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# Clinical profile and containment of the Ebola virus disease outbreak in two large West African cities, Nigeria, July–September 2014

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SUMMARY

*Introduction:* The Ebola virus disease (EVD) outbreak in Nigeria began when an infected diplomat from Liberia arrived in Lagos, the most populous city in Africa, with subsequent transmission to another large city.

*Methods:* First-, second-, and third-generation contacts were traced, monitored, and classified. Symptomatic contacts were managed at Ebola treatment centers as suspected, probable, and confirmed EVD cases using standard operating procedures adapted from the World Health Organization EVD guidelines. Reverse transcription PCR tests confirmed EVD. Socio-demographic, clinical, hospitalization, and outcome data of the July–September 2014 Nigeria EVD cohort were analyzed.

*Results:* The median age of the 20 EVD cases was 33 years (interquartile range 26–62 years). More females (55%), health workers (65%), and persons <40 years old (60%) were infected than males, non-health workers, and persons aged ≥40 years. No EVD case management worker contracted the disease. Presenting symptoms were fever (85%), fatigue (70%), and diarrhea (65%). Clinical syndromes were gastroenteritis (45%), hemorrhage (30%), and encephalopathy (15%). The case-fatality rate was 40% and there was one mental health complication. The average duration from symptom onset to presentation was 3 ± 2 days among survivors and 5 ± 2 days for non-survivors. The mean duration from symptom onset to discharge was 15 ± 5 days for survivors and 11 ± 2 days for non-survivors. Mortality was higher in the older age group, males, and those presenting late.

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*Conclusion:* The EVD outbreak in Nigeria was characterized by the severe febrile gastroenteritis syndrome typical of the West African outbreak, better outcomes, rapid containment, and no infection among EVD care-providers. Early case detection, an effective incident management system, and prompt case management with on-site mobilization and training of local professionals were key to the outcome.
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## 1. Introduction

Ebola virus disease (EVD) is a zoonotic hemorrhagic fever illness caused by a filovirus. Since its discovery in Zaire in 1976, human EVD infections have been rare but repeated among people living in forest communities of endemic central and east African countries. The endemic countries are the Democratic Republic of Congo, Uganda, Sudan, and Gabon. Between 1976 and 2013, only two countries outside the endemic region recorded Ebola cases. In 1994, an ethnologist was infected by a novel Ebola subtype from a wild chimpanzee in Côte d'Ivoire.[1] In 1996, the predominant Zaire subtype was implicated in a South African case.[2]

Although Nigeria and other West African countries have experienced cases of Lassa and dengue fever, the 2014 Ebola virus outbreak was the largest viral hemorrhagic fever (VHF) outbreak in these countries. The Nigeria outbreak began on July 20, 2014 when an infected Liberian-American diplomatic traveler (the index case) from neighboring Liberia arrived in Lagos, the commercial capital of Nigeria and Africa's most populous city. His entry into Lagos and subsequent spread of the disease to another large city – Port Harcourt – marked the first recorded spread of Ebola virus in an international mega-city or large urban setting. This heightened the international community's concern for an exponential increase in the magnitude of the already devastating West African EVD outbreak.

The clinical profile of patients affected by EVD has been documented in previous outbreaks. The incubation period is between 2 and 21 days, and this is followed by an abrupt presentation of non-specific symptoms. Initial symptoms may include fever, headache, abdominal pain, diarrhea, vomiting, macular rash, etc. Late in the clinical course, there may be hemorrhagic signs and weight loss. Macular rashes were used in previous outbreaks to aid the differential diagnosis because patients who presented with such rashes within 5–7 days of infection often showed signs of desquamation.[3] However, recent events have highlighted the unpredictability of Ebola virus in human hosts. For example, the 1996 case in Côte d'Ivoire presented with a variety of symptoms including prostration, but recovered after a prolonged illness. This contrasts with a case in a 12-year-old in Uganda who presented simply with fever and yet quickly progressed to hemorrhage and death within 3 days of presentation to a health care facility.[4]

Much of what is known of Ebola signs and symptoms has come from outbreaks in which data collection was limited. Other factors that have contributed to the limited understanding of EVD include the quick progression of clinical manifestations, as well as the level of infection prevention and control (IPC) measures needed to manage or study this disease.

