SUPPLEMENT ARTICLE

Elimination of Cholera in the Democratic Republic of the Congo: The New National Policy

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We evaluated published and unpublished data on cholera cases and deaths reported from clinical care facilities in the 56 health districts of the Democratic Republic of Congo to the National Ministry of Health during 2000–2011. Cholera incidence was highest in the eastern provinces bordering lakes and epidemics primarily originated in this region. Along with a strong seasonal component, our data suggest a potential *Vibrio cholerae* reservoir in the Rift Valley lakes and the possible contribution of the lakes' fishing industry to the spread of cholera. The National Ministry of Health has committed to the elimination—rather than control—of cholera in DRC and has adopted a new national policy built on improved alert, response, case management, and prevention. To achieve this goal and implement all these measures it will require strong partners in the international community with a similar vision.

Keywords. Africa; cholera; epidemiology; elimination; Democratic Republic of Congo; *Vibrio cholerae*.

The Democratic Republic of the Congo (DRC) is among the countries in the world most affected by cholera outbreaks, accounting for a substantial proportion of global cases and deaths. The national health system is organized in 3 levels:

1. Central level (Ministry of Health, Department of Disease Control), which has the normative and regulatory authority over all of the country's health structures.
2. Intermediate level (provincial health authority and health district): Provides technical support to the development of health zones
3. Peripheral level (health districts): This is the operational unit of planning and implementation of national policy.

The DRC has 11 health provinces subdivided into 56 operational health districts (planned to be expanded to 65 districts). These are divided into 515 health zones. The health sector is highly dependent on external funding and interventions. Patients are charged for routine care, but treatment in cholera treatment centers is generally free. The DRC currently has 401 hospitals: 176 are state-owned, 179 run by religious organizations, 46 by companies in the public- or private sector; 7725

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other care facilities include community health centers, maternity clinics, and polyclinics, which are also either owned by the state, by businesses, religious groups, NGOs, or private individuals.

The current article reviews the published and unpublished work of the cholera working group at the National Institute for Biomedical Research and the Department of Disease Control in Kinshasa on the epidemiology of cholera in DRC based on public health surveillance data, and describes how the Ministry of Health (MoH) used these data to develop a national strategic plan for elimination of cholera as a public health problem in DRC (2008–2012 and since this year 2013–2017). The DRC MoH hopes that this process will influence other African Countries affected by cholera to change their policies from control to elimination of cholera.

METHODS

We studied cases and deaths from cholera reported by the 56 district health offices to the National Ministry of Health between 2000 and 2011. We analyzed case notifications and environmental data to characterize the different geographic areas at the level of health district and province comprising all the different types of structures mentioned above. The Ministry of Health supplied demographic data by province and health district and the shape-files for constructing the polygons for mapping the distribution of cases in the mapping software HealthMapper (Ministry of Health DRC, 2002).

We reviewed over 150 status reports of cholera outbreaks produced between 2000 and 2011 by intervention teams of the Department for Disease Control, the Provincial Medical Inspections Office, the medical staff of the health zones, WHO and UNICEF, the nongovernmental organization (NGO) Doctors Without Borders, and other medical-humanitarian NGOs.

Incidences were calculated as notified cases of cholera per 100 000 population. Population data were provided by the DRC Ministry of Health.

Cholera cases were defined based on the WHO standard case definition as patients 5 years of age or older with acute watery diarrhea, with or without vomiting. In the DRC, cases 2 years and older are also notified to the national surveillance system but only during laboratory-confirmed cholera outbreaks. As recommended by WHO, outbreaks were usually confirmed by identification of *V. cholera* O1 in stool cultures; however, usually only sporadically at the beginning and the end of each outbreak are cases confirmed by stool culture of *Vibrio cholerae*.

RESULTS

Geographic Distribution of Cholera in DRC

In 2011, the DRC reported 21 700 (3.7%) of the globally notified 589 854 cases of cholera to the WHO and 584 (7.4%) of all 7816 cholera-related deaths in the world [1]. Between 2000 and 2011, the highest annual attack rates were mostly observed in the Eastern provinces bordering the Great Lakes, ie, the provinces of Orientale, North and South Kivu, Katanga, and Kasaï Oriental (Supplementary Figure 1).

