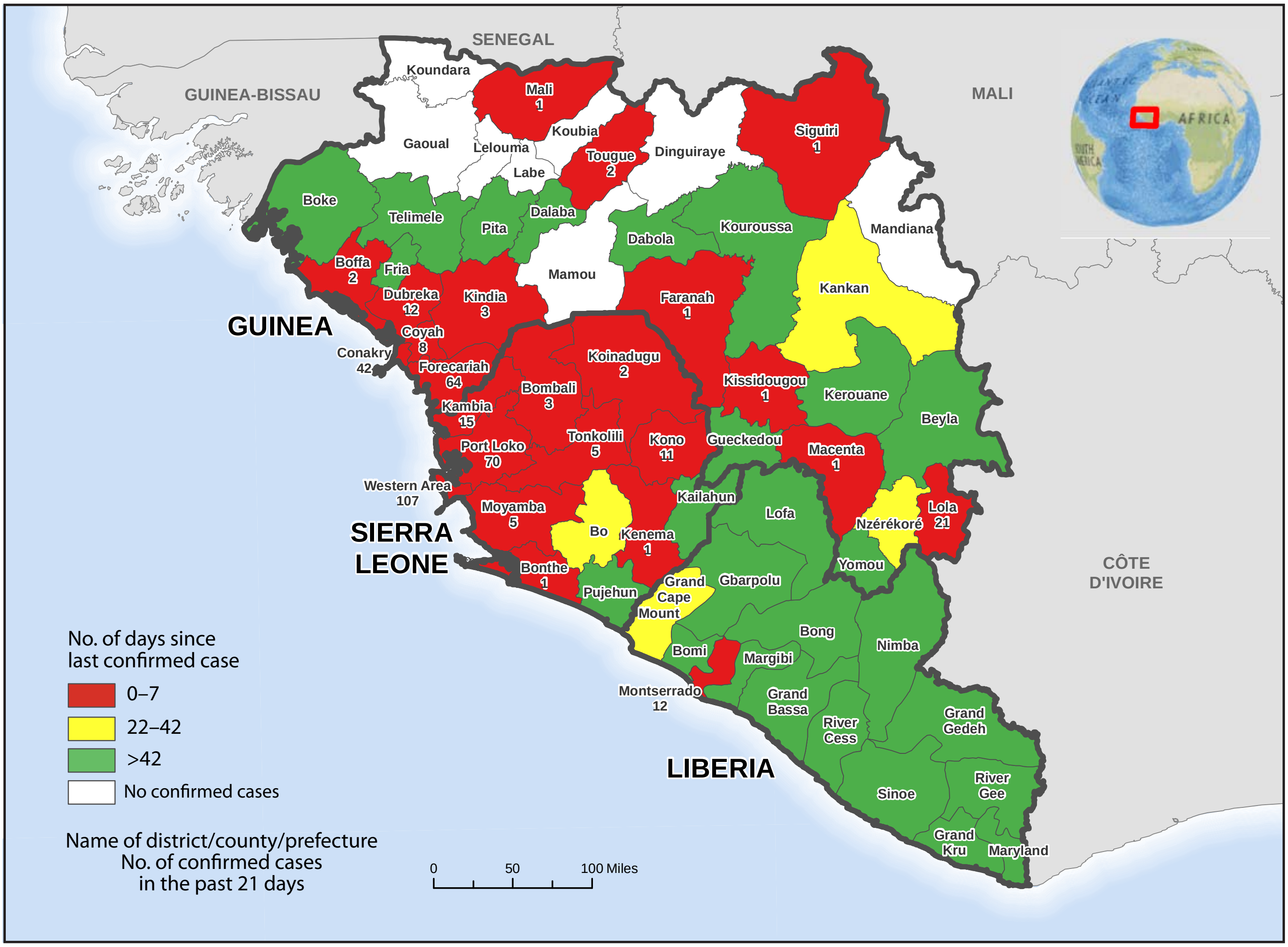
FIGURE. Number of days since last confirmed case of Ebola virus disease and number of confirmed cases in the past 21 days — Guinea, Liberia, and Sierra Leone, January 25–February 14, 2015*



Sources: Guinea Ministry of Health; Liberia Ministry of Health and Social Welfare; Sierra Leone Ministry of Health and Sanitation; World Health Organization.
* Data as of February 14, 2015.