The core case identification process, critical clinical presentations, morbidity patterns, primary clinical management, and outcomes of a confirmed EVD case cohort in Nigeria, seen during the successful containment effort during the period July 20–September 30, 2014, are described herein. This review contributes to the small but growing EVD presentation and management information from West Africa, which is of value to clinicians and public health practitioners.

## 2. Methods

### 2.1. Outbreak setting and population

The outbreak occurred in two large West African and Nigeria-state capital cities, namely Lagos and Port Harcourt. Lagos, the most populous city in Africa, is located in the South West geo-political region of the country, and Port Harcourt in the South South geo-political region, with land areas of approximately 3345 and 11 077 $km^2$, respectively. Lagos and Port Harcourt are complex urban megacities with a combined population of over 23 million people. The two cities host international airports and seaports, and have witnessed large influxes of people not only from within Nigeria, but also from neighboring countries, as they serve as major business, employment, and cultural centers.

Like many metropolises in developing countries, Lagos and Port Harcourt are crowded cities with many slums. More than 60% of the population in Lagos live in urban slums, which could pose a challenge to the containment and control of an infectious disease outbreak. However, compared to other cities in Nigeria, Lagos and Port Harcourt are among the State capitals with relatively better developed public and private health care infrastructure, including emergency response resources.

One of the main ports of entry into Nigeria is Murtala Muhammed International Airport in Lagos, which is a major hub for the West African travel route and other international flights. This airport is one of the busiest in Africa and was the point of entry for the Nigeria index EVD case.

### 2.2. Identification of suspected and confirmed EVD case patients and their management

All persons who were exposed to the index case were traced and monitored by the contact tracing team. If they subsequently became ill, their contacts were also traced, placed under surveillance, and monitored daily for clinical features of EVD, especially body temperature (using a self-administered axillary thermometer). As soon as they reported or were observed to have a body temperature of $\geq$38 °C or had other symptoms meeting the suspected case definition, such as abdominal pain, diarrhea, or vomiting, sudden bleeding or bloody diarrhea or blood in the urine, they were referred to the case management team for evaluation and subsequent evacuation to the Ebola treatment centre (ETC), in accordance with the adapted EVD screening and case management standard operating procedure (SOP). They were then reviewed by a medical officer and admitted to the suspected case isolation ward if they met the EVD suspected case definition. Third-generation contacts were also traced and managed based on the SOP, with significant outcomes especially in the second city – Port Harcourt. Two of the three tertiary contacts here had been in direct contact with a secondary contact, while one had shared only an emergency care centre facility (room) with the same secondary contact, implicating a nosocomial transmission (Figure 1 shows the EVD chain of transmission in Nigeria).

Blood samples were collected from suspected case patients and these were tested by reverse transcription PCR (RT-PCR) for