The western provinces of Equateur, Bandundu, Kinshasa, and Bas-Congo reported cases in 3 out of the 12 evaluated years, apart from an isolated outbreak in Kinshasa in 2001. In contrast, the provinces bordering the Great Lakes—namely, North and South Kivu and Katanga—suffered high incidences of over 10 per 100 000 every year during the same period. The province of Oriental, bordering the northernmost lake, reported cholera during all years but 2010, albeit with a lower incidence.

We compared the number of cholera cases notified throughout the country during the study period with the number of cases notified only in the eastern provinces of North and South Kivu, Katanga, and Kasai-Oriental, all bordering lakes (Figure 1). The lake-bordering provinces were hyperendemic and accounted for the majority of cases in DRC. This was especially true for 2005–2007 and December 2009, when all cases observed were notified from lake-bordering health-districts. During 2002–2003, October 2007 to March 2008, and throughout 2011, outbreaks occurred inland and farther west, namely, in the Upper Congo River Basin in Katanga [2], and other urban areas such as Mbuji-Mayi, the capital of Eastern Kasaï [2], and Kinshasa, the capital of the DRC [3].

The most recent available cumulative cholera notifications for 2011 followed the trends described above for 2000–2011. Again, the highly endemic areas are defined as those from which cases are reported continuously, with lull periods with zero notified cases of <6 months. These are all in the east of the country and border the lakes of the Rift Valley. The western provinces show a typical seasonal pattern of epidemics (Figure 2) are long lull periods of over 6 months between 2 cholera outbreaks.

Temporal Distribution of Cholera

Seasonal peaks exist, with most cases usually notified during the first quarter of the year. Other features of cholera outbreaks include (Figure 2): (1) a high level of cases all year in endemic lake bordering areas, (2) cases beginning in Province Orientale during week 9 and peaking during mid-March, and (3) the first cases notified during weeks 18, 22, and 24 in Equateur, Bandundu, and Kinshasa with the epidemic peak during mid-July, mid-June, and end of July, respectively.

A previous study conducted in DRC between 2002 and 2006 [4] reported overall cases, cases by season, and a residual component not explained for by the seasonality. Around lakes Upemba and Tanganyika, analysis found a repetitive seasonal pattern in notifications with higher case numbers between October and April and lower numbers from May to September. After subtracting the seasonal variations from the crude notifications, the remaining trend showed a marked decrease over the study

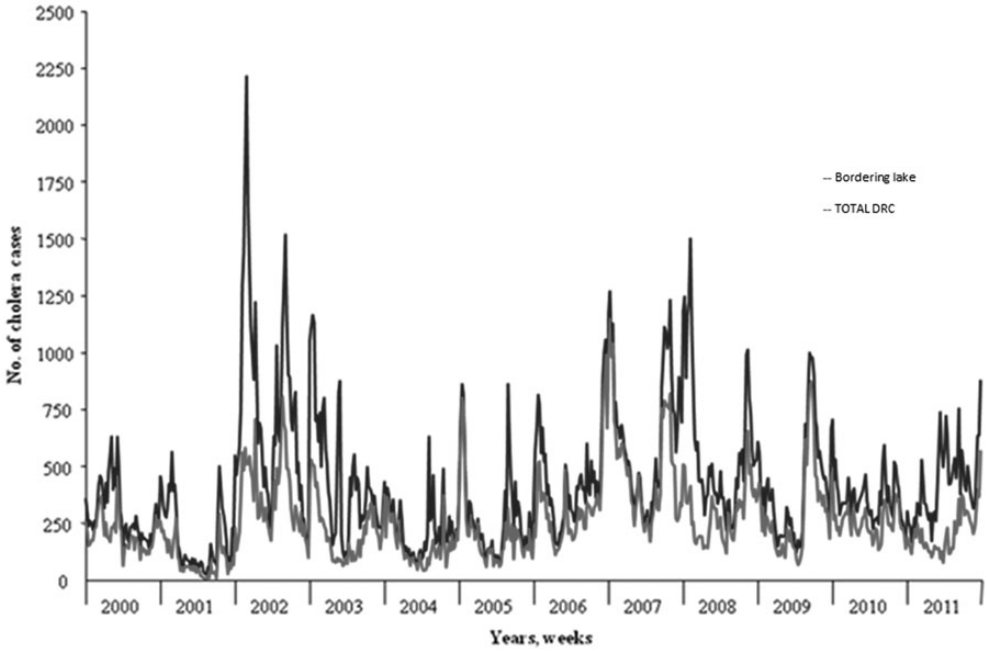

Figure 1. Suspected cholera cases, by week of notification, Democratic Republic of Congo (DRC), 2000–2011. In blue, the total notifications from DRC; in red, notifications from Katanga, North-/South Kivu and Kasai Oriental, lake-bordering areas in eastern DRC.

period. Additionally, this study found that the seasonal model explained the variation throughout the year between rainy and dry seasons but not the outbreaks during 2002 in Kalemie and Bukama, which would thus require an explanation outside of seasonal events.

