Am. J. Trop. Med. Hyg., 95(3), 2016, pp. 654–662
doi:10.4269/ajtmh.16-0206

Health-Care Workers' Perspectives on Ebola Virus Vaccine: A Focus Group and In-Depth Interview Interventional Study

Dorothy O. Esangbedo,[1] Maduka D. Ughasoro,[2]* Beckie N. Tagbo,[3,4] Adebiyi Olowu,[5] Chukwuemeka Anikene,[4] and Chimaobi C. Iwegbulam[6]

[1]*Pediatric Division, Providence Hospital, Lagos, Nigeria;* [2]*Department of Pediatrics, University of Nigeria Enugu Campus, Enugu, Nigeria;* [3]*Institute of Child Health, University of Nigeria Teaching Hospital, Enugu, Nigeria;* [4]*Department of Pediatrics, University of Nigeria Teaching Hospital, Enugu, Nigeria;* [5]*Department of Pediatrics, Olabisi Onabanjo University Teaching Hospital, Oshogbo, Nigeria;* [6]*Department of Pediatrics, Federal Medical Centre, Umuahia, Nigeria*

Abstract. Health-care workers (HCWs) will require Ebola virus vaccine (EVV) when it is introduced because of the high risk of exposure to the disease. Evaluations of factors that facilitate or limit vaccine uptake are critical for a successful vaccine program. Nigerian HCWs were interviewed to evaluate their knowledge, levels of acceptance, determinants of acceptance, and willingness to pay for EVV. The significance level was set at $P \leq 0.05$. None of the 193 participating HCWs had correct knowledge of EVV; 34.7% (67/193) of workers thought that EVV was an extract of the serum of Ebola virus patients. About 77.3% (51/66) of workers in a region that reported Ebola cases (Lagos) were willing to be vaccinated, compared with 4.7% (3/61) in Enugu and 13.6% (9/66) in Abia ($P = 0.0001$). After health education, the proportion of HCWs willing to receive EVV increased ($P = 0.006$) except for doctors ($P < 0.1$). The percentage of HCWs willing to pay for EVV was 86.4%, 72.1%, and 59% in Lagos, Enugu, and Abia, respectively. The workers had fears about EVV based on nonfactual assumptions. Therefore, the EVV introduction strategy should include a strong awareness campaign with adequate explanation about the content of EVV.

INTRODUCTION

At the beginning of November 2015, when the World Health Organization (WHO; Geneva, Switzerland) declared an end to the 2014 outbreak of Ebola virus disease (EVD) in west African countries, 11,316 deaths had occurred including more than 500 health-care workers (HCWs).[1] Thus, HCWs are a high-risk group for exposure to EVD. To date, the only effective control strategy is the use of strict sanitary control measures, but this strategy has often been difficult to implement in low-income countries. Therefore, the WHO has escalated efforts to encourage pharmaceutical companies to develop effective drugs and vaccines against EVD. The recent Ebola epidemic was possibly the last outbreak in which the only available tools to control the spread were sanitation, isolation, and quarantine.[2]

The WHO recently announced that the results of an interim analysis of phase III efficacy trials of Ebola virus vaccine (EVV) showed that it was highly effective against Ebola virus.[3] The EVV when approved for public use, will be administered to HCWs among others.

The acceptability of EVV among HCWs cannot be predicted, as reflected by the reports of previous studies on the acceptance of new vaccines among HCWs that showed a wide range of acceptance ranging from 10.3% to 90.0%,[4–7] and the challenges of an EVV trial in Ghana.[8] If any form of misconception about EVV among HCWs is not identified and promptly addressed, there may be a negative influence on the populace because the public look to HCWs for information and approval of any new health innovation.[9]

Unlike most other vaccines, the candidates of EVV have three peculiarities. First, it is a viral vector–based recombinant vaccine[10,11]; the first of its kind and different from previous vaccines, which are either killed virus[12] or live attenuated virus.[13] Second, the administration is not age based, which means that an entire population should receive the vaccine, irrespective of age. This latter attribute underscores the need for broad acceptance across all society. Third, HCWs are the recipients and the vaccinators of EVV; therefore, their acceptance of the vaccine will have a significant impact on an EVV program.

The extent of HCWs' knowledge of EVV was unknown, and among other factors, the knowledge of a vaccine is important in the model for the assessment of vaccine hesitancy developed by the Strategic Advisory Group of Experts Working Group (SAGE WG) for the WHO.[14,15] Previous studies have focused on parental perceptions of vaccines.[9,16,17] To the best of our knowledge, there were no published studies regarding the acceptability of EVV among HCWs when this study was conducted. This study aimed to determine HCWs' perceptions of EVV, their willingness to be vaccinated, and other determinants that could either mitigate or facilitate an optimal strategic introduction of the vaccine. The findings of this study could be useful in the development of a strategic plan for the successful implementation of EVV introduction program.