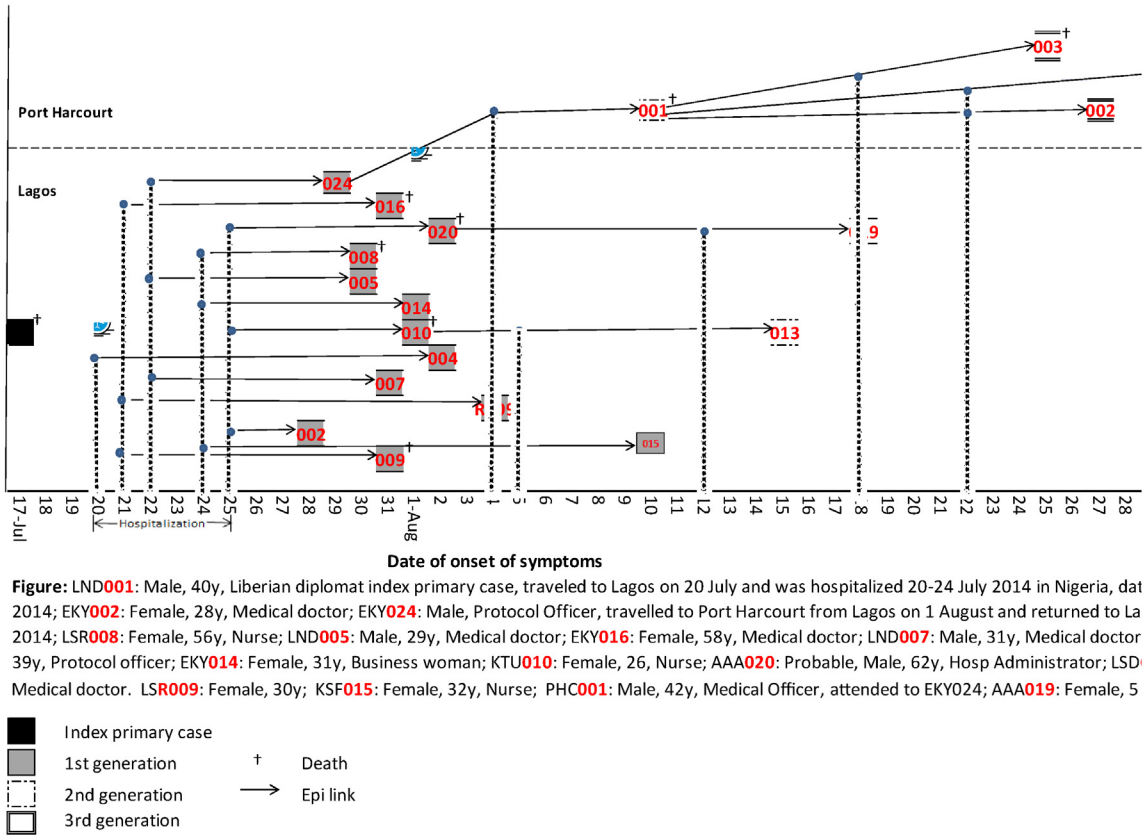


**Figure:** LND001: Male, 40y, Liberian diplomat index primary case, traveled to Lagos on 20 July and was hospitalized 20-24 July 2014 in Nigeria, dat
2014; EKY002: Female, 28y, Medical doctor; EKY024: Male, Protocol Officer, travelled to Port Harcourt from Lagos on 1 August and returned to La
2014; LSR008: Female, 56y, Nurse; LND005: Male, 29y, Medical doctor; EKY016: Female, 58y, Medical doctor; LND007: Male, 31y, Medical doctor
39y, Protocol officer; EKY014: Female, 31y, Business woman; KTU010: Female, 26, Nurse; AAA020: Probable, Male, 62y, Hosp Administrator; LSD
Medical doctor. LSR009: Female, 30y; KSF015: Female, 32y, Nurse; PHC001: Male, 42y, Medical Officer, attended to EKY024; AAA019: Female, 5

**Figure 1.** Ebola virus disease chain of transmission in Nigeria, July–September 2014.

filovirus at a World Health Organization (WHO)-accredited VHF laboratory run by the Lagos University Teaching Hospital and a European Union-donated mobile PCR laboratory in Port Harcourt manned by staff of the National Lassa Fever Research and Control Institute of the Specialist Teaching Hospital, Irrua-Edo State.

Admitted suspected case patients were treated empirically for malaria, volume and electrolyte requirements (in particular with supervised oral rehydration solution (ORS) intake or when necessary parenteral fluid and electrolyte therapy), and other possible concomitant medical issues such as Gram-negative bacterial sepsis, when appropriate. Food and vitamin supplementation were provided. Non-steroidal anti-inflammatory medications were avoided.