Factors Favoring the Spread of Cholera Outbreaks

Several studies have found an environmental reservoir for *V. cholerae* in the lakes of the rift valley [4, 5]. In previous studies we have described specific sources in lake areas and transmission pathways via main roads and railways [6]. The Congo River is a major means of transportation in DRC, with fishermen travelling at the end of the dry season from lakes in eastern DRC to bigger cities where they sell their fish [2]. Hence, seasonal variations may occur because of fishing and commercial activities concentrated along rivers.

As an example, between weeks 30–39 and 41–44 of 2007, cholera outbreaks spread from the lake districts of Bukama, Kasenga, and Kalemie to the cities of the southern Katanga province (Figure 3). The observed spread of cholera outbreaks correlated with the migratory patterns of the local fishermen. During June and July, the months with the lowest number of notifications, cases were mainly concentrated in the lake areas of Kalemie, Bukama, and Kinkondja Kabondo-Dianda (Katanga); Goma, and Kirotshe-Mutwanga (North Kivu); and Uvira, Katana, and Bukavuand Kyondo (South Kivu), suggesting lakes might act as natural reservoirs for *V. cholerae*. During that period, fishermen and merchants migrated to islands in the lake where they set up temporary settlements. At the beginning of the rainy season in late September, they started leaving those islands for cities such as Likasi, Kolwezi and Lubumbashi in the south of Katanga province. Around the same time as those migrations occurred case notifications from those cities rose leading to the hypothesis of migrating local fishermen and traders being likely to spread cholera. This hypothesis will need to be confirmed by molecular biology analyses.

An underlying problem is a lack of access to safe water. Different recent studies from 2010 and 2011 found a safe water coverage of households between 26% (38% urban, 17% rural) [7] and 47% (23% rural, 80% urban) [8]. In reality, even these figures do not reflect the geographic disparity in drinking water access, which in many areas is below 5% [8]. The main reasons for this low supply of drinking water are the current inadequate institutional framework and the lack of financial resources allocated to the sector. Armed conflict has exacerbated this already precarious situation by the destruction of existing infrastructure. Only 27% of all households (25% rural and 28% urban) use improved sanitation facilities [8]. The strategic cholera elimination plan is characterized by the priority given to those underdeveloped areas in lack of water and sanitation infrastructure that are highly endemic for cholera. The plan has a budget of nearly $160 million US dollars of which nearly 60% shall be spent on the improvement of water and sanitation infrastructure.

At present, still very few interventions are carried out around sanitation and improved drinking water sources. Point of use chlorination of water that people carry home from lakes and