MATERIALS AND METHODS

Ethical considerations. The Health Research Ethics Committee of the University of Nigeria Teaching Hospital, Enugu (Nigeria), gave its approval before the study was commenced. The Lagos State Health Services Commission (Lagos, Nigeria) also gave approval before the study was conducted in Lagos. An information sheet explaining the aims of the study was distributed to the participants before the study. Individuals who agreed to participate gave written consent before the interviews commenced.

Study area. The study was conducted in three states, Abia and Enugu states in southeast Nigeria, and Lagos State in southwest Nigeria. By October 2014, when the WHO certified Nigeria to be Ebola virus free, 19 of the 20 EVD cases that had been reported, and seven of eight EVD-related deaths had occurred in Lagos. There were no EVD cases or EVD-related

*Address correspondence to Maduka D. Ughasoro, Department of Pediatrics, University of Nigeria Enugu Campus, P.O. Box 1093, Enugu, Nigeria. E-mail: maduka.ughasoro@unn.edu.ng

deaths reported in the states of Abia and Enugu. A purposive sampling method was used to select Lagos State in the southwest geopolitical region of Nigeria because this state had reported the highest number of EVD cases and deaths. One EVD case and death was also reported in Rivers State in south-south Nigeria. The states of Abia and Enugu were randomly selected from a pool of five states: Abia, Anambra, Enugu, Ebonyi, and Imo in the southeast geopolitical region of Nigeria. The southeast geopolitical region is the only geopolitical region between the southwest and south-south regions (the two geopolitical regions that had reported EVD cases and deaths). There are direct transport links by air and by road between Lagos and Enugu states, but only one direct road transport link between Lagos and Abia states. The study was conducted in the major cities of the three states: Umuahia in Abia State, Enugu city in Enugu State, and the Isale-Eko District of Lagos State. Each of these sites has three levels of health-care delivery: primary, secondary, and tertiary.

According to a national census in 2009, Abia, Enugu, and Lagos states had populations of 2,833,999, 3,257,298, and 15,000,000 individuals, respectively.[18] Lagos State has a good mixture of people from the various ethnicities and religions in Nigeria, whereas Abia and Enugu states have people who are predominantly the Ibo tribe and primarily Christians.

Study design. This study was a descriptive qualitative cross-sectional study. HCWs were randomly selected from a tertiary institution in Enugu State, a secondary institution in Lagos State, and secondary and tertiary institutions in Abia State. HCWs eligible to participate in the study were those who, by the nature of their work, come into close contact with patients, or specimens or materials used in their treatment, as well as pharmacists, who do not have any direct contact with patients (except through patient folders and at times during their ward reviews).

Recruitment of participants for the focus group discussion. The participants included doctors, nurses, pharmacists, laboratory scientists, laundry workers, physiotherapists, medical record officers, drivers, security staff, and hospital assistants (e.g., cleaners). All eligible HCWs identified and selected through random sampling for the focus group discussion (FGD) were informed of the area of the study. Information sheets were provided for them to study for a few minutes before the commencement of the interviews. Five FGDs were conducted in each state. The FGDs targeted HCWs who were not the head of their individual departments. The FGDs involved many HCWs per session to allow for an opportunity to get opinions from many participants.

Identification of participants for the in-depth interviews. A list of all departments in three selected hospitals in each state was used to form a frame of random numbers; seven heads of department were randomly selected in Lagos State and five heads of department each were randomly selected in Enugu and Abia states, respectively. In-depth interviews (IDIs) were conducted for the heads of departments. Because there were few heads for different departments, it was impractical to organize them for a FGD. Their individual opinions were instead obtained through the IDIs. However, the same interviewer's guide was used for both IDIs and FGDs.

Data collection in the study. A sociologist reviewed the guides used for FGD and IDI. The guides were designed to obtain information on HCWs' knowledge of EVV, their willingness to accept EVV pre- and posthealth education about EVV, and their suggestions on how acceptance of EVV could be improved. A descriptive summary of the EVV was provided in an interactive manner to the respondents after they had given their responses about their knowledge of EVV and their willingness to accept the vaccine.

> The information given was as follows: *The EVV will be a viral-vector-based recombinant vaccine in which genes encoding protein of Ebola virus will be embedded within the gene sequence of another virus (not Ebola virus): recombinant replication-deficient adenovirus (cAd) or attenuated vesicular stomatitis viruses (VSVs), which are known to cause no serious side effects or disease in humans.*[10]
>
> *The Ebola virus genes encode proteins component which the immune system can recognize but which do not cause disease.*

The participants were allowed to ask questions and any ambiguity was explained to them. Efforts were made to ensure that they all understood the description of EVV. After education about the EVV, the participants' willingness to accept vaccination with EVV was reevaluated.

