



MEDICC Review

ISSN: 1555-7960

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Medical Education Cooperation with Cuba
Estados Unidos

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MEDICC Review, vol. 17, núm. 3, 2015, pp. 43-46

Medical Education Cooperation with Cuba
Oakland, Estados Unidos

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Sentinel Surveillance Detects Low Circulation of *Vibrio cholerae* Serotype Inaba in Haiti, 2011–2012

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ABSTRACT

Over 700,000 cases of cholera were reported in Haiti between October 2010 and February 2015. In November 2011, the Cuban Medical Team serving in Haiti established a laboratory-supported sentinel surveillance system for cholera in 10 public hospitals (one in each of Haiti's 10 departments), to estimate the proportion of hospitalized patients with cholera and detect emergence of new *Vibrio cholerae* serotypes. Each month, the first ten stool samples collected from patients admitted with acute watery diarrhea were studied in all hospitals involved. Surveillance system findings from November 1, 2011, to October 30, 2012 showed that acute watery diarrhea was caused by *V. cholerae* serogroup O1 in 45.9% (210/458) of patients: Serotype Ogawa was found in 98.6% of this isolates (207/210) and serotype Inaba in 1.4% (3/210), indicating low circulation level of the latter in Haiti. Continuing laboratory sentinel surveillance of *V. cholerae* is needed to monitor the spread of the disease and prevent and contain outbreaks, particularly of new serotypes. It is important to ensure that these findings are systematically integrated with data available to MSPP from other surveillance sources.

KEYWORDS *Vibrio cholerae*, serotype Inaba, serotype Ogawa, epidemiological surveillance, medical cooperation, Haiti, Cuba

INTRODUCTION

In 1998, Hurricane Georges struck Haiti, causing 230 deaths and leaving 167,000 people homeless. Cuba immediately sent emergency humanitarian medical assistance.[1] The program, set up on December 4, 1998, has since evolved into the Cuban Medical Team in Haiti (BMCH), providing continuous and expanded services on a longterm basis. The BMCH was bolstered by reinforcements from Cuba's Henry Reeve Emergency Medical Contingent after the January 2010 earthquake, also involving Cuban health professionals in efforts to treat and stem the cholera epidemic that appeared in the quake's aftermath.[2]

The cholera epidemic began in October 2010 with the causal strain confirmed as *Vibrio cholerae* serogroup O1, biotype El Tor, serotype Ogawa.[3] From October 20, 2010, to February 7, 2015, 731,880 suspected cases and 8741 deaths attributed to cholera were reported to Haiti's Ministry of Public and Population Health (MSPP).[4]

Vibrio cholerae infection confers serotype-specific immunity. This means that infected persons in Haiti have little or no protection against infection by serotype Inaba.[5] The Ogawa serotype provides less protective immunity than does Inaba against reinfection by the heterologous serotype.[6] Therefore, circulation of serotype Inaba could increase risk of cholera in people who have had cholera caused by the Ogawa serotype.[5]

On October 28, 2010, MSPP set up the National Cholera Surveillance System (NCSS) to collect data on the number of cholera cases, hospitalizations and cholera-related deaths in

cholera treatment facilities.[3,7] These include cholera treatment units (UTC) located in hospitals or special units with wards dedicated specifically to treat cholera patients in emergency situations,[1] and cholera treatment centers (CTC), newly created temporary treatment facilities (usually tents suitable for receiving many cholera patients).[3] Since the beginning of the cholera outbreak, the NCSS based its cholera case definition on signs and symptoms rather than on laboratory confirmation: patients of any age with ≥ 3 episodes of acute watery diarrhea (AWD) within 24 hours, with or without vomiting, coming from an area with at least one culture-confirmed case of *V. cholerae* O1.[3,5] However, a large percentage of cases diagnosed as cholera in Haiti by syndromic characteristics were found negative by laboratory tests; hence the importance of microbiological confirmation in sentinel sites.[8]

In April 2012, a sentinel surveillance system for AWD, based on laboratory tests, was set up by Haiti's National Public Health Laboratory (LNSP) and US Centers for Disease Control (CDC) at four locations in three departments: Ouest, Artibonite and Sud-Est. These facilities are located in large care units, three hours' drive from the capital, Port-au-Prince, where LNSP is located, making proper sample transportation feasible. From April 2, 2012, to March 29, 2013, the sentinel surveillance system identified 1020 isolates of *V. cholerae* serotype Ogawa and nine isolates of *V. cholerae* serotype Inaba[5] in 1616 stool samples from as many patients.

