



'The cat that kills people:' community beliefs about Ebola origins and implications for disease control in Eastern Democratic Republic of the Congo

Masumbuko Claude Kasereka^a and Michael T. Hawkes^{b,c,d}

^aDepartment of Medicine, Université Catholique de Graben, Butembo, Democratic Republic of Congo; ^bDepartment of Pediatrics, University of Alberta, Edmonton, Canada; ^cDepartment of Medical Microbiology and Immunology, University of Alberta, Edmonton, Canada; ^dSchool of Public Health, University of Alberta, Edmonton, Canada

ABSTRACT

The current Ebola epidemic in Eastern Democratic Republic of Congo (DRC) has surpassed 1 700 deaths. Social resistance, a major barrier to control efforts, invites exploration of community beliefs around Ebola and its origins. We conducted a mixed-methods study, using four focus group discussions (FGDs) involving 20 participants, and a 19-item survey questionnaire, administered to a nonprobability sample of 286 community members throughout the outbreak zone. FGDs and surveys were conducted between 4 and 17 August 2018. FGDs revealed a widespread rumor early in the epidemic of two twins bewitched by their aunt after eating her cat, who developed bleeding symptoms and triggered the epidemic. However, this myth appeared to dissipate as the epidemic progressed and biomedical transmission became generally accepted. In our survey, 6% of respondents endorsed supernatural origins of Ebola. These respondents were more likely to believe that traditional medicine practitioners can cure Ebola. Wild animals were recognized as sources of Ebola by 53% and FGD participants commented that 'Ebola leaves the forest and hides in the hospital,' recognizing that zoonotic origins gave way to nosocomial transmission as the epidemic progressed. Taken together, our findings suggest that a dynamic syncretism of mythical and biomedical understanding of Ebola may have shaped transmission patterns. Mythical conceptions and fear of contagion may have fueled the 'underground' transmission of Ebola, as patients sought care from traditional healers, who are ill-equipped to deal with a highly contagious biohazard. A deeper understanding of beliefs around Ebola origins may illuminate strategies to engage communities in control efforts.



KEYWORDS


Ebola; DRC; social resistance; transmission; community engagement; epidemic

Introduction

Ebola virus disease is a frequently fatal, highly contagious infection that produces explosive outbreaks in equatorial Africa [1]. The second largest outbreak in history is ongoing in North Kivu province in the Democratic Republic of the Congo (DRC). Unlike past successfully contained outbreaks in the DRC, the current outbreak appears refractory to control efforts [2]. Noteworthy epidemiologic observations from the current outbreak to date include: (1) 40% of Ebola deaths occurred outside the Ebola treatment unit (ETU) in the home settings [3]; (2) 25% of infections arose at local health centers [3]; and (3) 30% of infected were children [3], thought to have contracted the disease at local health centres. These concerning features point to the propagation of the epidemic through household and nosocomial transmission, and together indicate a general reluctance to engage with Ebola control efforts, with a preference for local facilities and traditional healers called 'tradipraticiens' [4].

We have previously described social resistance to Ebola control efforts in Eastern DRC in an important minority of community members [5,6]. In this and previous epidemics, resistance ranges from passive non-compliance to overt acts of aggression toward Ebola control teams [7–12]. Because of the highly contagious and lethal nature of the infection, resistance is puzzling and invites an exploration of community beliefs that may underpin this position. Previous authors have categorized upstream causes of social resistance in five domains: (1) rumors; (2) fear; (3) mistrust and lack of confidence in the authorities; (4) denial of the biomedical discourse; and (5) desire to be autonomous and avoid exogenous contamination [13,14]. We probed community beliefs around Ebola and its origins, hypothesizing that denial of the biomedical discourse may explain 'resistant' attitudes that minimize the infectious risks of Ebola. We also investigated the reasons underlying community avoidance of Ebola treatment facilities in favor of traditional medicine.

CONTACT Michael T. Hawkes  mthawkes@ualberta.ca  Department of Pediatrics, University of Alberta, 3-588D Edmonton Clinic Health Academy, 11405 87 Ave NW, Edmonton T6G 1C9, Canada

 The supplementary data for this article can be accessed [here](#).

© 2019 Informa UK Limited, trading as Taylor & Francis Group

Methods

Setting

The current Ebola epidemic in the Eastern DRC has been characterized as a ‘perfect storm’ [15] complicated by weak health-care infrastructure, active security concerns, and population displacement [16]. On 1 August 2018, the Ministry of Health of the Democratic Republic of the Congo (DRC) declared the country’s 10th Ebola outbreak which continues unabated now in its twelfth month [17]. As of 20 July 2019, 2 578 cases and 1 737 deaths have been reported [18]. Data collection was conducted in the affected communities in North Kivu in the midst of ongoing Ebola transmission. We focused on the village of Mangina, where the epidemic began, the larger centers of Béni and Butembo, where a large number of cases occurred and community resistance was fiercest, and the internally displaced persons (IDP) camp at Komanda.

