Chains of transmission and control of Ebola virus disease in Conakry, Guinea, in 2014: an observational study

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Summary

Background An epidemic of Ebola virus disease of unprecedented size continues in parts of west Africa. For the first time, large urban centres such as Conakry, the capital of Guinea, are affected. We did an observational study of patients with Ebola virus disease in three regions of Guinea, including Conakry, aiming to map the routes of transmission and assess the effect of interventions.

Methods Between Feb 10, 2014, and Aug 25, 2014, we obtained data from the linelist of all confirmed and probable cases in Guinea (as of Sept 16, 2014), a laboratory database of information about patients, and interviews with patients and their families and neighbours. With this information, we mapped chains of transmission, identified which setting infections most probably originated from (community, hospitals, or funerals), and computed the context-specific and overall reproduction numbers.

Findings Of 193 confirmed and probable cases of Ebola virus disease reported in Conakry, Boffa, and Télimélé, 152 (79%) were positioned in chains of transmission. Health-care workers contributed little to transmission. In March, 2014, individuals with Ebola virus disease who were not health-care workers infected a mean of 2·3 people (95% CI 1·6–3·2): 1·4 (0·9–2·2) in the community, 0·4 (0·1–0·9) in hospitals, and 0·5 (0·2–1·0) at funerals. After the implementation of infection control in April, the reproduction number in hospitals and at funerals reduced to lower than 0·1. In the community, the reproduction number dropped by 50% for patients that were admitted to hospital, but remained unchanged for those that were not. In March, hospital transmissions constituted 35% (seven of 20) of all transmissions and funeral transmissions constituted 15% (three); but from April to the end of the study period, they constituted only 9% (11 of 128) and 4% (five), respectively. 82% (119 of 145) of transmission occurred in the community and 72% (105) between family members. Our simulations show that a 10% increase in hospital admissions could have reduced the length of chains by 26% (95% CI 4–45).

Interpretation In Conakry, interventions had the potential to stop the epidemic, but reintroductions of the disease and poor cooperation of a few families led to prolonged low-level spread, showing the challenges of Ebola virus disease control in large urban centres. Monitoring of chains of transmission is crucial to assess and optimise local control strategies for Ebola virus disease.

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Introduction

An epidemic of Ebola virus disease of unprecedented size has been ongoing for about a year in parts of west Africa. As of Jan 11, 2015, there have been 21 296 probable, confirmed, and suspected cases, and 8429 deaths,[1] with a case fatality ratio of about 70%.[2] Guinea, Liberia, and Sierra Leone have been worst affected, although Nigeria and Senegal have also reported cases. WHO[3] declared the epidemic a public health emergency of international concern on Aug 8, 2014. The USA and Spain have reported nosocomial transmission.[1]

Transmission of Ebola virus disease occurs by direct contact with body fluids from symptomatic patients infected with Ebola virus. Care of patients at hospitals or by family or the community and touching bodies at funerals are both important routes of infection. Since patients become infectious after 11 days (range 2–21 days)[2] of incubation on average, contacts that have been exposed to Ebola virus can be identified, monitored, and, when symptomatic, be isolated to limit spread. Therefore, multifaceted control strategies against Ebola virus disease that include tight infection control in hospitals and at funerals, active case finding and isolation, and identification and follow-up of their contacts, are believed to be sufficient to stop epidemics.[4] However, after initial containment failed, there has been general agreement that drastic improvement in control measures would be needed to end this epidemic.[2] As more resources become available, strategic decisions to control the epidemic must be informed by experience gained in the field.

Investigators have described clinical features, case fatality rates, and key time periods,[2] but a detailed quantification of the routes of transmission and the effect of specific interventions is needed. Overall growth in case numbers (eg, doubling times and overall reproduction numbers) has been characterised[2,5] but many other questions remain unanswered. What are the relative contributions of hospitals and funerals to spread? What has been the effect of infection control in these settings? What is the effect of hospitalisation on transmission in the community? Do high population densities in urban centres increase opportunities for transmission? How does mobility in and out of these areas affect spread and control?

Here we describe chains of transmission of Ebola virus disease and use Conakry, the capital city of Guinea (figure 1) and the first urban centre ever affected by Ebola virus disease, as a case study. From February to August, 2014, Conakry was affected by three consecutive epidemic waves of Ebola virus disease, which led to two new foci in Boffa and Télimélé (figure 1). We assessed the role of the different modes of transmission and the effect of control measures in these three prefectures during this period.

Methods

Case definitions

We used WHO case definitions[1] for suspected, probable, and confirmed cases of Ebola virus disease (appendix). We did diagnostics with either real-time RT-PCR or serology methods for patients who were identified later than 10 days after the date of onset of symptoms and for whom results of the RT-PCR were negative.[6,7] We analysed only data from probable and confirmed cases.