FGDs and IDIs. In total, 15 FGDs were conducted, five in each state. The study was conducted from February 2015 to July 2015. Each group comprised nine to15 participants. Sex balance was ensured in the recruitment of participants for the FGDs. Each FGD lasted between 55 and 70 minutes. Light refreshment was given to the respondents after the discussions.

The IDIs were to elicit the opinion of the stakeholders on issues concerning EVV. A total of 17 IDIs were conducted.

With the consent of the interviewees and FGD participants, the interviews and FGDs were recorded. The audio recordings of interviews and discussion were transcribed verbatim into Microsoft Word documents (Microsoft, Redmond, WA) for analysis. To ensure transcription quality, all transcriptions were independently checked against the original audio recordings.

Data analysis. The study used deductive and inductive approaches for qualitative data analysis to ensure that the analysis fully captured the themes in the conceptual framework, and any themes outside the conceptual framework that emerged as important during the qualitative data collection and analysis. Other issues that were not anticipated during the research design were explored in depth as they arose during the qualitative data analysis. Thematic analysis was used to identify additional key issues that emerged from the data. These were used to develop the parent nodes and child nodes. The codes were entered into Nvivo software (QSR International, Melbourne, Australia) for the analysis. On the basis of the model developed by the SAGE WG for assessing the determinants of vaccine hesitancy,[14] this study used three arms: 1) contextual influences, 2) individual/social group influences, and 3) vaccine and vaccination-specific issues. Of these arms, the contextual influences and individual/social group influences evaluate more of an individual's previous experiences with a particular vaccine or vaccination program. The only arm that has domains that can be assessed for a vaccine yet to be introduced is the vaccine and vaccination-specific issues arm. This vaccine and vaccination-specific issues arm can be assessed under nine

subdomains: 1) risk/benefit (i.e., scientific basis), 2) vaccination schedule, 3) mode of administration, 4) mode of delivery, 5) introduction of a new vaccine or new formulation, 6) reliability of vaccine supply, 7) role of health-care professionals, 8) costs, and 9) tailoring vaccines/vaccination to needs. These subdomains can be grouped under three broad domains: confidence, complacency, and convenience.[14] Some of the responses were organized under thematic areas that were related to some of the subdomains of the vaccine and vaccination-specific arm. All costs were estimated in Nigerian naira and converted to U.S. dollars (USDs) at the 2015 exchange rate. The discrepancies in the cost structure and purchasing power of the Nigerian naira and USD were adjusted using purchasing power parity.

RESULTS

Population characteristics. A total of 193 HCWs participated in the 15 FGDs and 17 IDIs; 32.6% (63/193) were male and 67.4% (130/193) were female. Their mean age was 37.7 years with a range of 24–65 years (Table 1).

HCWs' knowledge about EVV. The response of the participants to the question, "what do you think is contained in EVV?" revealed that their knowledge about EVV was deficient and inaccurate. None (0/193, 0.0%) of the participants knew the correct content of the EVV. Most (126/193, 65.3%) participants had no clue about the content of the vaccine, whereas the remaining (67/193, 34.7%) participants responded, *EVV is obtained from the serum of persons infected by Ebola virus*. No one mentioned that EVV was a viral vector–based vaccine. There were diverse incorrect descriptions of the vaccine. Prominent among the responses were the following:

I have a faint idea. I think it is something from people that survived the virus. (A doctor in Abia State)

The vaccine is probably an antibody taken from a patient that recovered from the virus, to offer some kinds of immunity against infection. (A doctor in Enugu State)

I heard the news that they are trying to develop a vaccine from the serum of victims of Ebola virus disease. (A head nurse in Enugu)

The vaccine was only tried on mice, not on humans or monkeys. I wonder whether it will be compatible with humans since it wasn't tried on humans and it is an extract from Ebola patients injected into you to stimulate the antibodies. So it could be very risky because it could turn out to be deadly. (A physiotherapist in Enugu)

It is an inactive vaccine because it was antibodies generated from probably somebody that was infected and got healed of the infection, which was used to make the vaccine. (A doctor in Lagos)

Acceptance of vaccination with EVV. Acceptance before health education on EVV. There were regional variations in the proportion of the participants who were willing to accept the vaccine. Most (51/66, 77.3%) participants from Lagos (the region that reported EVD cases during the outbreak) were willing to accept the vaccine, compared with 3/61 (4.7%) of participants from Enugu State and 9/66 (13.6%) from Abia State (two regions that did not report any EVD cases). The observed difference was statistically significant ($P = 0.0001$; Table 2). Some of the responses to the question, "If there is a vaccine approved for Ebola virus prevention, will you be willing to accept vaccination?" were the following:

I don't think people are ready to receive that vaccine now. (A head of department in Enugu)

I don't know who will want to be a guinea pig. (A nurse in Lagos)