Focus group discussions

FGDs were conducted with key informants, including residents of affected communities as well as health-care providers. Each FGD was comprised of five individuals [19] and was conducted in the local languages (Kiswahili, Kinande, and French). FGDs were audio recorded and transcribed verbatim for later translation into English and analysis. FGD questions were elastic, open-ended and probing, allowing participants the freedom to guide the discussion. Rounds of FGDs were iterative, drawing on findings from previous rounds to refine and elaborate on themes of interest, and continued until saturation of themes [15]. For the qualitative thematic analysis, investigators read transcripts several times, noted preliminary concepts, constructed codes by highlighting relevant data, determined themes by collating codes across the data set, and refined themes. Statements of particular interest and representative quotations were used to support the qualitative conclusions. Investigator KMC, a physician from Butembo, DRC, conducted FGDs, transcribed the data, and interpreted the qualitative findings. MTH, a Canadian physician, coded the transcripts and conducted a thematic analysis, selecting representative supportive quotations. Both investigators discussed and reviewed the themes and quotations to ensure that they represented the full spectrum of views expressed during FGDs.

Survey questionnaire

We used survey questionnaires to confirm and quantify views expressed in FGDs. A sample of community members was purposively selected from affected

communities. A nonprobability sampling method was used, as follows. Surveyors were chosen from leaders among the medical students at the Université Catholique du Graben, Butembo, DRC. Medical students are trusted members of the local community with strong literacy skills, biomedical understanding of EVD, and tacit cultural competencies. They used their social networks (including faith-based assemblies, public gatherings such as market days) to recruit survey participants within the urban center of Butembo (epicenter of EVD transmission). They also traveled to surrounding towns/cities of Mangina (rural commune where the first EVD cases were detected), Béni (urban hotspot of EVD transmission), and Komanda (IDP camp) to cover all geographic areas affected by the epidemic. Participants were sought that would represent a full spectrum of views (maximum variability sampling), including occupation (agriculturalists, salaried employees, students), education level (no formal education to secondary and higher), as well as allopathic health-care workers and practitioners of traditional medicine. Participants were 18 or older.

A 19-item questionnaire was designed, based in part on past questionnaires used in Guinea, DRC, and Germany [20–23]. Questions from past surveys included participant characteristics, Ebola-specific knowledge, and attitudes toward response efforts. We included other questions which were not included in past surveys, based on qualitative FGD findings: an open-ended question on Ebola origin, belief in healing abilities of traditional practitioners, and bushmeat consumption.

Knowledge, beliefs, and attitudes with respect to Ebola

Items were adapted from previous questionnaires. ‘Comprehensive knowledge’ was defined as accepting three main concepts of prevention (avoiding body fluids, infected corpses, and adopting handwashing as a prevention practice), and rejecting three major misconceptions [24]. Affective response was assessed by the question ‘Are you worried about Ebola?’ [20]. As possible markers of ‘resistant’ attitudes toward Ebola control efforts, we asked participants if they would: (1) bring an infected family member to an ETU (‘no’ answer considered ‘resistant’); (2) hide an infected family member from the authorities (‘yes’ considered resistant); and (3) accept an official burial team to care for the body of a family member deceased with Ebola (‘no’ considered resistant) [5]. We also included one item probing beliefs about traditional healers and their ability to cure Ebola.

Origins of Ebola

As in a previous survey [23], we used an open-ended unprompted question about the origins of Ebola, and

categorized responses in major groups: (1) wild animals of the forest (responses ‘monkey’ and ‘bat’ were included in this category); (2) magical origins (responses ‘witchcraft,’ ‘magic,’ and ‘cat’ were included in this category); and (3) other responses.

Practices surrounding forest animals

In order to assess one risk factor for zoonotic transmission, we asked survey participants if they ate meat from wild animals.

This structured questionnaire was administered as an oral interview with consenting participants, in the local language, by study staff who were from the area and therefore had a high level of tacit cultural and linguistic understanding.

Statistical analysis

Data analyses were performed using R (version 3.3.3, R core team, 2017). Descriptive statistics were expressed as number and percentage for dichotomous variables and median and interquartile range for continuous variables. To examine associations between variables, two-tailed Pearson Chi-Square or Fisher’s exact test were used for categorical data, as appropriate. Among related items pertaining to knowledge and misconceptions of Ebola on the survey questionnaire, we used a latent factor analysis to derive an index of ‘Ebola knowledge’ (Supplemental online material).

Ethics approval

The Comité d’Éthique du Nord Kivu (Centre Hospitalier Universitaire du Graben, Butembo, DRC) approved the study. Participants provided verbal-informed consent for both FGDs and survey questionnaires. Written informed consent was waived by the Ethics Committee because: (1) FGDs and surveys carried minimal risk to participants; (2) participation in the FGDs and survey constituted tacit consent; and (3) excessive contact with participants and paperwork was discouraged (‘no-touch’ policy) in the context of the Ebola outbreak with potential for viral transmission by direct person-to-person contact and/or by fomites.