Rapid Response to Ebola Outbreaks in Remote Areas — Liberia, July–November 2014

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On February 20, 2015, this report was posted as an MMWR *Early Release on the* MMWR *website (http://www.cdc.gov/mmwr).*

West Africa is experiencing its first epidemic of Ebola virus disease (Ebola) (*1*). As of February 9, Liberia has reported 8,864 Ebola cases, of which 3,147 were laboratory-confirmed. Beginning in August 2014, the Liberia Ministry of Health and Social Welfare (MOHSW), supported by CDC, the World Health Organization (WHO), and others, began systematically investigating and responding to Ebola outbreaks in remote areas. Because many of these areas lacked mobile telephone service, easy road access, and basic infrastructure, flexible and targeted interventions often were required. Development of a national strategy for the Rapid Isolation and Treatment of Ebola (RITE) began in early October. The strategy focuses on enhancing capacity of county health teams (CHT) to investigate outbreaks in remote areas and lead tailored responses through effective and efficient coordination of technical and operational assistance from the MOHSW central level and international partners. To measure improvements in response indicators and outcomes over time, data from investigations of 12 of 15 outbreaks in remote areas with illness onset dates of index cases during July 16–November 20, 2014, were analyzed. The times to initial outbreak alerts and durations of the outbreaks declined over that period while the proportions of patients who were isolated and treated increased. At the same time, the case-fatality rate in each outbreak declined. Implementation of strategies, such as RITE, to rapidly respond to rural outbreaks of Ebola through coordinated and tailored responses can successfully reduce transmission and improve outcomes.

Outbreaks in remote areas posed a significant challenge to CHTs to mount an effective investigation and rapid response because of limited resources, personnel, and means to reach remote areas. The RITE strategy provided a framework to coordinate assistance from the central MOHSW and other agencies under the leadership of the CHT and developed several tools to help plan, manage, and track a response effort. The objectives of the investigation and response teams were to 1) rapidly isolate and treat Ebola patients, either by establishing isolation and treatment facilities in the community or by safely transporting patients to existing Ebola treatment units (ETUs); 2) ensure proper collection and safe transportation of samples for Ebola laboratory confirmation; 3) ascertain the index case (the first person in the transmission chain who entered the community from another county in Liberia) in each outbreak to better understand importation and transmission patterns; 4) identify all generations of cases by improving case finding and contact tracing to ensure no cases were missed; 5) train teams in safe burial procedures; and 6) observe contacts for 21 days from the death or ETU admission of the last case to ensure interruption of transmission. Investigation and response teams included Liberian MOHSW national and county representatives, CDC, WHO, the United Nations Children's Fund, and other multilateral and nongovernmental organizations.

The RITE strategy clearly articulated the role of CHTs to coordinate efforts of partners involved in response activities to rapidly mobilize resources that could be tailored to the needs in each outbreak. After initiation of the RITE strategy in October, outbreak responses were supported with structured rapid response microplanning tools implemented by CHTs that delineated each intervention component (e.g., isolation of patients, laboratory testing, and health promotion) and the organizations responsible for implementation. Outbreaks and response activities were reviewed on a weekly basis at the national level at the county operations subcommittee of the national incident management system (*2*), allowing MOHSW and partner organizations to plan and prioritize resources for the rapidly changing situation. An additional intervention beginning in November was the packaging of RITE kits that could be prepositioned in the counties, containing all commodities required for the first 14 days of response interventions (e.g., essential medicines for treatment of patients such as oral rehydration solution, antimalarial medication, and antibiotics; personal protective equipment; and construction materials for temporary isolation and treatment facilities). The availability of RITE kits at the county level would provide further flexibility to CHTs to tailor rapid responses appropriately for the community involved in the outbreak and add to their ability to rapidly deploy the necessary resources to the affected area.

For this report, Ebola outbreaks that occurred in remote areas, produced at least one generation of transmission in the community and had complete investigations were analyzed. An Ebola outbreak was defined as two or more epidemiologically linked Ebola cases. Cases were classified as suspected, probable, or confirmed using the Liberian case definitions (*3*).

Initial alerts of possible Ebola outbreaks were received by CHTs as rumors, reports of clusters of ill persons or unexplained deaths, or reports of patients admitted to ETUs. Case investigation reports were gathered through interviews with ill persons or their proxies. Databases from ETUs were searched to supplement incomplete case investigation reports. Transmission-chain diagrams were constructed back to the first case to enter the county from another county in Liberia (the index case). The first generation of cases was defined as resulting from contact with the index patient, and the total number of generations was determined from the transmission-chain diagrams. To monitor the effectiveness of rapid response to outbreaks over time, the number of days between the symptom onset of the index patient and the date the CHT was first alerted to a potential outbreak, and the date the CHT first sent in a team to investigate were computed for each outbreak. Outbreak duration was calculated as the number of days between the symptom onset date of the index case and the last case in the outbreak, defined as the last case in a chain of transmission to occur before 21 days passed with no new cases. Demographic characteristics of patients and the proportion of patients isolated and treated in an ETU or similar facility were summarized by outbreak.