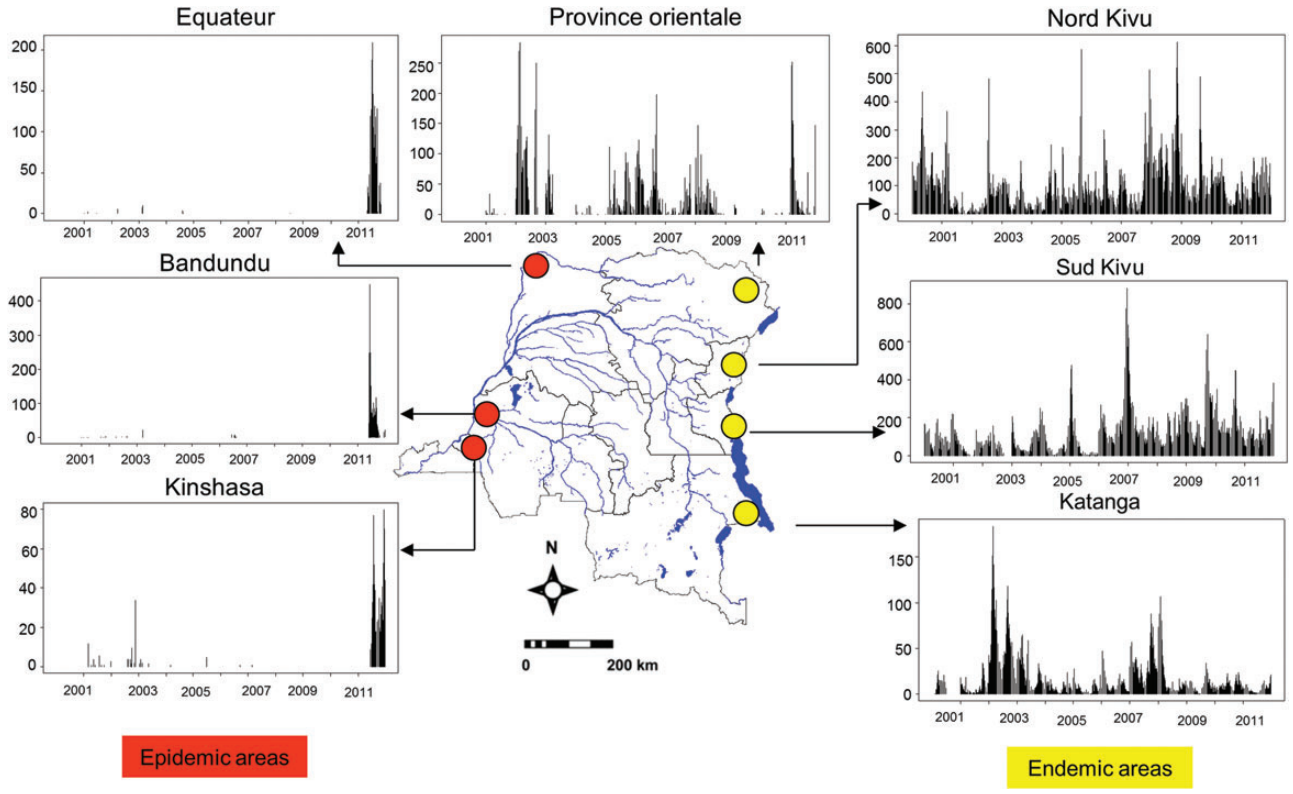

Figure 2. Reported cholera cases in 7 provinces of the Democratic Republic of Congo (DRC) during 2000–2011. The colored spots are located in the geographic center of these provinces and do not correspond to the exact location of the notified cholera cases. Yellow spots represent endemic areas; red spots represent epidemic areas. Endemic regions of eastern DRC were those from which cases are reported continuously, with lull periods with zero notified cases of <6 months despite no changes in the surveillance system and methodology. A region was defined as epidemic when there are long lull periods of >6 months between 2 cholera outbreaks.

rivers is often used, but there has never been a study to assess its effectiveness. Thus, in the absence of water, even during epidemics the population continues to use the contaminated water of rivers and lakes. Regarding behavior change, campaigns have failed to integrate the disease perception of local people. As an example, people were asked to boil water in areas of swampy savannas like parts of Bukama and Katanga where wood and coal are rare and expensive and used only for cooking.

DISCUSSION

Between 2000 and 2011, the highest annual incidence of reported cholera cases in DRC was observed in the Eastern provinces of Orientale, North- and South Kivu, Katanga, and Kasaï Oriental, with high incidence of cholera and higher attack rates repeatedly found in communities close to lakes. Our work has identified 3 key elements relevant to cholera control efforts, namely:

1. Epidemics primarily originated in the same areas of Eastern DRC.
2. Cholera epidemics were seasonal in DRC, with low incidence between May and July.
3. During this period of low incidence, cholera was concentrated in the lake areas, possibly implicating lakes as natural reservoirs for *V. cholerae*.

Seven cities located on the lake shore have been identified as the main source of cholera epidemics in the DRC, implying these could be reservoirs [9]. The corresponding health zones (Figure 4) have been targeted according to the strategic plan of cholera elimination in the DRC. Seasonal patterns will assist with planning public health activities to prevent cholera outbreaks.

The work performed in the DRC constitutes an important step in understanding the spatio-temporal dynamics of cholera epidemics in the region. The methods we have used could be applied in other cholera-affected African countries, thereby assisting in cholera control efforts. Such studies in Africa are important to understand the specific role of certain geographical areas, to identify temporal dynamics of the disease, to quantify precisely lull periods, and to identify populations at risk.