Results

Focus group discussions

We began with a qualitative exploration of community beliefs around Ebola origins and their relationship with health-seeking behavior. Four FGDs involving a total of 20 participants (Table 1) generated rich qualitative data, which were grouped based on the following themes: (1) magical origins; (2) zoonotic origins; and (3) impact of Ebola on the health-care system. We expand on each

Table 1. Description of focus group discussion (FGD) composition.

FGD#1 (5 participants)
Doctor
Nun and health centre nurse
Community Health Worker
Community member
Community member
FGD#2 (5 participants)
Nurse anesthetist
Member of NGO
Community Health Worker
Community member
IDP camp resident
FGD#3 (5 participants)
Doctor
Member of NGO
Community Health Worker
Community member
Morgue worker
FGD#4 (5 participants)
Doctor at Health Centre
Doctor, Vaccine Team
Doctor, Ebola Case Management
Nun and head nurse at health centre
Nurse and Ebola survivor

theme below and provide supporting representative quotations, translated into English.

Magical origins: ‘the cat that kills people’

The origin of the Mangina epidemic, according to local lore, took on mythical, magical proportions:

“This is the story of Ebola in Mangina, as told by the community. At the beginning of the month of May 2018, two twins, about thirty years old, fell sick after eating their aunt’s cat. The aunt was angry and bewitched them. They vomited blood and were brought to the hospital where they died two weeks later. Five others in the family died. The community was angry and chased away the witch aunt.” (community member)

“Witchcraft ... See, for example, this epidemic in Mangina, with the cat. The cat that kills people.” (community member)

“Mangina behaves like a small village, a family. So a rumour spreads from one corner to the next. And we were all convinced that it was the aunt who was very angry.” (nun and nurse)

“At the beginning, we thought this was an abnormal disease, witchcraft, based on this story of the twins.” (Community Health Worker, CHW)

One participant, a catholic nun and nurse, expressed a sense of spiritual terror felt early in the epidemic:

“We were alerted [of the situation] by our sisters at the health centre and we could sense the panic in their souls.” (nun and nurse)

One FGD participant drew a link between supernatural views of causation and seeking healing from traditional practitioners:

“witchcraft, the devil, poison, or washing oneself with hot water. People are convinced that the traditional healers can cure this, as well.” (community member)

As the epidemic evolved, many community members shifted from a supernatural to a biomedical understanding, perhaps related to public health messaging:

“At the beginning, I was convinced that the origin of this disease here at our place was witchcraft but with education, we learned that it comes from wild animals.” (CHW)

“The theory of witchcraft ... is increasingly set aside, but some people still believe in this.” (community member)

“witchcraft was there at the beginning, but now people have understood” (CHW)

“I agree ... 90% of the population now are convinced that it’s a normal disease. And that you have to protect yourself.” (NGO employee)

Still, some FGD responses suggested that superstitions were not altogether discarded:

“Also, let’s not forget witchcraft, evil spirits. Even if the health care personnel don’t believe in that, myself, I think this path should not be forgotten.” (IDP)

“some members of the community still think of witchcraft, of poisons.” (CHW)

Of note, one FGD participant, invoking supernatural causation, linked Ebola to the ongoing violent conflict in Eastern DRC:

“God has become angry. With all the killings in the zone, here. The humans have become savages. This can only make God unhappy.” (nun and nurse)

Zoonotic origins: ‘Ebola leaves the forest and hides in the hospital’

FGD participants were aware of the potential for Ebola virus transmission from the forest and its wild animals:

“The animals of the forest ... die of the disease in the forest and because the community visits these forests and handles these animals, that is the origin of the disease.” (NGO worker)

“the reservoir is the animals of the forest. Discouraging the community from eating these dead animals will distance us from these epidemics.” (doctor)

Demonstrating an understanding of the zoonotic origin of Ebola as well as the nosocomial transmission of the virus in hospitals, one FGD participant remarked that:

“Ebola leaves the forest and hides in the hospital.” (CHW)

Yet the reaction of an FGD participant from the Bambute community, whose livelihood depends on hunting, was emphatic:

“No, no, no. You people, each time there is something abnormal you say that it’s us. We have been eating these animals for a long time and no one has ever fallen sick. We have to look for the origin of this disease elsewhere. This is our life, we live off these animals. Saying that hunting brings Ebola, that’s false. The animals in the forest don’t eat filth. Where will they pick up Ebola?” (member of indigenous Bambute pygmy group)

Other FGD participants depended on the trade of bushmeat:

“Me, I sell bushmeat and that’s what allows my family to survive.” (IDP)

“poverty sometimes drives you to eat dead animals because you can’t find money to buy inspected meat.” (community member)

One participant summarized the ambivalent relationship with the forest as follows:

“These forests are both a treasure and a danger for us. Ebola is there.” (anesthetist)

Impact on the health-care system: ‘there are no more patients’

Health facilities were understood to be potential hot-spots for Ebola transmission and were sometimes avoided.