Among 15 Ebola outbreaks in remote areas of nine counties with index case symptom onset dates during July 16–November 20, 2014, 12 investigations had complete data (Figure 1). Investigations of these 12 outbreaks identified 263 patients (Table), including 155 (59%) with laboratory-confirmed cases of Ebola, 71 (27%) with probable cases, and 37 (14%) with suspected cases. There were 190 deaths (case-fatality rate = 72%). The median number of cases in an outbreak was 22 (range = 4–64), and the median population in the affected communities was 800 (range = 301–6,200). Attack rates ranged from 1 to 71 cases per 1,000 population. The median age of the patients was 32 years (range = 15 days to 84 years), and 144 (55%) were female. Eight (67%) outbreaks began with the introduction of an Ebola case from Monrovia, two from a neighboring county, and the source of introduction for three outbreaks was not identified (one outbreak had two index cases) (Table). Transmission of Ebola occurred through close contact with persons who were ill with Ebola, including providing care to a patient at home, or contact with a person who had recently died from Ebola. In Small Ganta, Nimba County, the death and burial of a woman who cared for the index patient resulted in 16 (25%) of the 64 Ebola cases in that outbreak. Although several traditional healers were infected in these outbreaks, no cases in health care workers from public or private health facilities were identified.

FIGURE 1. Locations of 12 Ebola outbreaks in remote communities — Liberia, July 16–November 20, 2014

The median time between symptom onset in the index patient and an alert received by the CHT was 33 days (range = 0–58 days); the median time to alert was 40 days for the six outbreaks before October 1 (prior to initiation of the RITE strategy) and 25 days for the six outbreaks with onset after October 1 (after the RITE strategy) (Figure 2). The median duration of the outbreaks was 43 days (range = 7–97 days). The median duration of the early outbreaks was 53 days, compared with 25 days for the later outbreaks. The median number of generations of cases was four (range = 1–7) for the early outbreaks and two (range = 1–4) for the later outbreaks.

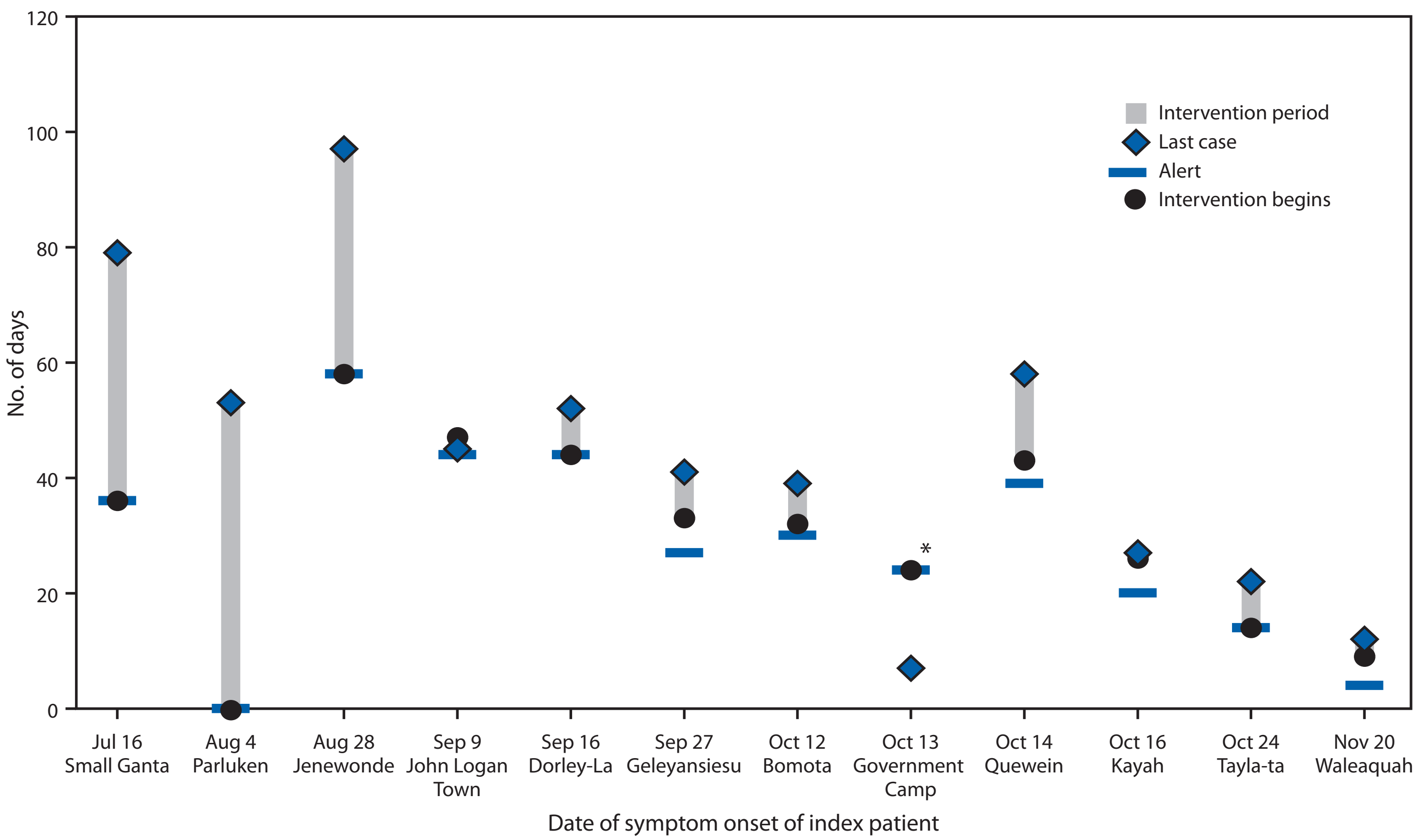
Interventions in the 12 outbreaks included 1) engagement of traditional and community leaders in response activities; 2) community education about Ebola virus transmission and prevention; 3) active case finding, contact tracing and monitoring; 4) quarantine of asymptomatic high risk contacts at home or in designated quarantine facilities; 5) isolation and treatment of patients; and 6) safe burials. In each community, the appropriate level of intervention was determined by the community's requests, the number and severity of cases, the remoteness and accessibility of the community, and the