Limitations of the Presented Data

This article presents the currently available aggregate weekly notifications from the 56 health districts in the DRC of suspect cases that presented to the health posts. No active case finding

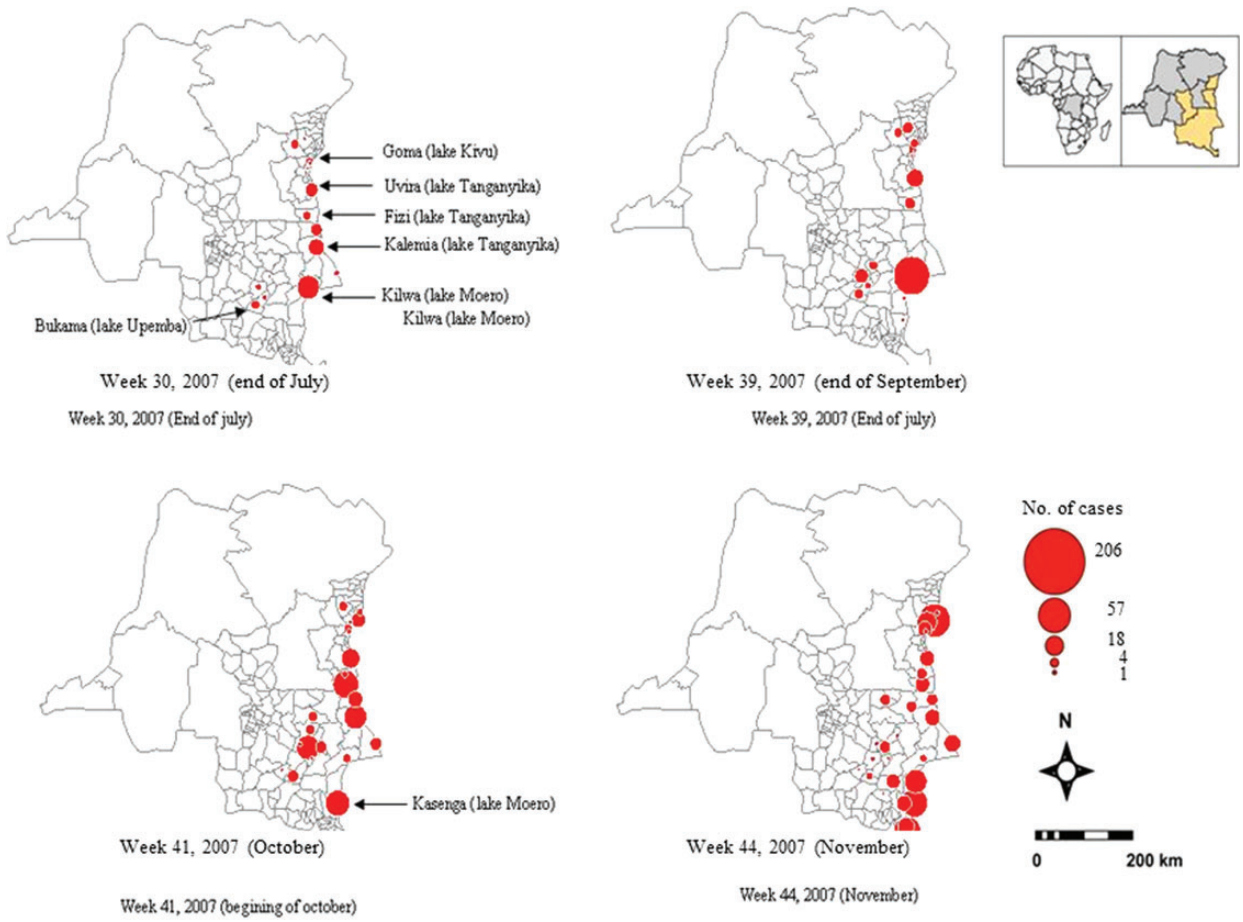

Figure 3. Graphical representation of a cholera outbreak spread from week 30 to week 44, 2007 in the Democratic Republic of Congo.

is undertaken, so there is no reliable way to estimate the number of cases and deaths outside the existing health structures. Only sporadically at the beginning and the end of each outbreak are cases confirmed by stool culture of *V. cholerae*. The health authorities in the DRC are trying to introduce case-based surveillance in sentinel sites [10]. This includes asking cases presenting at treatment centers to name other cases of diarrhea in their household. This exhaustive surveillance is supposed to be extended by the national authorities beyond the surveillance sites to better estimate the burden of cholera in the community.