In my opinion, irrespective of who brings the vaccine, I need to observe somebody who has taken the vaccine for some months, or even years. If they do not develop any negative reaction; and after they are exposed

TABLE 1
Sociodemographic characteristics of the respondents

Variables	Isale-Eko (Lagos) $N = 66$ (%)	Enugu (Enugu) $N = 61$ (%)	Umuahia (Abia) $N = 66$ (%)
Locality			
Total participants ($N = 193$)	66 (34.2)	61 (31.6)	66 (34.2)
Age			
Mean (SD)	36.3 (5.44)	31.1 (4.65)	38.8 (7.83)
Range	26–65	24–45	28–56
Gender			
Male	21 (31.8)	27 (44.8)	15 (22.7)
Female	45 (68.2)	34 (55.2)	51 (77.3)
Designation			
Doctors	22 (33.3)	19 (31.2)	31 (47.0)
Nurses	18 (27.3)	20 (32.8)	13 (19.7)
Physiotherapists	6 (9.1)	18 (29.5)	12 (18.2)
Laboratory scientists	3 (4.5)	2 (3.3)	3 (4.5)
Pharmacists	3 (4.5)	1 (1.6)	0
Others	14 (21.2)	1 (1.6)	7 (10.6)
Years of practice			
Mean (SD), years	11.85 (9.45)	5.25 (5.12)	12.17 (8.55)
Range	2.5 months–35 years	1 month–24 years	2 months–34 years

SD = standard deviation.

TABLE 2
Impact of health education on the HCWs' acceptance of EVV and their WTP

Variables	Isale-Eko (Lagos) $N = 66$ (%)	Enugu (Enugu) $N = 61$ (%)	Umuahia (Abia) $N = 66$ (%)	χ^2	P value
Knowledge of content of EVV					
Correct	0 (0.0)	0 (0.0)	0 (0.0)		
Wrong	66 (100)	61 (100)	66 (100)	NA	NA
Acceptance of EVV (prehealth education)					
Yes	51 (77.3)	3 (4.7)	9 (13.6)	64.96	0.0001*
No	15 (22.7)	58 (95.3)	57 (86.4)		
Impact of health education on acceptability of EVV					
Acceptance rate (prehealth education)	51 (77.3)			1.27	0.259
Acceptance rate (posthealth education)	57 (86.4)				
Acceptance rate (prehealth education)		3 (4.7)		29.73	0.0001*
Acceptance rate (posthealth education)		31 (50.9)			
Acceptance rate (prehealth education)			9 (13.6)	16.05	0.0001
Acceptance rate (posthealth education)			30 (45.5)		
Preferred time to receive the vaccine (prehealth education)					
Once available	41 (59.1)	1 (1.6)	7 (10.6)	49.7	0.0001*
Later after adequate information and observation	25 (40.9)	60 (98.4)	59 (89.4)		
Impact of health education on the preferred time to receive the vaccine					
Once available (prehealth education)	41 (59.1)			0.126	0.722
Once available (posthealth education)	38 (57.6)				
Once available (prehealth education)		1 (1.6)		7.49	0.006*
Once available (posthealth education)		11 (18.0)			
Once available (prehealth education)			7 (10.6)	7.66	0.006
Once available (posthealth education)			21 (31.8)		
WTP to receive EVV					
Yes	57 (86.4)	44 (72.1)	39 (59.1)	3.12	0.08
No	9 (13.6)	17 (27.9)	27 (40.9)		
Average amount willing to pay in USD (overall)	4.91				
Mean (individual locality)	4.29	6.63	3.8		
Standard deviation from mean	7.91	18.12	15.27		
Range	0.25–30	5–75	0.5–100		

EVV = Ebola virus vaccine; HCW = health-care workers; USD = U.S. dollar; WTP = willingness to pay.
*Yates correction.

to Ebola virus, they are not infected, I may then consider the vaccine. (A physiotherapist in Enugu)

Because Ebola virus disease had killed a lot of people, we need to be sure that those who received the vaccine did not develop serious side effects which will be traced back to the vaccine the person took. (A doctor in Abia)

HCWs who said they would accept being vaccinated with EVV when it is introduced were of the following opinion:

I will accept it, once it has gone through trial and is approved. (A pharmacist in Lagos)

If the vaccine is a drastically attenuated strain of the virus, with no possibility of causing symptoms of Ebola virus disease, I really don't think that there is anything wrong with the vaccine. I will take it once it is found to be efficacious and effective. (A doctor in Abia)

Based on the success rate on control of other diseases with vaccine, I have confidence to try out the vaccine, because it is either effective or not effective. If it is effective, I will be denying myself the chance to have benefited from the immunization, but if it is not effective, I will not be losing out much. (A pharmacist in Lagos)