TABLE. Characteristics of 12 Ebola outbreaks in remote communities — nine counties, Liberia, July 16–November 20, 2014

County	Community	Estimated pop.	Date of symptom onset of index case	Origin of index case	Days from index case onset to investigation	Total no. of cases (% laboratory-confirmed*)	Estimated attack rate (per 1,000 pop.)	% female	% isolated and treated	Case-fatality rate (%)
Nimba	Small Ganta	900	July 16	Monrovia	36	64 (47)	71	64	25	73
Grand Kru	Parluken	2,000	August 4	River Gee	0	17 (47)	9	41	18	82
Grand Cape Mount	Jenewonde	800	August 28	Monrovia	58	35 (40)	44	51	31	91
Grand Bassa	John Logan Town	5,000	September 9	Unknown	47	17 (12)	3	29	6	94
Bomi	Dorley-La	301	September 16	Monrovia	44	10 (40)	33	50	50	100
Gbarpolu	Geleyansiesu	800	September 27	Kakata, Margibi	33	22 (82)	28	41	68	73
Bong	Bomota	397	October 12	Unknown	32	14 (86)	35	57	86	50
Sinoe	Government Camp	6,200	October 13	Monrovia	24	4 (75)	1	25	75	50
Grand Bassa	Quewein	371	October 14	Monrovia	43	24 (75)	65	65	54	61†
Rivercess	Kayah	5,000	October 16	Monrovia	26	22 (59)	4	64	41	59
Bong	Tayla-ta	500	October 24	Monrovia	14	28 (96)	56	68	96	50
Grand Cape Mount	Waleaquah	700	November 20	Monrovia	9	6 (100)	9	33	100	50

* Laboratory confirmation of cases was performed by real-time polymerase chain reaction testing at one of four laboratories in Liberia.
† One patient died from an accident and was not included in the case-fatality rate calculation.

FIGURE 2. Number of days from Ebola symptom onset of the index patient to alert of the county health team, beginning of intervention, and the last reported case in 12 Ebola outbreaks in remote communities — Liberia, July 16–November 20, 2014



* The alert to the county health team did not come until after the last reported case on October 20. The investigation, which included contact monitoring, began on November 6.

FIGURE 3. Challenges facing Ebola teams traveling to remote communities in Liberia have included impassable roads such as this one on the way to John Logan Town (left) and difficult river crossings such as this one on the way to Bomota (right)

Photo/Justin Williams Photo/Sampson Dolo

distance to Ebola treatment facilities. Resistance to assistance was encountered in several communities, and response was suspended until discussions with county and traditional officials or the increasing burden of cases and deaths encouraged community acceptance of intervention. In two outbreaks (Kayah District, Rivercess and Quewein, Grand Bassa), the availability of nongovernmental partners to rapidly establish isolation and treatment facilities permitted on-site or nearby care of patients. In these and other outbreaks, some patients were able to reach ambulances at the closest road access point and were taken to established ETUs. In one outbreak (Jenewonde, Grand Cape Mount), delays in the establishment of an isolation and treatment facility resulted in only one patient being cared for in the facility before the outbreak was over.