Laboratory and epidemiological investigations

We used three complementary datasets: the linelist of all confirmed and probable cases in Guinea (Sept 16, 2014); a laboratory database of information about socioeconomic status, outcome of infection, symptoms, course of infection, and viral load; and the results of additional epidemiological investigations of confirmed and probable cases that provided further insights into chains of transmission. The linelist has been described in detail elsewhere.[2] A standard case investigation form was used to obtain clinical and demographic data for all confirmed, probable, and suspected cases of Ebola virus disease identified through clinical care and contact tracing in Guinea. When possible, patients with the disease were also interviewed to document contacts with other infected patients, as well as exposures at funerals. Furthermore, we (EH and a team of investigators) interviewed relatives and neighbours of identified cases to identify additional cases, collect additional contextual information, and validate and complement information provided by cases in particular about possible contacts and sources of infection.

On the basis of the data gathered during these investigations, we established chains of transmission. For the subset of patients who are present in these chains, information from the three datasets was merged into a single dataset, with several variables: identification of patient, status (confirmed, probable), date of symptom onset, start and end of hospitalisation, date of death, occupation (health-care worker or not), district, age, sex, identification of possible infectors, start and end dates of possible contacts with infectors, indicator for family relationship with possible infectors (=1 if they had the same family name or if a family relationship was documented), indicator for nosocomial transmission, attending the funeral of a patient with Ebola virus disease (identification of possible infectors, dates of the funerals), and viraemia (appendix).

Reconstructing the transmission tree

Most individuals had one source of exposure. For the few patients with several possible infectors or contexts of infection, we developed statistical techniques to handle uncertainty about the source. For each patient with Ebola virus disease in the tree, we applied a simple algorithm to establish an exhaustive list of their exposure occurrences in which the identification of the possible person who gave them the infection (the infector), the date of exposure, and the context (community, hospital, or funeral) defined an exposure occurrence. For each pair of case and possible infector, we proceeded as follows: if the start and end dates of contact were available, we used

See Online for appendix

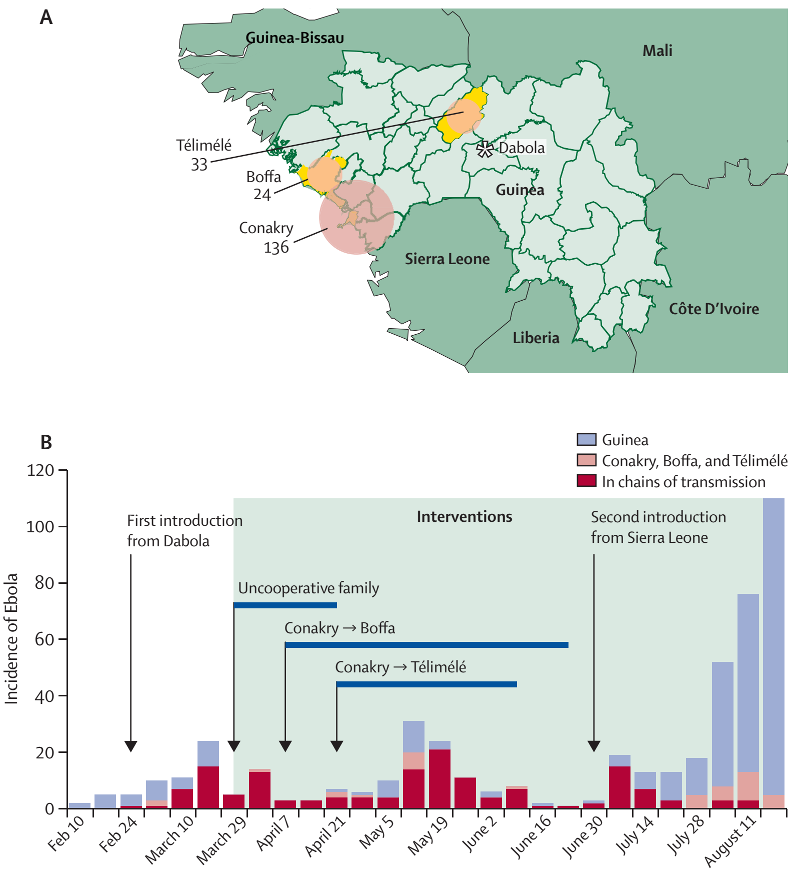

Figure 1: **Epidemiological context**

(A) Shows a map of Guinea with Conakry, Télimélé, and Boffa, highlighted. Numbers show the show the total number of probable and confirmed cases reported from Feb 10 to Aug 25, 2014. The first case of Conakry was imported from Dabola, which is shown with an asterix. (B) Epidemic curve of probable and confirmed incidence of Ebola virus disease in Guinea (blue) and for the prefectures of Conakry, Télimélé, and Boffa (pink). The number of cases positioned in the chains of transmission in Conakry, Télimélé, and Boffa appear in red. From the end of March, 2014, control measures were implemented, including the opening of a treatment centre, social mobilisation among health-care workers, and secured burial by professional staff.