I lived in fear for months—fears for myself and for my family. So if there is something that can help, I'm not scared to receive it, because we were the ones that were at risk. So I don't think there will be a lot of refusal. (A laboratory scientist in Lagos)

I believe that before it is made available to the public, it would have been properly tested. It would have been proven to be safe, so I will take it. (A head nurse in Enugu)

Once I am convinced on the effect and efficacy of the vaccine, I will be able to convince the next person that this is beneficial. (A nurse in Abia)

Once approved, I may get vaccinated, with the second or third group. (A doctor in Lagos)

Acceptance after health education on EVV. The would-be content of EVV and the lack of possibility of contracting Ebola virus from the vaccine were explained to the participants, after which their acceptance of the vaccine was reevaluated. There was an overall increase in the proportion of participants who said they would accept the vaccine (Table 2). In Lagos, 57/66 (86.4%) of participants were willing to accept the vaccine; the difference when compared with preeducation was not statistically significant ($P = 0.259$). In the states of Enugu and Abia, 31/61 (50.9%) and 30/66 (45.5%) participants, respectively, were willing to be vaccinated and the difference with the preeducation acceptance rate was statistically significant ($P = 0.0001$; Table 2). The

proportion of participants that would be willing to receive the vaccine as soon as it was available was compared between pre- and posthealth education. Before health education, 41/66 (59.1%), 1/61 (1.6%), and 7/66 (10.6%) participants in Lagos, Enugu, and Abia states, respectively, were willing to be vaccinated early and the difference between the states (i.e., Lagos versus Enugu and Abia) was statistically significant ($P = 0.0001$). After health education, 38/66 (57.6%), 11/61 (18.0%), and 21/66 (31.8%) participants for Lagos, Enugu, and Abia states, respectively, were willing to be vaccinated early, and the difference between the pre- and postwillingness to be vaccinated early in Enugu and Abia states, respectively, compared with Lagos State, was statistically significant (Lagos versus Enugu, $P = 0.006$; Lagos versus Abia, $P = 0.006$; Table 2).

The reasons for the delay in acceptance were captured in some responses:

I want to observe the people that I know have received it; not just illiterate people, but verifiable people. (A doctor in Lagos)

I think we have little and limited information about the vaccine. We don't know the side effects. There is no adequate follow-up to know the level of protection one can get, the efficacy is not established, and the long term side effects are not known. So the information we have is not enough to build trust for the vaccine. (A doctor in Abia)

Because it contains protein component of the Ebola virus does not make it 100% safe, there is still possibility that the virus can mutate. (A laboratory scientist in Abia)

If there is an outbreak, I think there will be a rush for that vaccine. (A physiotherapist in Enugu)

We are still talking the way we do because there is no Ebola virus epidemic presently. Our mindset will change by the time we have one. (A doctor in Abia)

Education is important. Some of us initially thought that the vaccine is from pooled plasma of infected patients, I am sure that the impression has changed. Notwithstanding there is still some doubts on the side effects. So, I may still not readily go for it, but if there is an outbreak, the risk of getting the infection outweighs the side effects. (A doctor in Abia)

The knowledge that it cannot cause Ebola disease makes it easier to accept the vaccine. (A nurse in Enugu)

We need a proof of success. Maybe somewhere people have taken the vaccine and they were fine afterwards. (A doctor in Lagos)

Making available the people that have actually tried the vaccine will help the acceptance. (A nurse in Lagos)

HCWs' perceptions about WTP for the vaccine. Most HCWs, 57/66 (86.4%), 44/61 (72.1%), and 39/66 (59.1%) in Lagos, Enugu, and Abia states, respectively, ($P = 0.08$), would agree to pay for the vaccine if it was not publicly funded (Table 2), although there were differences in the amount suggested as appropriate. In spite of the impressive WTP for the vaccine, some HCWs still reemphasized that the government should subsidize the cost. However, some (13/193, 6.7%) HCWs had the opinion that if recipients were required to pay for the vaccine, it would convince those recipients of the benefit of the vaccine. Some of their responses included the following:

If the initial recipients of the vaccine were made to pay for the vaccine it will convince people to vaccinate. This will help to expand the pool of people that have received the vaccine and thus the number of recipients others will observe. (A doctor in Enugu)

If you make it (EVV) free, people will somehow think that you are trying to use them for a test. If you make Ebola vaccine expensive, like five thousand naira (USD25), people will actually ask you less questions. (A doctor in Enugu)

I am talking about the public, if it is free of charge, refusal will be high. The federal government can subsidize it but let it be later. (A doctor in Lagos)

I will pay to receive it if it is something I can afford. But I also advocate that policy should be formulated to make it available for people who cannot afford it. (A nurse in Abia)

Life is involved. I can pay triple, we are not supposed to have second thought on payment. We have to pay. (A health attendant in Lagos)

A minority of participants, 9/66 (13.6%), 17/61 (27.6%), and 27/66 (40.9%) in Lagos, Enugu, and Abia states, respectively, ($P = 0.08$), opposed the idea of paying for the vaccine. They felt that the economic benefit would fuel adulteration and counterfeiting of the vaccine. Others were of the opinion that because most vaccines in the National Program on Immunization (Lagos, Nigeria) are given free of charge, the EVV should likewise be administered free of charge.