The standard infection prevention and control practices of Médecins Sans Frontières (MSF) and the WHO[5] were observed, as in the adapted Nigeria EVD IPC SOP. Those patients with a positive PCR result for Ebola were classified as EVD-confirmed case patients. Confirmed case patients were continued in care but separated from suspected case patients into different isolation wards. After the initial use of temporary isolation wards during the first 2 weeks of the outbreak, a pre-existing 40-bed international-standard infectious disease facility built for multidrug-resistant tuberculosis patients was adopted as the ETC in Lagos. A 26-bed primary healthcare facility was modified and used as the ETC in Port Harcourt. These facilities allowed adequate separation of isolation wards for suspected and confirmed EVD cases, as well as the effective practice of EVD IPC procedures with the guidance of the WHO and MSF experts.

In accordance with the adapted Nigeria EVD discharge SOP, discharged patients underwent decontamination and were provided with replacement clothes, footwear, basic personal effects, and a discharge certificate. Psychosocial support for patients and families was undertaken during the ETC stay, at discharge, and post-discharge.

Following the initial paucity of EVD-experienced health workers at the beginning of the outbreak, case management subsequently relied heavily on extensive mobilization and onsite training of local professionals, including nurses experienced in the care of VHF patients and other infectious disease patients from the Irrua Specialist Teaching Hospital, Lagos State Mainland Hospital, and Lagos University Teaching Hospital, supported by government resources and technical/material contributions from the WHO, MSF, United Nations International Children's Emergency Fund (UNICEF), US Centers for Disease Control and Prevention (CDC), and the private sector, effectively coordinated by the National Ebola Emergency Operations Centre (E-EOC) Case Management Team. Over 250 local case management team volunteers consisting of physicians ($n = 52$), including infectious disease experts ($n = 7$) and psychiatrists ($n = 3$), nurses ($n = 50$), laboratory scientists ($n = 20$), nurse-assistants ($n = 18$), environmental health officers/technicians ($n = 30$), psychologists ($n = 3$), social workers ($n = 10$), pharmacists ($n = 9$), and emergency service workers ($n = 60$), were mobilized and trained by the WHO, CDC, MSF, and local infectious diseases experts coordinated by the E-EOC Case Management Team coordinator. Key topics included an overview of EVD, EVD IPC procedures, basics and demonstrations of donning and un-donning personal protective equipment (PPE), and case evacuation, burial, and decontamination procedures, as well as EVD patient care apprenticeship under the WHO and MSF EVD clinical care experts.

### 2.3. Data collection and review methods

A suspected case was a primary, secondary, or tertiary contact of the index case or any traveler from an EVD-infected country

with the acute onset of fever, malaise, myalgia, or headache, followed by vomiting or diarrhea, with or without a maculopapular rash, pharyngitis, or hemorrhage of unknown predisposing condition. A probable case was defined as a deceased suspected case (where it had not been possible to collect a specimen for laboratory confirmation) with an epidemiological link to a confirmed case. A confirmed EVD case was defined as a suspected case with laboratory-confirmed diagnostic evidence of an Ebola virus infection using real-time RT-PCR in Nigeria during the period July 20 to September 30, 2014.

ETC case management procedures and the clinical and laboratory data of all confirmed and probable EVD cases identified during the period July 20 to September 30, 2014 (2014 EVD cohort) were reviewed by qualified medical professionals in the case management team. Socio-demographic (age, sex, occupation, city of residence), clinical (respiratory rate, pulse rate, blood pressure, presenting symptoms, signs, syndromes, outcome), laboratory (real-time RT-PCR), and administrative data (date of symptom onset, duration from symptoms to ETC admission or discharge, length of ETC stay (LOS)), collected with locally designed data tools (suspect evaluation form, case investigation form, laboratory request form, laboratory result form, clinical chart abstraction form, contact tracing interview notes) were abstracted and entered into a Microsoft Office Excel 2007 spreadsheet (Microsoft Inc., Seattle, WA, USA).

