Nepalese origin of cholera epidemic in Haiti

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Abstract

Cholera appeared in Haiti in October 2010 for the first time in recorded history. The causative agent was quickly identified by the Haitian National Public Health Laboratory and the United States Centers for Disease Control and Prevention as *Vibrio cholerae* serogroup O1, serotype Ogawa, biotype El Tor. Since then, >500 000 government-acknowledged cholera cases and >7000 deaths have occurred, the largest cholera epidemic in the world, with the real death toll probably much higher. Questions of origin have been widely debated with some attributing the onset of the epidemic to climatic factors and others to human transmission. None of the evidence on origin supports climatic factors. Instead, recent epidemiological and molecular-genetic evidence point to the United Nations peacekeeping troops from Nepal as the source of cholera to Haiti, following their troop rotation in early October 2010. Such findings have important policy implications for shaping future international relief efforts.

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Introduction

The cholera epidemic in Haiti has been the world's largest such epidemic during recent decades, with 526 524 suspected cases and 7025 deaths reported by the Haitian government from mid-October 2010 through to January 2012 (Ministry for Public Health and Population (MSPP), Haiti, 20 January 2012). When the outbreak was first observed, immediate focus was on case management, water chlorination and hygiene awareness. Within 2 months, cholera cases were observed throughout the country [1], with dozens of deaths per day, peaking at more than 100 per day by mid-December, 2010 (MSPP, Haiti, 4 January 2011). Cholera had never been reported in Haiti [2] so many wondered where the pathogenic microbe came from.

Some scientists supported a climatic hypothesis for the origin of cholera in Haiti, arguing that *Vibrio cholerae* is primarily an aquatic bacterium, typically living dormant in coastal waters until an event disturbs the local environment and leads to a disease outbreak [3]. Noting that early cholera cases were reported in the Artibonite Valley near the Haitian coast, Professor David Sacks mentioned the climatic hypothesis to a reporter in late October 2010 [4]. According to the reporter, Sacks opined that the most likely explanation for the Haiti cholera outbreak was a rise in temperature and salinity in the river estuaries around the Bay of Saint Marc in the Artibonite Department of Haiti [2]. The climatic hypothesis was also supported by cholera expert Professor Rita Colwell [3,4]. Other people suspected a human source, the pathogen being brought from country where it was endemic, with early focus on United Nations (UN) peacekeeping troops who had recently settled in the country [5,6], and on non-governmental organizations [7]. The human hypothesis was first circulated by reporters from two different international news organizations who noticed serious sanitary problems in a military camp of MINUSTAH, the French abbreviation for the Haiti UN peacekeeping mission

[5,6]. Although understanding whether the climatic or human hypotheses were true had no impact on the initial management of cholera in Haiti, the consequences of such understanding are vital for future prevention of similar disasters.

Methods

References were identified through searches of PubMed for articles, regardless of language, from October 2010 to December 2011, using the terms, 'origin of cholera in Haiti', 'cholera, Haiti' and 'vibrio cholera Haiti'. For the news articles, we employed Google search using the terms, 'cholera, origin, Haiti' and 'cholera Haiti Nepal' with equivalent words in English, French, Haitian Creole and Spanish. All internet items, searched on a weekly basis starting in December 2010, were computer-archived for subsequent retrieval in case the original citation was deleted.

The bibliographic research also involved the collection of available reports in the field, e-mail exchanges with reporters and scientists having potentially interesting information, direct discussions with physicians, microbiologists and epidemiologists involved in the treatment, diagnosis and investigation of the first cholera cases in Haiti, and meetings with sanitarian and political authorities in Haiti (including the President of Haiti, the Minister of Health, the special representative of the UN Secretary-General in Haiti, and the staff of MINUSTAH).

Three field investigations were conducted in Haiti by two of us (RB, RP). The first two were joint French–Haitian investigations, one in November 2010 and the second in April 2011. The third investigation was during the first year of the epidemic by the National Public Health Laboratory and the Department of Epidemic Surveillance of MSPP (i.e. following the epidemic and investigating new cholera foci) assisted by one of us (RB). The laboratory investigations of the Haitian isolates alone were performed by other researchers, and on similarly timed Haitian and Nepalese isolates by one of us (PSK).

Previous publications directly related to the assessment of the origin of cholera in Haiti are summarized in Table 1. Primary information refers to sources extensively addressed in the article, whereas the secondary information contains sources mentioned in the article but described more completely in the Supplementary material, Data S1 section.

TABLE 1. Previous publications on cholera in Haiti

Authors (reference number)	Type of investigation	Location[a]
Primary information		
Cravioto A, Lanata CF *et al.*, (8, S5)	Epidemiological	Haiti
Piarroux R, Barrais R *et al.*, (9, S7)	Epidemiological	Haiti
Hendriksen RS, Price LB *et al.*, (17)	Laboratory	Haiti, Nepal
Secondary information		
LNSP and CDC, (11, S11)	Laboratory	Haiti
Chin C, Sorenson J *et al.*, (12, S12)	Laboratory	Haiti
Ali A, Chen Y *et al.*, (13, S13)	Laboratory	Haiti
Reimer AR, Van Domselaar G, *et al.* (14, S15)	Laboratory	Haiti
Ceccarelli D, Spagnoletti M, *et al.* (15, S14)	Laboratory	Haiti

[a]Location of field investigation or time-similar specimens.
LNSP, National Public Health Laboratory; CDC, Centers for Disease Control.

Results

Background information

Background information is presented in detail in the Supplementary material (Data S1). Briefly, our findings shows that in early October 2010 a Nepalese contingent of UN peacekeepers with 1280 personnel was exposed to a cholera epidemic in Nepal either during the 3-month training period or, more probably, during a 10-day home visit before leaving for Haiti. Once they returned to their battalion to embark for Haiti, the soldiers were not subjected to a medical examination or stool testing. In Haiti, most of the soldiers were housed in a camp near Mirebalais and the remainder in two smaller settlements in neighbouring towns (Fig. 1). Sanitation conditions were assessed in the MINUSTAH camp near Mirebalais by a panel of scientists assembled by the UN to investigate the origin of the epidemic [8]. They reported many important hygiene deficiencies and concluded that the sanitation conditions were not sufficient to prevent faecal contamination of the neighbouring river, the water source for local cooking and drinking. Although the panel of scientists in their review of the camp's early medical records reported no cases of severe diarrhoea and dehydration, they made no mention of mild or moderate diarrhoea. In addition, no review was made of medical records of Nepalese troops assigned to the two other neighbouring camps. Septic wastewater from all three camps was trucked to and deposited in an open septic pit by the camp near Mirebalais, where the panel of scientists reported that the local river flowed 'a short walk down the hill from the pit' (see Fig. 1).

Epidemiological information

Several epidemiological field studies of cholera were conducted in Haiti, notably by investigators at CDC, but they did not address the origin issue, or the cause of the explosive outbreak that followed. There have only been two public documents addressing the origin of cholera in Haiti. One is a report by the panel of scientists appointed by the UN [8], and the other is an article published in a scientific peer-reviewed journal that relates the findings of two field investigations [9]. The first of the two field investigations was made in the Mirebalais region by a team of Haitian epidemiologists during