Over time, the proportion of patients in each outbreak that were isolated and treated increased from a median of 28% in the early outbreaks to 81% in the later outbreaks (Table). The proportion of laboratory-confirmed cases increased from a median of 44% in the early outbreaks to 81% in the later outbreaks because a greater proportion of patients reached treatment facilities and specimen collection in the field improved as part of the RITE strategy. The case-fatality rate of each outbreak also improved over time; the median case-fatality rate in the early and later outbreaks were 87% and 50%, respectively. As of January 8, 2015, all of these outbreaks had ended with no further cases identified within 21 days of exposure to the last patient.

Discussion

Implementing an effective rapid response is critical to limiting the magnitude and duration of Ebola outbreaks. The remoteness and complexity of the outbreaks described in this report have posed challenges to rapid response; movement of personnel and supplies was greatly hindered by distance, river crossings, poor or nonexistent roads (Figure 3), and limited communication options (*4*). Nonetheless, implementation of the RITE strategy resulted in substantial reductions in the time from symptom onset of the index patient to outbreak alerts, in the duration of outbreaks, and in the case-fatality rate.

Four of the six outbreaks that occurred before development of the RITE strategy remained undetected until they were in at least the third generation of transmission, whereas five of the six later outbreaks were detected in the first or second generation. In addition to the RITE strategy, greater community awareness of Ebola helped alert authorities earlier to clusters of unexplained deaths or illness consistent with Ebola and also facilitated faster community acceptance of interventions. Availability of ETU beds for isolation and treatment of patients also improved significantly over the period covered by these outbreaks (*5*), and the increasing proportion of patients reaching an ETU or other type of isolation and treatment facility likely contributed to the shorter duration of outbreaks. Continued access to early treatment, efforts to improve community awareness, and deployment of rapid, coordinated, and effective responses to remote rural outbreaks will need to continue until Ebola transmission in West Africa is halted.

What is already known on this topic?

The epidemic in West Africa has resulted in the largest number of Ebola cases in history. Ebola is associated with a high case-fatality rate that can be reduced through supportive care. Ebola transmission can be interrupted through isolation of infected patients, infection control, monitoring of patients' contacts, and safe burial of dead bodies. Remote rural areas pose challenges for rapid isolation and treatment of patients because of their distance, difficult access, and lack of communications infrastructure.

What is added by this report?

A national strategy in Liberia to coordinate rapid responses to remote outbreaks of Ebola reduced by nearly half the time between the first new case in remote areas and notification of health authorities. As coordination of the rapid response strategy improved over time, the median duration of outbreaks decreased from 53 to 25 days as the number of generations of cases decreased from a median of four to two. The proportion of patients isolated increased from 28% to 81%; survival improved from 13% to 50%.

What are the implications for public health practice?

Ebola outbreaks in remote rural areas require rapid responses, including the movement of patients to treatment facilities. Interventions can be as simple as arranging safe ambulance transport for patients who might have to walk out of remote areas, but might also require establishment of mobile isolation and treatment facilities if patients are too ill to move or delays in transport are anticipated. Comprehensive and innovative rapid response units can improve outcomes and shorten duration of Ebola outbreaks, and should be employed wherever possible.

Acknowledgments

The county and district health teams of Bomi, Bong, Grand Bassa, Grand Cape Mount, Grand Kru, Nimba, Sinoe, RiverCess, and Gbarpolu, Liberia. The Liberia Ministry of Health and Social Welfare. United States Agency for International Development, Office of U.S. Foreign Disaster Assistance. Denise Allen, Michael Beach, Laurie Fuller, Neil Gupta, Romel Lacson, James V. Lange, Terrence Q. Lo, Minal K. Patel, Agam K. Rao, Jay Roth, John M. Saindon, Paul Weidle, CDC Liberia Team. Gebru Gebrukrstos, Moses Jerunlon, Emeka Agbo, Mohamed El Ghazaly, Esther Namukose Muwanguzi, Musu Duworko, Rabiul Sarkar, Jarlath Tunney, World Health Organization. The African Union. Concern Worldwide. E-Health. Global Communities. International Medical Corps. Last Mile. Liberian Red Cross. Médecins Sans Frontières. Peace Corps. Samaritan's Purse. United Nations Children's Fund. United Nations Mission for Emergency Ebola Response. United States Navy. National Institutes of Health. United States Army. Randall Young.