“Very few people come to the hospital. People are scared of the [health] centre.” (CHW)

“Better not to go to these hospitals. If I feel sick, I prefer to get medications at a pharmacy.” (IDP camp resident)

“A health centre can be emptied of its patients in a few minutes just because of a rumour.” (NGO worker)

“We had a case of a suspected Ebola death at the health centre. The information spread like smoke and within hours even the community around the health centre was gripped by an extreme panic ... Calls were coming in from everywhere.” (doctor)

Fear of Ebola changed the quality of care provided in health facilities:

“Fear reigns there [in the health centre]. The sick are no longer examined, out of fear of getting exposed. And if you get sick, the probability of dying is high.” (anesthetic nurse)

“For us, when you go to the hospital, the doctor should touch you. With Ebola, no. Yes, they have to protect themselves, too.” (CHW)

“A few days ago, a team on the ground received a patient with a bad smell. The people that were

accompanying her were wearing masks. In the courtyard of the hospital, everyone was asking why these people were bringing us a case of Ebola in our centre. No one had the courage to approach and still less to register the patient. But it was just a bullet wound that was giving off a nauseating smell, a gangrene. Panic is there." (anesthetic nurse)

Survey questionnaire

Having qualitatively described a broad range of community beliefs and health-seeking behavior, we next administered a survey questionnaire to 286 participants. Our aim was to 'triangulate' our FGD findings and quantify the prevalence of these views in an independent sample. Demographic characteristics of the survey cohort are shown in Table 2. Overall, participants were sampled across a wide geographic area, from diverse occupational and educational backgrounds.

Knowledge and attitudes with respect to Ebola control are shown in Table 3. Overall, 25% had a comprehensive knowledge of Ebola. Of note, Ebola-specific knowledge increased with educational attainment: 5.5%, 28%, and 31% of respondents with no, primary, and secondary education, respectively ($p = 0.0011$). We also derived an index of Ebola knowledge using latent factor analysis that correlated with comprehensive knowledge and educational attainment (Supplemental online material). Affective response ('worried' about Ebola) was common (91%). One or more resistant attitudes toward control efforts were expressed by 40%, including 16% who responded that they would not take an infected family member to the ETU. With respect to Ebola origins, an open-ended, unprompted question reflected significant uncertainty (38% responded 'I don't know'). Responses are given in Table 3. Eighteen (6%) survey respondents

Table 2. Demographic characteristics of survey participants.

Characteristic	n(%)
Age [yr], median (IQR)	28 (22–36)
Sex	
Male	166 (58)
Female	119 (42)
Site	
Mangina	136 (49)
Komanda	85 (31)
Béni	31 (11)
Butembo	16 (5.8)
Other	9 (3.2)
Educational attainment	
No formal education	55 (19)
Primary	100 (35)
Secondary or higher	130 (46)
Occupation	
Farmer/Herder	107 (37)
Merchant	32 (11)
Student	25 (8.7)
Government/Police/Military	18 (6.3)
Nurse/Doctor	17 (5.9)
Traditional medicine practitioner	11 (3.8)
Unemployed	45 (16)
Other	30 (11)
Internally Displaced Person	85 (31)

Table 3. Knowledge, attitudes, and practices with respect to Ebola.

Survey item	n (%)
Knowledge and beliefs	
Transmission modes	
Ebola can be prevented by avoiding contact with:bodily fluids of an infected person	230 (81)
Ebola can be prevented by avoiding contact with:the corpse of someone who died of Ebola	249 (87)
I wash my hands more often since the Ebola outbreak began	175 (61)
Misconceptions	
Ebola is transmitted in the ambient air	56 (20)
Ebola can be prevented by avoiding mosquito bites	71 (25)
Ebola can be prevented by bathing in hot and salty water	49 (17)
Ebola comprehensive knowledge^a	
What is the origin of Ebola? (open ended question)	
Wild animals from forest, monkeys, bats	152 (53)
Witchcraft, magic, cat	18 (6.3)
Hygiene	7 (2.4)
Mosquito	1 (<1)
Political fabrication	1 (<1)
I don't know	108 (38)
Can traditional healers cure Ebola?	
Yes	49 (17)
No	196 (69)
I don't know	41 (14)
Attitudes	
Affective response: worried about Ebola	
256 (91)	
Resistance to control efforts	
Would not bring infected family member to ETU	45 (16)
Would hide infected family member from authorities	56 (20)
Would not permit official team to bury infected deceased family member	30 (11)
One or more resistant attitudes	120 (40)
Practices	
Do you eat meat from wild animals?	
Yes	112 (39)
No	172 (61)

^aComprehensive knowledge was defined as correctly identifying three main modes of avoiding Ebola transmission (avoiding infected body fluids, avoiding infected corpses, washing hands) and correctly rejecting three misconceptions (transmitted in ambient air, by mosquitos, cured with warm salt baths) [24].