The exposure history, presenting symptoms, history of presenting symptoms, course of illness, excerpts of clinical management, and illness outcome of the individual case patients were abstracted from their medical records or contact tracing interview notes and summarized as case histories.

### 2.4. Data analysis

The key socio-demographic, clinical, administrative, and outcome data expressed as counts, percentages, median with range or mean ± standard deviation were displayed in tables, and frequency charts as appropriate, and subjected to univariate analysis. The morbidity pattern was summarized through case histories, common presenting symptoms, types of clinical syndrome, and ETC length of stay, and comparisons were made by dichotomized clinical outcome. The clinical outcome was summarized as one of three categories: non-survivor, survivor, and survived with complications. The dichotomized clinical outcome – dead or alive – was compared by age group, sex, duration from symptoms to ETC admission, and type of clinical syndrome in bivariate analysis using the Student *t*-test for means and the Chi-square test or Fisher's exact test for proportions. Statistical significance was ascertained using the 95% confidence interval (CI), or a two-tailed *p*-value of $<0.05$. Epi-Info version 7 (CDC, Atlanta, GA, USA) was used for all data analyses.

## 3. Results

The results comprise a summary of the aggregate EVD case profiles and the transmission chain.

The total number of EVD cases was 20 (19 confirmed and one probable); these patients had a median age of 33 years (interquartile range 26–66 years). By age group, the highest percentage of cases (35%) was among those aged 30–39 years and the lowest (15%) among those aged 40–49 years. Overall, most EVD cases (60%) were aged <40 years. More cases were found among females (55%) than males, and among health workers (65%) than non-health workers (Table 1). The common clinical signs (Blood pressure, respiratory rate, pulse rate) and syndromes (hamorrhagic, gastroentric, encephlopathic syndromes) elicited from EVD case-patients at the time of first presentation to the ETC are summarized in Table 2.

The index case was a 40-year-old male Liberian-American diplomat who spread the disease to 13 of the first-generation contacts. The first reported case among his contacts was a 28-year-old female physician. Only two cases occurred among second-generation contacts in Lagos. Another first-generation contact, a male protocol officer in Lagos, travelled against medical advice to another city – Port Harcourt – and was clandestinely treated by a 42-year-old male physician who acquired the disease as a second-generation contact and subsequently transmitted the disease to three of his third-generation contacts. In all, 13 of the 19 secondary cases were among first-generation contacts and three cases each among second- and third-generation contacts (Figure 1).

The common presenting symptoms among cases were fever (85%), fatigue (70%), diarrhea (65%), anorexia (55%), and vomiting (50%). Bleeding and headache were present in only 35% and 30% of cases, respectively (Figure 2). Diarrhea, vomiting, and bleeding occurred in higher proportions among non-survivors, but this finding was not statistically significant. The mean duration from symptom onset to ETC admission was longer among non-survivors ($5 \pm 2$ days) than survivors ($3 \pm 2$ days), while the mean duration from symptom onset to discharge was shorter for non-survivors ($11 \pm 4$) than survivors ($15 \pm 5$ days) (Table 3). One survivor had mental health complications, which were managed successfully by the psychosocial unit. Being male, ≥40 years old (older age), and having severe gastroenteritis or encephalopathy as a complication seemed to be more related with mortality among EVD cases (Table 4).

**Table 1**
Socio-demographic characteristics of EVD cases in Nigeria, July–September 2014 ($N = 20$)

| Characteristics | EVD cases (%) |
|---|---|
| Age group (years) | |
| <30 | 5 (25) |
| 30–39 | 7 (35) |
| 40–49 | 3 (15) |
| ≥50 | 5 (25) |
| Sex | |
| Male | 9 (45) |
| Female | 11 (55) |
| Occupation | |
| Health worker | 13 (65) |
| Non-health worker | 7 (35) |

EVD, Ebola virus disease.