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Revised Device Labeling for the Cepheid Xpert MTB/RIF Assay for Detecting *Mycobacterium tuberculosis*

Division of Microbiology Devices, Office of In Vitro Diagnostics and Radiological Health, Center for Devices and Radiological Health, Food and Drug Administration

The Food and Drug Administration (FDA) has cleared the Xpert MTB/RIF Assay (Cepheid; Sunnyvale, California) with an expanded intended use that includes testing of either one or two sputum specimens as an alternative to examination of serial acid-fast stained sputum smears to aid in the decision of whether continued airborne infection isolation (AII) is warranted for patients with suspected pulmonary tuberculosis (*1*). This change reflects the outcome of a recent multicenter international study demonstrating that negative Xpert MTB/RIF Assay results from either one or two sputum specimens are highly predictive of the results of two or three negative acid-fast sputum smears.*

When compared with the results of two or three serial fluorescent-stained acid-fast sputum smears, a single Xpert MTB/RIF Assay result detected approximately 97% of patients who were acid-fast bacilli (AFB) smear–positive and culture-confirmed as infected with *Mycobacterium tuberculosis* complex (MTBC), and two serial Xpert MTB/RIF Assay results detected 100% of AFB smear–positive/MTBC culture-positive patients. In the setting of an overall prevalence of culture-confirmed pulmonary tuberculosis of 22.4% (14.2% [88 of 618] in the United States and 37.1% [127 of 342] outside the United States), a single negative Xpert MTB/RIF Assay result predicted the absence of AFB smear–positive pulmonary tuberculosis with a negative predictive value of 99.7% (99.6%% in the United States and 100% outside the United States); for two serial negative Xpert MTB/RIF Assay results, the negative predictive value was 100%. These findings confirm the results from earlier reports (*2,3*). In addition, one or two Xpert MTB/RIF Assay tests detected 55% and 69%, respectively, of sputum specimens that were AFB smear–negative but culture-positive for MTBC.

Updated labeling for the Xpert MTB/RIF Assay includes the recommendation that the decision whether to test one or two sputum specimens in determining the need for continued AII should be based on specific clinical circumstances and institutional guidelines. Clinical decisions regarding the need for continued AII should always occur in conjunction with other clinical and laboratory evaluations, and negative Xpert MTB/RIF Assay results should not be the sole basis for infection control practices. The revised label also includes information demonstrating that Xpert MTB/RIF Assay performance is similar in human immunodeficiency virus (HIV)-infected and HIV-uninfected adults, although HIV-infected adults with pulmonary tuberculosis might be more likely to be AFB smear negative at presentation. The Xpert MTB/RIF Assay should not be used for decisions regarding the need for continued AII if MTBC has been detected by the Xpert MTB/RIF Assay or by other methods.

Product labeling retains the recommendation that regardless of Xpert MTB/RIF Assay results, serial collection of sputum specimens for mycobacterial culture remains necessary because nucleic acid amplification testing does not detect all patients with pulmonary tuberculosis, and recovery of organisms for further characterization and drug-susceptibility testing is needed when MTBC is present. Concomitant acid-fast microscopy of serial sputum specimens is also needed when excluding nontuberculosis mycobacterial disease. Readers are encouraged to review the updated product labeling and the previous related *MMWR* report for additional information regarding the Xpert MTB/RIF Assay (*1,4*).

* These results represent independent FDA analysis of results from study ACTG A5295/TBTC 34. Additional information is available from Luetkemeyer A, Firnhaber C, Kendall M, et al., on behalf of the ACTG A5295/TBTC 34 study teams. Xpert MTB/RIF versus AFB smear to determine respiratory isolation of U.S. TB suspects. Presented at the Conference on Retroviruses and Opportunistic Infections, February 23–26, 2015, Seattle, Washington.

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Notes from the Field

Cryptosporidiosis Associated with Consumption of Unpasteurized Goat Milk — Idaho, 2014

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On August 27, 2014, the Idaho Department of Health and Welfare's Division of Public Health (DPH) was notified of two cases of cryptosporidiosis in siblings aged <3 years. Idaho's Southwest District Health (SWDH) investigated and found that both children had consumed raw (unpasteurized) goat milk produced at a dairy licensed by the Idaho State Department of Agriculture (ISDA) and purchased at a retail store. Milk produced before August 18, the date of illness onset, was unavailable for testing from retail stores, the household, or the dairy. Samples of raw goat milk produced on August 18, 21, 25, and 28, taken from one opened container from the siblings' household, one unopened container from the retailer, and two unopened containers from the dairy, all tested positive for *Cryptosporidium* by real-time polymerase chain reaction (PCR) at a commercial laboratory. On August 30, ISDA placed a hold order on all raw milk sales from the producer. ISDA and SWDH issued press releases advising persons not to consume the raw milk; SWDH issued a medical alert, and Idaho's Central District Health Department issued an advisory to health care providers about the outbreak.