We got the vaccine and drugs free for TB. I might afford the cost, but for the general populace, I think the vaccine that is coming out for the first time, it is better for it to be free. If not, the acceptability could be a problem. (A pharmacist in Lagos)

Some do not even have this money, so government is supposed to protect us. (A health attendant in Lagos)

I don't think it is easy to pay for what you don't trust. (A doctor in Abia)

When introducing something new, in order to attract people, you have to remove the cost entirely because of the financial and economic condition of the people of the country. (A laboratory scientist in Abia)

They need to make it free so that it will reach every citizen of this country. (A health attendant in Lagos)

The impact of health education on different cadres of HCWs. The acceptability by all cadres but doctors ($P = 0.1$ and 0.2 in Enugu and Abia states, respectively) improved significantly after the health education (Table 3).

Determinants of acceptability. Table 4 shows the concerns expressed by the participants with regard to the different aspects of EVV. The lack of adequate knowledge of the vaccine was the greatest concern (83/193, 43.0%), followed by the risk of being infected with Ebola virus (79/193, 40.9%) and concern of the virus being extracted from the serum of patients who had survived from EVD (67/193, 34.7%). Some (62/193, 32.1%) participants wanted a price that is affordable for the public.

DISCUSSION

This study showed that most participants had heard about EVV, but none knew its correct content. This finding gave insight into the knowledge gap that exists. In-depth knowledge of the vaccine content by the HCWs was not expected because the vaccine was still under trial when the study was conducted. However, the decision to test their knowledge on EVV based on the common feature shared by all the candidates of EVV, which was that the EVVs are viral vector–based recombinant vaccines, in which genes encoding protein of Ebola virus will be inserted into the genome of another virus (not Ebola virus) like recombinant replication-deficient adenovirus (GlaxoSmithKline cAd3-EBOZ, Middlesex, United Kingdom), attenuated vesicular stomatitis viruses (NewLink Genetics and Merck's rVSV-ZEBOV, Kenilworth, NJ), or Johnson & Johnson (New Brunswick, NJ) Ad26-EBOV prime with Bavarian Nordic (Redwood City, CA) MVA-BN boost doses and other vaccine formulations, rather than include other attributes of vaccines such as adverse effect, safety, and affordability, may have contributed to the poor knowledge that was elicited in the study. However, it is a concern that nobody had bothered to learn the details, even though there was significant awareness that EVV was under trial. The health education session on vaccines delivered during routine immunization clinics to caregivers often does not include detailed scientific description of vaccines, but HCWs are expected to know more than the general public. There was anxiety due to the misconception that the content of EVV was an extract from the serum of patients who had survived EVD, leading to the fear that recipients of EVV can contract EVD through the vaccine. There were also concerns about other issues of vaccine safety and adequacy of the length of time of vaccine trials. Some were of the opinion that the period of clinical trial was inadequate for thorough observation of all the possible effects of the vaccine. Thus, some HCWs desired to observe those who had received the vaccine to ensure that there will not be subsequent manifestation of any untoward effects. Their concern about the duration of clinical trial may be valid, because during the period the study was conducted, all the EVVs were still on clinical trial and none was completed. However, it will be pertinent to improve the poor knowledge and doubts through direct delivered messages, seminars, workshops, and radio and television slogans[9,19–21] before the vaccine is introduced. Professional seminars and workshops could be used to target HCWs and improve their knowledge of the vaccine with emphasis on providing information on vaccine efficacy,

TABLE 3
Impact of health education on the acceptability of EVV among different cadres of HCWs