In December 2007, national experts agreed on the strategic plan for the elimination of cholera in the DRC [11]. In this policy document signed by the Minister of Health the elimination of cholera is declared the long-term objective of cholera control efforts. The general objective of this plan is to improve the health of the Congolese population by reducing morbidity and mortality due to cholera. The specific objective is lowering the incidence of cholera to <1 case per 100 000 population, meaning <500 cumulative confirmed cases of cholera per year in the DRC by 2013.

To achieve this goal, 7 main strategies are being pursued, with priority on 7 lake-bordering areas that are highly endemic for cholera (Figure 4):

1. Strengthening active and passive epidemiological surveillance
2. More timely alert of outbreaks (by abolishing the notification threshold currently used)
3. Strengthening prevention in the targeted health areas (health promotion, vaccination, . . .)
4. Improved infrastructure for drinking water and sanitation and hygiene conditions in the lake areas "sources" as a priority;
5. Improved case management
6. Strengthening coordination (for the relationship between donors, operational actors and researchers
7. Promotion of operational research

The implementation of the plan has led to the improvement of epidemiological surveillance, improved case management, and the strengthening of coordination through the creation of an Intersectoral Committee for the Fight Against Cholera. In the areas of water, hygiene, and sanitation, sustainable actions

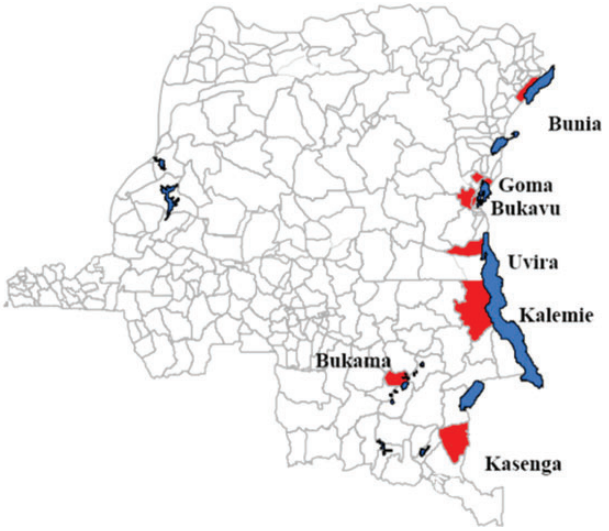

Figure 4. The 7 targeted health zones, according to the strategic plan of cholera elimination in the Democratic Republic of Congo.

have been initiated and are currently progressing in 4 priority cities of Bukama, Kalémie, Uvira, and Goma.

In the DRC as in several African countries, the idea of a possible elimination of cholera as a public health problem is still considered unachievable. Yet the experience in other regions, such as the elimination of cholera in Latin America only 12 years after the first outbreak in 1991, shows that this can be achieved. The recent decision by the Pan American Health Organization (PAHO), World Health Organization (WHO), UNICEF, US Centers for Disease Control and Prevention, and the 2 governments of Haiti and Dominican Republic, to move from control to elimination of cholera in the island of Hispaniola [12], should serve as an example to policy makers and the international community regarding the elimination of cholera in Africa. The call to action for the elimination of cholera in the island of Hispaniola demonstrates the importance of political courage and institutional commitment when confronting a disease that results largely from social inequities.

In the DRC, despite the fact that the dynamic and the source of cholera outbreaks are already known [13], these elements remain absent, including a strong statement by the international community that the goal is elimination and not merely control. While the DRC Ministry of Health has expressed a desire for cholera elimination, the current circumstances of the DRC dictate that international funding and technical groups must also commit to this goal and work with the DRC government and local experts to achieve it.

Supplementary Data

Supplementary materials are available at *The Journal of Infectious Diseases* online (http://jid.oxfordjournals.org/). Supplementary materials consist of data provided by the author that are published to benefit the reader. The posted materials are not copyedited. The contents of all supplementary data are the sole responsibility of the authors. Questions or messages regarding errors should be addressed to the author.

Notes

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Potential conflicts of interest. All authors: No reported conflicts.

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