referred to supernatural causes of Ebola: 'witchcraft,' 'magic,' 'sorcerer cat,' 'cat' (see qualitative FGD results for further details on the widespread rumor of 'the cat that kills people'). These participants still endorsed biomedical explanations of Ebola transmission (15/18 (83%) and 14/18 (78%) recognized that body fluids and corpses could transmit Ebola, respectively) in proportions statistically similar to other survey respondents ($p > 0.05$ for both comparisons). On the other hand, participants who invoked supernatural origins of Ebola were more likely to believe that traditional healers could cure Ebola (7/18 (39%) versus 42/268 (16%), $p = 0.027$). Our survey also included 11 self-identified traditional healers (8 (73%) male, median (IQR) age 29 (23–37) years). Their demographics, biomedical knowledge of Ebola, beliefs about Ebola origins, and attitudes were not statistically different from other survey respondents. Of note, 6/11 (55%) of traditional healers compared to 43/275 (16%) other

survey respondents answered that traditional healers could cure Ebola ($p = 0.0032$).

Wild animals of the forest were recognized as sources of Ebola by 53% (Table 3). Bushmeat consumption was acknowledged by 39%, was similar between semi-urban (Butembo and Beni) and rural (Mangina) locations, and similar between IDPs and non-IDPs ($p > 0.05$ for both comparisons). Of note, knowledge of zoonotic transmission was similar in bush meat consumers and non-bush meat consumers (58% vs 48%, $p = 0.13$).

Discussion

Community beliefs around Ebola origins in Eastern DRC included supernatural ('the cat that kills people') and biomedical (zoonotic) explanations. These underlying beliefs appeared to influence health-seeking behavior; for example, individuals holding metaphysical beliefs around Ebola were more likely to trust in traditional healers, whose practices may spread the infection. As this illustrates, social resistance may have some roots in alternative paradigms of disease causation. A deeper understanding of these views may illuminate a path to improve community cooperation with biomedically informed control efforts.

Notable differences were seen between our study and past published surveys using identical questionnaire items. Knowledge of Ebola transmission was lower: 81% understood transmission from infected body fluids, compared to 87% in Sierra Leone [23] and 92% in Guinea [21]. Resistant attitudes were more prevalent: unwillingness to send a family member suspected of being infected with Ebola to an ETU (16% versus <9% in Guinea [21]) and intention to hide family member from health authorities (20% versus 4% in Guinea [21]). Beliefs about supernatural causation were more common: 6% and 53% of respondents cited supernatural origins and wild animals, respectively, as the origin of the Ebola outbreak, compared to 1% and 74% in Sierra Leone in 2014 [23].

Previous authors have examined proximal causes of social resistance, such as rumors, fear, mistrust, lack of confidence in the authorities, denial of the biomedical discourse, and the desire to be autonomous and avoid exogenous contamination [13,14]. Our findings are broadly consistent with these explanatory factors. Rumors and denial of the biomedical discourse are reflected in the mythical account of the epidemic's origins in Mangina. Mistrust and lack of confidence in public health authorities were suggested by attitudes measured in the survey questionnaire (e.g., 20% would hide an infected family member from the authorities, Table 3). Fear (e.g., 91% worried about Ebola, Table 3) and the desire to avoid contamination ('Ebola leaves the forest and hides in the hospital') also emerged as themes in FGDs and survey questionnaires.

Beliefs in supernatural causation could conceivably interact with Ebola control efforts in several ways. People who favor metaphysical explanations and reject biomedical models of disease may have lower knowledge of Ebola transmission routes, may have a fatalistic attitude and lower sense of self-efficacy, may not adopt personal prevention measures against microbial transmission, may prefer traditional healers to allopathic health systems and authorities, and/or may prioritize cultural or spiritual rites surrounding the dead and dying over biological control. Colorful accounts of the Ebola origin invoking witchcraft arose in FGDs and suggested that beliefs in supernatural causes were common, especially at the beginning of the epidemic. However, quantitative survey results found that few (6%) of respondents cited supernatural origins (e.g., witchcraft, cat) of Ebola in an unprompted question; instead, the majority of respondents cited biological causes (e.g., zoonotic origins). Even those who held supernatural views of Ebola causation were not statistically different from other survey respondents in terms of knowledge, attitudes, prevention practices, or intention to access the ETU or hospital for care of suspected Ebola cases. Our findings are consistent with 'medical syncretism' described in other infectious diseases [25,26]: pre-existing logics can coexist rather than compete with biomedical knowledge.