Before 2012, however, BMCH had established a surveillance system (later adapted to combat the cholera epidemic in Haiti). This report describes the main features of the system, including our estimate of the proportion of laboratory-confirmed cholera cases in patients treated at UTCs and CTCs from November 1, 2011, to October 30, 2012. We describe clinical and epidemiological characteristics and educational actions undertaken when *V. cholerae* serotype Inaba was detected.[1]

INTERVENTION

In January 2010, following the devastating earthquake, BMCH established a syndromic surveillance system for infectious diseases in 33 sentinel sites in 83 communes (municipalities) in Haiti, which provided information to MSPP.[9] Later, with the onset of the cholera epidemic, epidemiological surveillance was expanded to UTCs and CTCs. On November 1, 2011, BMCH implemented a laboratory-supported cholera sentinel surveillance system in 10 community reference hospitals (HCR). These hospitals are public institutions with UTCs and CTCs, located in each of Haiti's 10 departments: HCR Thomazeau, Ouest Department; HCR Mirebalais, Centre Department; HCR L'Assile, Nippes Department; HCR Aquin, Sud Department; HCR Cayes-Jacmel, Sud-Est Department; HCR Corail, Grand'Anse Department; HCR L'Estere, Artibonite Department; HCR Grande Rivière du Nord, Nord Department; HCR Bassin Bleu, Nord-Ouest Department; and HCR Trou du Nord, Nord-Est Department.[2] Since the onset

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of the cholera epidemic, statistical data generated in health institutions where BMCH works have been shared with MSPP and are part of NCSS.[9,10]

Rationale Microbiological confirmation of *V. cholerae* in patients with AWD and detection of emerging serotypes are useful to determine the magnitude of the cholera epidemic in Haiti, alert health authorities to the risk of new outbreaks, and inform their decisions for disease control.

Description of BMCH sentinel surveillance system Statistical data generated by UTCs and CTCs served by BMCH are sent to each department's BMCH team leader, who prepares and sends daily statistical reports of cholera cases and deaths to the BMCH central office. This information is processed, analyzed and sent to MSPP in the course of the day.[1] In addition, BMCH-generated data inform written reports presented at weekly LNSP meetings with MSPP and other members of the Cholera Health Cluster in Haiti.[9,10]

Procedures Every month at the 10 selected HCRs, the first 10 stool samples collected from patients with AWD of <5 days duration were examined. Laboratory technicians collected the samples in sterile cups and two swabs were placed in Cary Blair transport medium[11] and sent for processing within 72 hours to the BMCH reference laboratory in La Renaissance HCR, Port-au-Prince. Diagnosis was performed by *V. cholerae* culture.[12] *V. cholerae* isolates were sent to LNSP periodically during the first year of the epidemic, with 100% agreement on identification of species, serogroup, and serotype (unpublished data). Patients who had used antibiotics at home or in hospital during the month prior to admission were excluded, as were samples received >72 hours after inoculation in Cary-Blair transport medium.

Identification of bacterial isolates Samples were inoculated onto thiosulfate-citrate-bile salts-sucrose agar medium (TCBS) (Biolife, Italy) and incubated overnight at 37 °C. Inoculation was also done in alkaline peptone water (pH 8.5) and incubated for 6–8 hours at the same temperature for subsequent subculturing in TCBS agar at 37 °C for overnight incubation. Suspicious colonies were identified as *V. cholerae* by biochemical methods such as oxidase, catalase and the string test; and by serotyping with polyvalent O1 and O139 antisera and monovalent Ogawa and Inaba antisera (Denka Senken, Japan).[13] The ATCC strains *V. cholerae* 55331 serotype Inaba and *V. cholerae* O1 serotype Ogawa were used as controls, the latter previously identified by LNSP.

Patient data recorded A written questionnaire was applied to patients to collect demographic, clinical and risk factor information.

Demographics: age, sex

Patient residence: neighborhood (subcommune, commune, department)

Illness onset: date of onset of symptoms

Signs and symptoms: profuse and frequent watery diarrhea; mild, moderate or severe dehydration; vomiting[2,3]

Cholera risk factors: ingestion of untreated river water; outdoor defecation

The following data were collected from clinical histories.

Hospital stay: days in hospital

Treatment: intravenous hydration (Ringer lactate, 30 mL/kg for the first 30 minutes, then 70 mL/kg in the next 2.5 h) or

oral rehydration solution;[12] antibiotics (doxycycline, 300 mg, oral, single dose)[2]

Outcome: patient dead or alive

Active community case-finding and educational activities After the first 24 hours of AWD patient admission in a UTC or CTC at a selected HCR, a BMCH-coordinated medical team was sent to each patient's home to detect new cholera cases and undertake community educational activities. Each team was composed of at least six people (at least one of whom was fluent in Creole): two doctors (one Cuban, one Haitian), two nurses and two paramedics, plus local leaders. Educational activities focused primarily on household contacts who shared common sources of food and water with the index patient at least five days before symptom onset.[2] Medical staff were mobilized with resources to handle cholera cases in the field, provide health education on risk factors, teach individual and collective ways to prevent transmission and instill public awareness concerning the importance of immediately using oral rehydration solution and seeking care at the nearest medical facility immediately upon symptom onset. MSPP-prepared information cards in Creole (with easy-to-understand illustrations for those who could not read) were used to provide information on cholera signs and prevention.[14]

Every household contact was visited 15 days later by the same medical team to check for cholera symptoms.