Cadres of HCWs	Isale-Eko (Lagos) $N = 66$ (%)	Enugu (Enugu) $N = 61$ (%)	Umuahia (Abia) $N = 66$ (%)	χ^2	P value
Doctors ($N = 72$)	$N = 24$				
Acceptance of EVV (prehealth education)	10 (41.6)			3.96	0.05*
Acceptance of EVV (posthealth education)	18 (75.0)				
		$N = 22$			
Acceptance of EVV (prehealth education)		1 (4.5)		2.70	0.10*
Acceptance of EVV (posthealth education)		6 (27.3)			
			$N = 26$		
Acceptance of EVV (prehealth education)			4 (15.4)	1.64	0.20*
Acceptance of with EVV (posthealth education)			9 (34.6)		
Nurses ($N = 51$)	$N = 17$				
Acceptance of EVV (prehealth education)	13 (76.5)			0.21	0.65*
Acceptance of EVV (posthealth education)	13 (76.5)				
		$N = 18$			
Acceptance of EVV (prehealth education)		1 (5.5)		8.5	0.004*
Acceptance of EVV (posthealth education)		12 (66·7)			
			$N = 16$		
Acceptance of EVV (prehealth education)			1 (6.3)	21.13	0.0001*
Acceptance of EVV (posthealth education)			15 (93.8)		
Other professional allied ($N = 70$)	$N = 25$				
Acceptance of EVV (prehealth education)	23 (92.0)			0.000	1.000*
Acceptance of EVV (posthealth education)	24 (96.0)				
		$N = 21$			
Acceptance of EVV (prehealth education)		1 (4.8)		19.4	0.0001*
Acceptance of EVV (posthealth education)		16 (76.2)			
			$N = 24$		
Acceptance of EVV (prehealth education)			2 (8.3)	7.88	0.005*
Acceptance of EVV (posthealth education)			11 (45.84)		

EVV = Ebola virus vaccine; HCW = health-care workers.
*Yates correction was used because all the variables have figures less than five.

TABLE 4
The determinant of EVV hesitancy based on vaccine and vaccination-specific arm of SAGE WG model of vaccine hesitancy

Domain	Subdomains/components	*N* = 193 (%)
Confidence		
Efficacy	Will it be able to prevent Ebola virus infection?	3 (1.6)
Safety	Contains impurity?	1 (0.5)
	Live virus?	2 (1.0)
	Human serum?	67 (34.7)
	Adverse events?	0
Risk of being infected	Can one contract Ebola disease from the vaccine?	79 (40.9)
Competence of health-care provider	N/C	–
Motivating factor for introducing the vaccine	N/C	–
Complacency		
Side effects	Can it cause infertility/sterility?	2 (1.0)
Knowledge of vaccine	New vaccine?	26 (13.5)
	Lack adequate information on the vaccine?	83 (43.0)
	Clinical trial period was short?	45 (23.3)
	Need to observe others first?	52 (26.9)
Convenience		
Time of administration	N/C	–
Place of administration	N/C	–
Route	N/C	–
Affordability	It has to be affordable	62 (32.1)
	It has to be free	48 (24.9)
Comfort	N/C	–

EVV = Ebola virus vaccine; N/C = no concern expressed. None of the participants had comments that described all the domains but all had a comment described in one or more of the subdomains. Evaluation of the EVV using model of determinants of vaccine hesitancy developed by the Strategic Advisory Group of Experts Working Group (SAGE WG) for the assessment of the determinants of vaccine hesitancy.[14]

side effects, long-term safety, and detailed scientific content of the different Ebola vaccines as appropriate for the cadre of HCWs. This is important because a study has shown that the public regard health-related information as superior if obtained from HCWs.[9] Thus, HCWs should share health information during their direct contact with patients and program managers should use the services of HCWs in the dissemination of vaccine-related information through radio and television programs.

The willingness of HCWs to be vaccinated with EVV was higher in the region (i.e., Lagos) that reported EVD, compared with the response from the two regions (i.e., Enugu and Abia) that had not reported any cases of the disease. In spite of a uniform lack of knowledge about the content of EVV across the three regions, the high acceptance of the vaccine in the affected area could be due to fear of contracting the disease, as captured by the responses of some of the participants:

> *And I think we are still talking like this because we don't have any epidemic with us right now. Maybe our mindset might change by the time…but as it is now, it is very difficult to accept it without such data.* (A doctor in Abia)

> *I lived in fear for one good month—fears for myself and for my family. So if there is something that can help, I'm not scared….because we were the ones that were at risk. So I don't think there will be a lot of refusal.* (A laboratory scientist in Lagos)

> *If there is an outbreak, I think there will be a rush for that vaccine.* (A physiotherapist in Enugu)

These answers highlight that provision of adequate and verifiable information on the EVV alone may not in reality yield optimal acceptance if the fear factor is not addressed in the campaign. Studies have shown that the concern about the potential outcome of untreated illnesses and the benefits of treatment are greater driving forces than the enjoyment of good health, in the decision to accept any treatment.[22] Even in areas that have been declared Ebola free, every effort should be made to retain reminders of the disease outbreak through vivid billboards and awareness advertisements.