Medical syncretism has explanatory power in the current Ebola epidemic and can be compared and contrasted with a parallel example: malaria in Tanzania [25]. Investigators illustrated how biomedical knowledge of malaria interdigitated with traditional notions of witchcraft, resulting in syncretic disease models: (1) witches can cause a disease that 'looks like' malaria; or (2) witches could interfere with 'normal' malaria, making the parasites undetectable by hospital diagnostics [25]. Nonetheless, informants profoundly believed that malaria is curable by Western medicine, and consulted a traditional healer only after one or more visits to the hospital failed to treat the illness [25]. Thus, an interpretation of malaria as witchcraft became probable if the biomedical treatment did not produce the expected outcomes [25]. In contrast to malaria, for which biomedical treatment is rapidly curative, Ebola has no specific therapy and is frequently fatal despite supportive treatment in Western-style ETUs. In this context, shifting views ('at the beginning, we thought this was an abnormal disease, witchcraft' to '90% of the population now are convinced that it is a normal disease') may indicate that biomedical explanations were convincing, but did not entirely supplant mythical conceptions ('let us not forget witchcraft, evil spirits. Even if the health-care personnel do not believe in that, myself, I think this path should not be forgotten'). However, biomedicine for Ebola offers less pragmatic value than

for malaria; this may divert health-seeking behavior from Western-styled facilities (16% in our survey would not bring an infected family member to the ETU and 20% would hide a family member from the authorities) to practitioners of traditional medicine. When competing logics interact (syncretism), compliance with biomedical control efforts may be influenced as much by the pragmatic curative value of biomedicine as the 'science' behind the message. This may suggest strategies to engage with communities facing an Ebola epidemic: providing information and dispelling myths is not sufficient [27]; the equal emphasis should be placed on building trust and ongoing dialogue to address syncretic belief systems.

Traditional medicine, incorporating local traditions and beliefs, remains a dominant form of primary health care in many African settings, where modern health-care facilities are either sparsely located or non-existent [28,29]. In the current Ebola outbreak, the nosocomial transmission has been linked to visits to 'tradipraticiens' [4]. Previously described traditional practices conducive to Ebola transmission include the application of warm salt baths [30], or even making skin incisions and rubbing herbal medicine in [31]. Traditional healers may be called upon to attend to severely sick patients without proper protective equipment and may contract the disease themselves and/or transmit it to other patients [31]. Similar to a previous report, in which traditional and spiritual healers claimed to have the ability to cure Ebola [30], 55% of traditional healers that participated in our survey questionnaire believed they could cure Ebola. This view was held by 17% of survey respondents overall and was statistically associated with belief in supernatural causation of the disease. Engagement and education of traditional practitioners may be a useful approach to enhance current control efforts [31].

To date, 10 Ebola outbreaks have been described in the equatorial forests of the DRC, more than in any other country. A natural zoonotic reservoir of Ebolavirus is the fruit bat [32], and contact with infected animals including bats, duiker antelopes, and nonhuman primates played a role in previous Ebola outbreaks [33]. In our survey, 53% of respondents identified forest animals as the origin of Ebola. However, after initial spillover of Ebolavirus from an animal source, most Ebola epidemics are driven by human-to-human transmission [34,35]. The lush forest of Eastern DRC is inhabited by a local indigenous pygmy group, the Bambute, whose livelihood depends on hunting forest game. In addition, some community members including IDPs, trade in bushmeat. Overall, 39% of survey respondents in our study consumed bushmeat (Table 3). In our FGDs, we explored the views of communities living in close proximity to the equatorial jungle with respect to forest origins of Ebolavirus. As noted in a previous 'bushmeat ban' in West Africa, messaging which stressed the health risk posed by wild meat contradicted the experiences of

target publics such as the Bambute, who consume wild meat without incident [12]. This epistemic dissonance [12] may undercut confidence in public health messaging which places undue emphasis on transmission modes no longer relevant in a generalized epidemic.

Our study is subject to several limitations. Survey questionnaire items were adapted from prior studies, allowing direct comparison with past studies [20-23]; however, the instrument has not been formally validated in the DRC. Translation of survey questionnaires and FGD transcripts may have resulted in the loss of some nuanced meanings. Because of the need to conduct the survey in the throes of an epidemic, comprehension of survey questions in French or other languages was not evaluated. Social desirability bias may have influenced some participants' responses, which tended to align with public health messaging. Finally, for survey questionnaires, we used a nonprobability sample purposively drawn from the area of the outbreak, rather than a random, regionally representative sample.

In summary, an exploration of community beliefs about Ebola revealed a folktale of legendary proportions about the cat, the witch aunt, and the cursed twins. The direct influence of this narrative on community behaviors is not clear but suggests a prevalent worldview that may not be wholly supplanted by biomedical models of disease. In our surveys, belief in supernatural causation was associated with trust in traditional healers, a group that has been epidemiologically linked to nosocomial Ebola transmission. On the other hand, FGDs suggested that supernatural views of causation diminished with the progression of the epidemic and only 6% of survey participants endorsed supernatural origins of Ebola (compared to 53% who recognized its zoonotic origin), suggesting that traditional beliefs can co-exist with biomedical knowledge and prevention practices. Finally, our data give voice to local community perspectives, too frequently neglected in the discourse on social resistance to Ebola control efforts.