**Table 2**
Clinical features of EVD cases at presentation, Nigeria, July–September 2014

| Clinical feature | Proportion of confirmed cases (%) |
|---|---|
| Signs | |
| Pulse rate ($n = 12$) | |
| High (>100 beats/min) | 5 (42.7) |
| Normal (60–100 beats/min) | 6 (50) |
| Low (<60 beats/min) | 1 (8.3) |
| Respiratory rate ($n = 10$) | |
| Fast (> 20 beats/min) | 9 (90) |
| Normal (12–20 beats/min) | 1 (10) |
| Slow (<12 beats/min) | 0 (0) |
| Blood pressure ($n = 11$) | |
| High (systolic > 120 mmHg) | 2 (18.2) |
| Normal (systolic 90–120 mmHg) | 6 (54.5) |
| Low (systolic <90 mmHg) | 3 (27.3) |
| Syndromes ($n = 13$) | |
| Hemorrhage | 1 (7.7) |
| Gastroenteritis | 9 (69.2) |
| Encephalopathy | 3 (23.1) |

EVD, Ebola virus disease.

**Table 3**
Characteristics of EVD cases by clinical outcome, Nigeria, July–September 2014

| Characteristics | EVD cases | | RR | *p*-Value |
|---|---|---|---|---|
| | Dead ($n=8$) | Alive ($n=12$) | | |
| Age (years), mean ± SD | | | | |
| Male | 45.5 ± 10.4 | 34.6 ± 8.2 | | 0.06 |
| Female | 50.5 ± 16.5 | 33.3 ± 8.5 | | 0.06 |
| Symptoms | | | | |
| Fever | | | | |
| Positive | 6 (35.3) | 11 (64.7) | 0.53 | 0.54 |
| Negative | 2 (66.7) | 1 (33.3) | | |
| Fatigue | | | | |
| Positive | 6 (42.9) | 8 (57.1) | 1.3 | 1.0 |
| Negative | 2 (33.3) | 4 (66.7) | | |
| Diarrhea | | | | |
| Positive | 6 (46.2) | 7 (53.8) | 1.6 | 0.6 |
| Negative | 2 (28.6) | 5 (71.4) | | |
| Anorexia | | | | |
| Positive | 2 (18.2) | 9 (81.8) | 0.3 | 0.06 |
| Negative | 6 (66.7) | 3 (33.3) | | |
| Vomiting | | | | |
| Positive | 5 (50.0) | 5 (50.0) | 1.7 | 0.6 |
| Negative | 3 (30.0) | 7 (70.0) | | |
| Headache | | | | |
| Positive | 2 (33.3) | 4 (66.7) | 0.8 | 1.0 |
| Negative | 6 (42.9) | 8 (57.1) | | |
| Bleeding | | | | |
| Positive | 4 (66.7) | 2 (33.3) | 2.0 | 0.3 |
| Negative | 4 (28.6) | 8 (57.1) | | |
| Onset of symptoms to admission (days), mean ± SD | 5 ± 2.2 | 3.4 ± 2.0 | | 0.07 |
| Onset of symptoms to discharge (days), mean ± SD | 11.3 ± 4.3 | 15.5 ± 4.9 | | 0.03 |

EVD, Ebola virus disease; RR, risk ratio.

## 4. Discussion

The first outbreak of EVD in Nigeria began in the most populous city of Africa, with subsequent transmission to a second large city, and reflected mainly a febrile severe gastroenteritis illness with less of the hemorrhagic syndrome typifying an extension of the ongoing West African EVD outbreak.[6–9] However, Nigeria had moderate-to-severe clinical syndromes, less intra-city spread, and a relatively low case-fatality rate compared to the situation in sister West African countries. This could be because Lagos and Port Harcourt are among the cities with a relatively more developed public and private health care infrastructure. This includes emergency response resources leveraged by the government-led multi-partner Ebola emergency operations centre, leading to the early identification and isolation of most cases, with the deployment of prompt and effective containment measures.