All seven of Idaho's Public Health Districts and DPH continued to monitor cryptosporidiosis reports submitted from Idaho health care providers and laboratories statewide as required by Idaho law. Public Health Districts investigated reports by interviewing ill persons or their parents using a standardized questionnaire. After the hold order, SWDH and the Central District Health Department identified nine ill persons in four households. Four persons who had regularly consumed raw goat milk produced before August 18 experienced symptoms of gastroenteritis, and five household members who had not consumed the milk experienced onsets of symptoms of gastroenteritis 3–8 days after the first household member became ill. No other common exposures were identified. CDC case definitions for cryptosporidiosis were used (*1*). In total, the 11 ill persons were aged 2 months–76 years (median = 11 years); six were female. One patient was hospitalized. Stool specimens were obtained in three primary cases (i.e., illnesses in those who drank the raw goat milk) and three secondary cases (i.e., illness in contacts of those who drank the raw goat milk); CDC isolated *Cryptosporidium parvum* subtype IIaA16G3R1 from all six. The last reported outbreak-associated illness was a secondary case with an onset date of September 3.

In addition to the four tested milk samples from containers, five of five milk samples collected along the production line on September 2 tested positive for *Cryptosporidium* by PCR at the commercial laboratory. Testing of all nine milk samples (four from containers and five from the production line) at CDC for *Cryptosporidium* by PCR and direct fluorescent antibody test was negative. CDC and the commercial laboratory collaborated to validate the negative result by using sequencing to determine that false-positive results at the commercial laboratory were likely caused by goat DNA amplification during PCR. An inspection of the dairy did not reveal any obvious contamination sources. Water from the producer's well tested negative at Idaho Bureau of Laboratories for *Cryptosporidium* by direct fluorescent antibody test after ultrafiltration. Goat stool was unavailable for testing. Negative results led ISDA to release the hold order on September 18.

Epidemiologic evidence implicated contaminated raw goat milk as the outbreak source. It was not possible to obtain confirmatory laboratory evidence of milk contamination. Milk consumed before illness onset was unavailable for testing and could have been subjected to a single, undetected contamination event. No other common source was identified, and isolation of the identical *Cryptosporidium* genotype from ill persons did not disprove a common source. This outbreak highlights an infrequently reported cryptosporidiosis risk from unpasteurized milk (*2,3*), the value of sequencing to validate PCR protocols, the utility of genotyping *Cryptosporidium* isolates for strengthening epidemiologic evidence, and the risk for secondary transmission of *Cryptosporidium*. An increasing number of enteric outbreaks are associated with raw milk consumption (*4,5*). Resources for consumers, health care providers, and public health officials regarding risks from raw milk consumption are available at http://www.cdc.gov/foodsafety/rawmilk/raw-milk-index.html.

Acknowledgments

Marv Patten, Idaho State Department of Agriculture. Division of Public Health (DPH), Idaho Department of Health and Welfare. Amanda Bruesch, Robert Voermans, Idaho Bureau of Laboratories, Idaho DPH. Christine Hahn, Kathryn Turner, Bureau of Communicable Disease Prevention and Control, Idaho DPH. Laurie Boston, Raemi Nolevanko, Jennifer Tripp, CJ Soltis, Southwest District Health. Sarah Correll, Tammie McCarter, Marty Jones, Tom Schmalz, Central District Health Department. Logan Hudson, Tanis Maxwell, Robert Erickson, South Central Public Health District. Chandra Schneeberger, Jothikumar Narayanan, Michele Hlavsa, Division of Foodborne, Waterborne, and Environmental Diseases, National Center for Emerging and Zoonotic Infectious Diseases, CDC. Kristine Bisgard, Division of Scientific Education and Professional Development, Center for Surveillance, Epidemiology, and Laboratory Services, CDC.

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Announcement

World Birth Defects Day — March 3, 2015

Every year an estimated 7.9 million infants (representing 6% of total births worldwide) are born with a serious birth defect (*1*). In many countries, birth defects are one of the leading causes of death in infants and young children (*2*). Infants who survive and live with these conditions are at an increased risk for long-term disabilities. For this event's inaugural year, CDC is collaborating with 11 other organizations to implement World Birth Defects Day. The goals of this worldwide observance are to 1) increase global awareness about the occurrence of birth defects; 2) increase awareness of available treatment services; 3) expand referral and care services for all persons with birth defects; 4) increase implementation of primary prevention programs for birth defects; and 5) stimulate action among the public, members of governments, nongovernmental organizations, and health care providers to improve the care of affected children.

For World Birth Defects Day, CDC and its partners seek to build momentum for this initiative and together, work to increase birth defects surveillance capacity and expand prevention initiatives worldwide. CDC invites others to participate in World Birth Defects Day this year by sharing stories and information on social media using the hashtag #WorldBDDay. On March 3, all are encouraged to join the worldwide effort towards healthier women, healthier pregnancies, and healthier infants.