Acknowledgments

We thank all the patients and their families, the community health workers and research assistants that collected study data.

Authors' Contributions

KMC conceived the study, supervised and conducted the data collection in the field, and critically reviewed the manuscript. MTH designed the study, performed the data analysis, wrote and critically reviewed the manuscript.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This study was supported by Association for Health Innovation in Africa (AFHIA, Grant Number 2018-03 [KMC]). The funder had no role in study design, data collection, data analysis, data interpretation, writing of the report, or decision to submit the article for publication.

References

- [1] WHO. Ebola virus disease fact sheet. 2016. [cited 2018 Aug 13]. Available from: <http://www.who.int/media/centre/factsheets/fs103/en/>
- [2] WHO Ebola situation reports: Democratic Republic of the Congo. [cited 2018 Oct 27]. Available from: <http://www.who.int/ebola/situation-reports/drc-2018/en/>
- [3] New York Times. Ebola Epidemic in Congo Could Last Another Year, C.D.C. Director Warns. Available from: <https://www.nytimes.com/2019/03/16/health/ebola-congo-cdc.html>
- [4] Ebola: 13 nouveaux cas confirmés au Nord-Est de la RDC. Available from: <https://digitalcongo.net/article/5c0bbca9099ea600046aaccc/>
- [5] Claude KM, Unterschultz J, Hawkes MT. Ebola virus epidemic in war-torn eastern DR Congo. *Lancet*. 2018;392(10156):1399–1401. PubMed PMID: 30297137.
- [6] Kasereka MC, Sawatzky J, Hawkes MT. Ebola epidemic in war-torn Democratic Republic of Congo, 2018: acceptability and patient satisfaction of the recombinant Vesicular Stomatitis Virus - Zaire Ebolavirus Vaccine. *Vaccine*. 2019;37:2174–2178. PubMed PMID: 30878249.
- [7] Washington Post. Health workers in Congo's Ebola outbreak attacked weekly; [cited 2018 Nov 3]. Available from: https://www.washingtonpost.com/world/africa/health-workers-in-congos-ebola-outbreak-attacked-weekly/2018/10/22/19f7f648-d63a-11e8-8384-bcc5492fef49_story.html?noredirect=on&utm_term=.d84fbc771013
- [8] Schnirring L. CIDRAP News. Sep 24, 2018. Violence suspends response in DRC Ebola hot spot as cases rise; [cited 2018 Nov 3]. Available from: <http://www.cidrap.umn.edu/news-perspective/2018/09/violence-suspends-response-drc-ebola-hot-spot-cases-rise>
- [9] AP News. Battles over safe Ebola burials complicate work in Congo; [cited 2018 Nov 3]. Available from: <https://www.apnews.com/7156bd9e0550431ea7116f1c670e4208>
- [10] Mackenzie D. CNN News. Deadly violence in DRC hampers Ebola control; [cited 2018 Nov 3]. Available from: <https://www.cnn.com/2018/10/22/health/drc-violence-ebola-control-africa-intl/index.html>
- [11] Schnirring L. CIDRAP News. Sep 05, 2018. DRC Ebola outbreak expands to large city as Beni cases rise; [cited 2018 Nov 3]. Available from: <http://www.cidrap.umn.edu/news-perspective/2018/09/drc-ebola-outbreak-expands-large-city-beni-cases-rise>
- [12] Schnirring L. CIDRAP News. Oct 01, 2018. DRC reports 4 more Ebola cases over the weekend; [cited 2018 Nov 3]. Available from: <http://www.cidrap.umn.edu/news-perspective/2018/10/drc-reports-4-more-ebola-cases-over-weekend>
- [13] Wilkinson A, Fairhead J. Comparison of social resistance to Ebola response in Sierra Leone and Guinea suggests explanations lie in political configurations not culture. *Crit Public Health*. 2017;27(1):14–27. PubMed PMID: 28366999; PubMed Central PMCID: PMC5351787.
- [14] Wilkinson A, Parker M, Martineau F, et al. Engaging 'communities': anthropological insights from the West African Ebola epidemic. *Philos Trans R Soc Lond B Biol Sci*. 2017;372(1721):20160305. PubMed PMID: 28396476; PubMed Central PMCID: PMC5394643.
- [15] Reuters. WHO extremely concerned about Ebola 'perfect storm' in Congo. Available from: <https://www.reuters.com/article/us-health-ebola-congo/who-extremely-concerned-about-ebola-perfect-storm-in-congo-idUSKCN1M510T>
- [16] Coghlan B, Brennan RJ, Ngoy P, et al. Mortality in the Democratic Republic of Congo: a nationwide survey. *Lancet*. 2006 Jan 10;367(9504):44–51. S0140-6736(06)67923-3 [pii]. PubMed PMID: 16399152.
- [17] World Health Organization. Ebola virus disease – Democratic Republic of the Congo. Disease outbreak news; 2018 Aug 4 [cited 2018 Oct 27]. Available from: <https://www.who.int/csr/don/4-august-2018-ebola-drc/en/>
- [18] WHO. Ebola situation reports: democratic Republic of the Congo. [cited 2019 Jul 20]. Available from: <http://www.who.int/ebola/situation-reports/drc-2018/en/>
- [19] Kitzinger J. Qualitative research. Introducing focus groups. *BMJ*. 1995;311(7000):299.
- [20] Obenauer J, Rubsamen N, Garsevanidze E, et al. Changes in risk perceptions during the 2014 Ebola virus disease epidemic: results of two consecutive surveys among the general population in Lower Saxony, Germany. *BMC Public Health*. 2018;18(1):628. PubMed PMID: 29764410; PubMed Central PMCID: PMC5952518.
- [21] Jalloh MF, Robinson SJ, Corker J, et al. Knowledge, attitudes, and practices related to Ebola virus disease at the end of a national epidemic - Guinea, August 2015. *MMWR Morb Mortal Wkly Rep*. 2017;66(41):1109–1115. PubMed PMID: 29049279; PubMed Central PMCID: PMC5689093.
- [22] Irwin KL, Jalloh MF, Corker J, et al. Attitudes about vaccines to prevent Ebola virus disease in Guinea at the end of a large Ebola epidemic: results of a national household survey. *Vaccine*. 2017;35(49 Pt B):6915–6923. PubMed PMID: 28716555.
- [23] Jalloh MF, Senghe P, Monasch R, et al. National survey of Ebola-related knowledge, attitudes and practices before the outbreak peak in Sierra Leone: august 2014. *BMJ Glob Health*. 2017;2(4):e000285. PubMed PMID: 29259820; PubMed Central PMCID: PMC5728302.
- [24] Buli BG, Mayigane LN, Oketta JF, et al. Misconceptions about Ebola seriously affect the prevention efforts: KAP related to Ebola prevention and treatment in Kouroussa Prefecture, Guinea. *Pan Afr Med J*. 2015;22(Suppl 1):11. PubMed PMID: 26740839; PubMed Central PMCID: PMC4695529.
- [25] Muela SH, Ribera JM, Mushi AK, et al. Medical syncretism with reference to malaria in a Tanzanian community. *Soc Sci Med*. 2002;55(3):403–413. PubMed PMID: 12144148.
- [26] Parveen S, Islam MS, Begum M, et al. It's not only what you say, it's also how you say it: communicating nipah virus prevention messages during an outbreak in Bangladesh. *BMC Public Health*. 2016;16:726. PubMed PMID: 27495927; PubMed Central PMCID: PMC4974711.