Molecular studies have shown variations in clinical severity based on the circulating subtype.[10] For instance, outbreaks of the Zaire subtype in Congo (1976), Gabon (2001), and Congo (2007) had case-fatality rates (CFR) of 88%, 82%, and 71%, respectively. Sudan subtype outbreaks had lower CFRs of 56% in Sudan (1976) and 53% in Uganda (2000).[2] Although the West African outbreak, which is now known to be due to a variant of the Zaire subtype, has shown a modest CFR, the Nigeria outbreak recorded the lowest CFR so far. Other studies have reported the reasons for the differential severity in clinical presentation of EVD cases as being due to the infective subtype[11] and variation in immune response, as well as to a swift outbreak response.[4]

Suggestions of differential or better immune response capacity based on socio-economic differences in Nigerian city dwellers compared to rural dwellers in the case of other West African countries or previous outbreaks, might be difficult to ascertain. This moderate-to-severe picture is probably due to early case

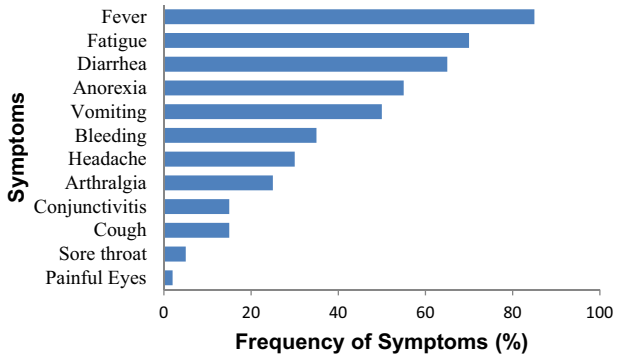


**Figure 2.** Frequency of presenting symptoms among Ebola virus disease cases in Nigeria, July–September 2014.

**Table 4**
Key factors related with mortality in EVD confirmed and probable cases, Nigeria, July–September 2014

| | Outcome | | RR | 95% CI |
|---|---|---|---|---|
| | Dead | Alive | | |
| Age group (years) | | | | |
| ≥40 | 5 (71.4) | 2 (28.6) | 3.1 | 1.0–9.3 |
| <40 | 3 (23.1) | 10 (76.9) | | |
| Sex | | | | |
| Male | 4 (44.4) | 5 (55.6) | 1.2 | 0.4–3.6 |
| Female | 4 (36.4) | 7 (63.6) | | |
| Occupation | | | | |
| Health worker | 5 (38.5) | 8 (61.5) | 0.9 | 0.3 –2.7 |
| Non-health worker | 3 (42.9) | 4 (57.1) | | |
| Syndromes | | | | |
| Gastroenteritis | | | | |
| Positive | 4 (44.4) | 5 (55.6) | 1.2 | 0.4–3.6 |
| Negative | 4 (34.4) | 7 (63.6) | | |
| Encephalopathy | | | | |
| Positive | 2 (66.7) | 1 (33.3) | 1.8 | 0.6–5.3 |
| Negative | 6 (35.3) | 11 (64.7) | | |

EVD, Ebola virus disease; RR, relative risk; CI, confidence interval.

identification, prompt clinical management, mobilization, training, and engagement of voluntary workers, and effective coordination of resources driven by the government-led inter-agency incident management system (IMS). The availability of in-country personnel from the National Centre for Disease Control and National Polio Eradication Emergency Operations Centre experienced in IMS was an added advantage. It is plausible that a positive attitude towards the EVD outbreak response as demonstrated by key public health sector personnel, the organized private sector, and volunteers from the public might have contributed to the relatively better outcomes observed in Nigeria compared to other affected West African countries. Also, the swift deployment of over 100 trained and trainee field epidemiologists from the 7-year-old Nigeria field epidemiology and laboratory training program and other partner-agency professional staff to engage in epidemiological and surveillance activities, especially contact tracing and monitoring aided by modern information technology innovations, facilitated a highly sensitive and timely case identification process. The rapid deployment of the WHO and MSF EVD case management experts, availability and prompt mobilization of pre-existing public medical emergency service resources, and adaptable case isolation facilities with rapid onsite training of local personnel by international experts further augmented by partners or private sector material donations, greatly facilitated rapid case isolation and early case management.