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Errata

Vol. 64, No. 6

In the report, "Measles Outbreak — California, December 2014–February 2015," two errors occurred.

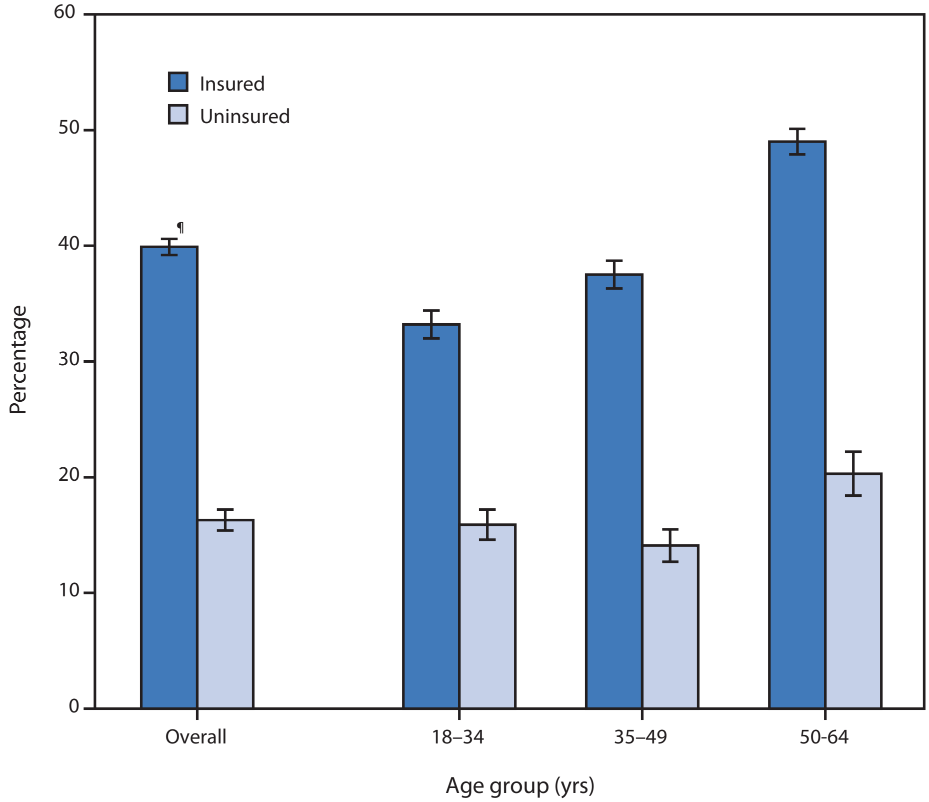
In the second paragraph, the sixth sentence should read, "In addition, 15 cases linked to the two Disney theme parks have been reported in seven other states: Arizona (seven), Colorado (one), Nebraska (one), Oregon (one), **Texas (one),** Utah (three), and Washington (two), as well as linked cases reported in two neighboring countries, Mexico (one) and Canada (10)."

In the third paragraph, the third sentence should read, "Among the 37 remaining vaccine-eligible patients, 28 (**76%**) were intentionally unvaccinated because of personal beliefs, and one was on an alternative plan for vaccination."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage of Adults Aged 18–64 Years Who Have Seen or Talked with a Mental Health Professional in the Past 12 Months,* by Health Insurance Status† and Age Group — National Health Interview Survey, United States, 2012–2013§



* Based on response to the question, "During the past 12 months, have you seen or talked to any of the following health care providers about your own health? A mental health professional such as a psychiatrist, psychologist, psychiatric nurse, or clinical social worker."

† Health insurance status is coverage at the time of interview. Persons were defined as uninsured if they did not have any private health insurance, Medicare, Medicaid, Children's Health Insurance Program, state-sponsored or other government-sponsored health plan, or military plan. Persons also were defined as uninsured if they had only Indian Health Service coverage or had only a private plan that paid for one type of service.

§ Estimates are based on household interviews of a sample of the noninstitutionalized U.S. civilian population and are derived from the National Health Interview Survey sample adult component.

¶ 95% confidence interval.

During 2012–2013, the percentage of insured adults aged <65 years who reported seeing or talking with a mental health professional in the past 12 months was more than twice that of uninsured adults for all age groups. The percentage of adults generally increased with age for both insured and uninsured adults, with a larger increase occurring from persons aged 35–49 years to persons aged 50–64 years, for which the percentage increased from 37.5% to 49.0% for insured adults and from 14.1% to 20.3% for uninsured adults.

Source: National Health Interview Survey, 2012–2013. Available at http://www.cdc.gov/nchs/nhis.htm.

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ISSN: 0149-2195