- [27] Chandler C, Fairhead J, Kelly A, et al. Ebola: limitations of correcting misinformation. *Lancet*. 2015;385(9975):1275–1277. PubMed PMID: 25534188.
- [28] Kambizi L, Afolayan AJ. An ethnobotanical study of plants used for the treatment of sexually transmitted diseases (njovhera) in Guruve District, Zimbabwe. *J Ethnopharmacol*. 2001;77(1):5–9. PubMed PMID: 11483371.
- [29] Ndubani P, Hojer B. Traditional healers and the treatment of sexually transmitted illnesses in rural Zambia. *J Ethnopharmacol*. 1999;67(1):15–25. PubMed PMID: 10616956.
- [30] Odidika UJU, Nkechi BEE, Maryjoanne CU, et al. Ebola viral disease in Nigeria: thepanic and cultural threat. *Afr J Med Health Sci*. 2014;13(1):1–5.
- [31] Manguvo A, Mafuvadze B. The impact of traditional and religious practices on the spread of Ebola in West Africa: time for a strategic shift. *Pan Afr Med J*. 2015;22(Suppl 1):9. PubMed PMID: 26779300; PubMed Central PMCID: PMC4709130.
- [32] Mari Saez A, Weiss S, Nowak K, et al. Investigating the zoonotic origin of the West African Ebola epidemic. *EMBO Mol Med*. 2015;7(1):17–23. PubMed PMID: 25550396; PubMed Central PMCID: PMC4309665.
- [33] Olivero J, Fa JE, Real R, et al. Recent loss of closed forests is associated with Ebola virus disease outbreaks. *Sci Rep*. 2017;7(1):14291. PubMed PMID: 29085050; PubMed Central PMCID: PMC5662765.
- [34] Baize S, Pannetier D, Oestereich L, et al. Emergence of Zaire Ebola virus disease in Guinea. *N Engl J Med*. 2014;371(15):1418–1425. PubMed PMID: 24738640.
- [35] Gire SK, Goba A, Andersen KG, et al. Genomic surveillance elucidates Ebola virus origin and transmission during the 2014 outbreak. *Science*. 2014;345(6202):1369–1372. PubMed PMID: 25214632; PubMed Central PMCID: PMC4431643.