Barring the limitation of a small EVD patient population, this study showed that the percentage of female cases was marginally greater than that of male cases, although males seemed to have a higher mortality, which is different from the findings in Guinea in 2014[11] and Bundibugyo, Uganda in 2007.[12,13] Most cases were less than 40 years old, while more health workers were infected compared to non-health workers. Although health workers are often traditionally infected in EVD outbreaks, they seemed less likely to die compared to non-health workers in the Nigeria experience. In addition, the concentration of cases within the health facilities provided an insight into the effectiveness of barrier nursing and standard health facility infection control as being critical ways of mitigating such contagious infectious diseases. Also, the rather encouraging fact that aside from health workers who had been in contact with the index case prior to the EVD diagnosis in Lagos and the unfortunate case of the over-ambitious physician in Port Harcourt who clandestinely treated a known contact of the index case, no member of the EVD case management team contracted the disease in Nigeria, gives credence to the excellent infection prevention and control measures including clinical care process management.

Fever, defined as a body temperature above 38 °C, was evident in 85% of cases. This contrasts with the Bundibugyo outbreak, where a febrile illness was observed in 100% of cases.[12] This variation might have occurred because post-mortem cases whose temperature records were not collected during acute infection were included among those without fever.

While fatigue (70%) and diarrhea (65%) were among the most prevalent symptoms seen in this outbreak, hemorrhage occurred in only 30% of cases. The absence of bleeding in most cases once more underlines the fact that an insistent search for this distinctive hemorrhagic fever presentation might lead to EVD misdiagnosis. The pulse rate and blood pressure at time of presentation were found to be normal in most of the patients; however, the respiratory rate was elevated in most of the cases. Hence a normal blood pressure and pulse may not be used to exclude illness in suspected EVD cases.

The key clinical syndrome observed was a febrile, moderate-to-severe gastroenteritis with consequent fatigue. This syndrome should alert clinicians to the possibility of EVD in at-risk persons. However, those presenting with bleeding seemed to have a higher mortality, hence suggesting that a hemorrhagic syndrome might be an indicator of EVD severity. The case fatality of 40% observed in this population is lower than that observed in the other affected countries in this outbreak, as well as in previous outbreaks. The reason for this is unclear, but it could potentially be attributed to rapid contact tracing, early recognition of suspected cases with prompt isolation based on a dynamic incident management system, and effective treatment of EVD cases with an emphasis on aggressive oral rehydration therapy, parenteral replacement when needed, anti-malarial therapy, antibiotics, good nutrition, and psychosocial care. Other unrecognized factors or statistical limitations due to the low number of cases in Nigeria might also be a possibility. Observations from other outbreaks have also indicated that prompt identification and effective management of EVD cases could account for lower case fatality rates.[14]

The Nigeria EVD outbreak study encountered some limitations, including incomplete clinical and administrative data due to the scarcity of case management personnel during the first 2 weeks of the outbreak, non-availability of routine onsite laboratory tests for clinical care of EVD patients other than EVD diagnostics, and a relatively small patient population with insufficient data for robust comparative analysis. However, the prompt and effective contact tracing and case management based on the multi-disciplinary IMS with the relatively better outcomes (including a low CFR, limited intra-city spread, no infection among EVD care-providers, and successful management of a mental health complication) compared to similar outbreaks,[9–11] provides an additional reference resource for local and international EVD/VHF outbreak response or similar public health emergency management. It also reinforces the need for a robust early warning or surveillance system for EVD and other VHFs, backed by pre-positioned appropriate human and material resources, especially at ports of entry.

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*Conflict of interest:* The authors have no conflict of interest to declare.

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