The BMCH personnel cholera module was used: an individual tent, protective gear, additional shoes, individual clothing kit, food kit, medication kit, thermometer, flashlight, Aquatabs, notebook and pen.[2]

RESULTS

We collected stool samples from 696 patients at the ten selected sentinel sites. Excluded were samples from 62 patients who had used antibiotics previously and 176 samples received >72 hours after inoculation in transport medium. Microbiological culture was performed of 458 stool samples from as many patients with AWD

Of samples tested, 210 isolates were identified as *V. cholerae* serogroup O1, for 45.9% (210/458) positivity; of these, 98.6% (207/210) were found to be serotype Ogawa and 1.4% (3/210) serotype Inaba.

The results of the clinical-epidemiological study and the educational measures set out below are limited to patients in whom *V. cholerae* serotype Inaba was isolated. The results of cases where serotype Ogawa was isolated will be addressed in future papers.

The three isolates of *V. cholerae* O1 serotype Inaba were obtained from patients with AWD and dehydration who were admitted to UTCs of Bassin Bleu and Cayes-Jacmel HCRs between July 2 and 6, 2012. The first two patients came from the same neighborhood in Pendu subcommune, Gros Morne commune (Artibonite Department) and the third was from Ravine Normande subcommune in Cayes-Jacmel commune (Sud-Est Department). All three were adults who reported drinking untreated river water from a contaminated source. The two patients from Artibonite Department were linked epidemiologically; both practiced open defecation and had suffered cholera a year earlier. All patients were

admitted within 48 hours of onset of profuse and frequent diarrhea (6–18 stools), accompanied by mild-to-severe dehydration. Vomiting was a predominant symptom in two of the three cases. The patient with severe dehydration was treated intravenously, followed by oral rehydration; the other two patients received oral rehydration solution only. All were treated with antibiotics and were asymptomatic on discharge, 24–48 hours after admission.

Inspections of the three households revealed that only the one in Ravine Normande had a sanitary latrine and an adequate system for handling and storing drinking water. Overall, 34 household contacts were identified; they were interviewed by the medical team and had no symptoms or signs of cholera. A second visit found 32 of the 34 household contacts symptom-free (the other two were unavailable for interview).

LESSONS LEARNED

The laboratory-supported sentinel surveillance system for cholera allowed confirmation that *V. cholerae* serogroup O1, predominantly serotype Ogawa, caused almost half the diarrhea-related hospitalizations among adults at UTCs or CTCs of selected HCRs between November 2011 and October 2012, one year after the cholera epidemic started in Haiti. Circulation of *V. cholerae* serotype Inaba was reported in three isolates from two communes (Gros Morne and Cayes-Jacmel) where it had not previously been detected.

This surveillance system provides data on AWD burden attributable to cholera and complements the NCSS. Since the data were collected from 10 HCRs located in all Haitian departments (rather than just the four in NCSS) the findings are more representative of cholera cases in Haiti, making detection of emerging new *V. cholerae* serotypes more likely.

It is worth noting that two of the three patients in whom *V. cholerae* serotype Inaba was isolated reported having had cholera a year earlier (not laboratory confirmed). Since Ogawa had been the predominant serotype in Haiti, from 2010,[3,5] this reinforces the observation that serotype Ogawa provides little immune protection against reinfection with the heterologous serotype.[15]

The location of some sentinel sites distant from the BMCH reference laboratory may have influenced the lower percentage of


V. cholerae isolation reported by BMCH (45.9%) than by LNSP (63.7%).[5] Refrigeration is known to increase positivity in the recovery of *V. cholerae* and other enteric microorganisms,[13] and it was not always possible to ensure refrigeration of samples in Cary Blair transport medium from remote sites to the BMCH laboratory.

Most samples that were rejected because they exceeded the recommended limit (>72 hours for transport in Cary Blair medium) came from the departments farthest from the capital: Grand Anse, Nord-Est, Nord and Nord-Ouest. To keep these sentinel sites operational in the future, proper sample transport must be guaranteed. In general, improving the recovery rate of *V. cholerae* requires increasing the number of samples sent by sentinel sites and ensuring adequate refrigeration.

Laboratory-supported cholera sentinel surveillance has limitations. The real disease burden of morbidity and mortality is underestimated, particularly in remote areas. Some cases seen are not laboratory confirmed, and, inevitably, some patients with AWD caused by other pathogens are misclassified as cholera. Finally, the nonrepresentative nature of the convenience sample prevents quantification of the true proportion of cholera patients with *V. cholerae* serotype Inaba.[3,5]

Three new isolates of *V. cholerae* serotype Inaba were identified in this study, which together with nine others detected by the LNSP between 2012 and 2013[5] reveal circulation of this serotype in Haiti. Although the numbers are low, they represent risk for a new cholera epidemic caused by this serotype.

The BMCH intervention stresses correct case management and importance of community educational activities for reducing spread of cholera and other diarrheal diseases, and reaffirms the urgent need to ensure access to safe water and sanitation in Haiti, especially in rural areas.

Continuing laboratory sentinel surveillance of *V. cholerae* is needed to monitor the spread of the disease and prevent and contain outbreaks, particularly of new serotypes. It is important to ensure that these findings are systematically integrated with data available to MSPP from other surveillance sources. 

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Submitted: December 5, 2014

Approved for publication: July 10, 2015

Disclosures: None