The level of acceptance of EVV among all cadres of HCWs except for doctors improved after health education. This finding is similar to that observed in other studies,[9,19] in which acceptance improved with health education, although these studies were with non-HCWs. Most studies that have assessed the acceptability of any vaccine by HCWs have reported low acceptability.[4–6] However, in a study by Chor and others,[6] the acceptability of the AH1N1 vaccine against influenza was 28.4% at epidemic level 3; this marginally increased to 47.9% at level 5 (i.e., the highest level of epidemic, based on the WHO classification). This change was not substantial; however, it is still a sufficient indication that with adequate information and appreciation of the disease burden among HCWs, their acceptance of a vaccine can improve. It is important to note that the level of acceptability of EVV varied among different cadres of HCWs, with doctors recording the lowest level of acceptance. Nevertheless, while the EVV is still undergoing trials, program managers should endeavor to gain the acceptance of the candidate EVV by all cadres of HCWs by providing correct and verifiable information on the content and safety of the vaccine.[11] The acceptance may also be improved by organizing demonstration workshops and seminars, where scholars of repute give presentations on the vaccine and receive the EVV in the full view of the workshop participants.

The introduction of the vaccine should be strategic, ensuring that an adequate awareness campaign preceded it. The EVV should be administered on "opt-out bases," where the vaccine will be offered to the HCWs and those who will accept to be vaccinated will receive the vaccine, whereas those who will

refuse will be left alone. This will create easy access and indirectly offer other HCWs the privilege of observing some recipients beyond the incubation period of 22 days without causing the stigmatization of those recipients. However, every effort should be made to avoid coercion so as to prevent deadlock. Furthermore, a massive deployment of the EVV should also start in the regions where HCWs have started to receive the vaccine, especially those regions that experienced outbreak, as acceptability of vaccine has been shown to increase whenever there is an epidemic.[23]

Charging for the vaccine was not a major limitation for acceptability among HCWs, provided that the price was affordable and this is similar to findings in other studies,[9,24] although this may not be reflective of the general populace. The mean acceptable price volunteered by the participants was 4.91 USD. It may be that individuals paying for the vaccine will help to indicate the end of clinical trials of the vaccine and improve confidence in the value of the vaccine, which was suggested by some study participants. HCWs may be confused about the economics of free medical products. The recipients are not paying out of pocket for the full cost of product because the cost has been partly borne by a third party.[25–28] Therefore, an awareness campaign about the vaccine should include an explanation on the misconception about the actual cost and payment for vaccines.

Vaccines, whether in use or newly introduced, are often faced with challenge of acceptability. Vaccine hesitancy, according to SAGE WG, is when a respondent lacks confidence about the vaccine, is complacent toward a vaccine, and/or considers the mode and place of administering vaccine inconvenient. The risk of contract EVD from the vaccine (40.9%) due to the misconception that the vaccine will be an extract from the serum of patients that survive the EVD (34.7%) was the major factor that affected their confidence in EVV. Because neither of the proposed candidates of EVV is serum extract nor carries the risk of causing EVD among recipients, the confidence of the HCWs can easily be restored with proper health education and information. On complacency, lack of adequate information on the vaccine (43%), the need to observe other recipients of the vaccine before receiving (26.9%), and the concern about the brief period the vaccine spent on clinical trial (23.3%) were expressed by the respondents. Only few were concerned about the vaccine being relatively new (13.5%). It is most likely that by the time the vaccine is launched for public use, more information would have been made available and more time would have been spent on clinical trials. It is hoped that HCWs would be more convinced on the vaccine and a less number would want to observe others before receiving the EVV. The concern about the convenience of the EVV was only on affordability of the vaccine in terms of cost (32.1%) and preferably given at no charge (24.9%). It is not feasible to project how this concern will be resolved considering that multiple factors play out in setting the price of vaccines and drugs. It is notable that some HCWs stated that paying a fee for the vaccine may not be a major limitation. However, determining an affordable price for the populace may be the challenge.

There are some limitations in the study. First, the study sites were restricted to three states rather than all the states of the Federation. Second, the study was conducted while the EVD epidemic was controlled. The study results, therefore, may not accurately describe HCWs' perceptions of EVD and EVV in an uncontrolled epidemic area where the risk of contracting EVD would be much greater. Third, the impact of some determinants such as the need to observe others first before receiving the vaccine and the assumption that the vaccine is an extract from human serum were not evaluated after health education with regard to the decision to receive the vaccine. This shortcoming could be attributed to the interviewer guide used for the study, which only reevaluated the participants' willingness to receive the vaccine after health education, because some of the responses were unanticipated.

This study highlights that the acceptability of EVV among HCWs was poor, and many HCWs claimed that with adequate information they might consider receiving the vaccine. Nonetheless, there were factors associated with fear borne out of misinformation regarding the content of the vaccine and the potential risk of contracting EVD from it.

These misconceptions need to be resolved before introduction of the vaccine to achieve optimal uptake. To achieve this, program managers should start early by organizing workshops and demonstration sessions for advocacy and the dissemination of information on EVV, especially information on the content of the vaccine, potential vaccine associated adverse events, and insight into the outcome, with visuals of the subjects used in the clinical trials for the vaccine. With good acceptance among HCWs, the introduction of the vaccine in the community will have a higher chance of success. Whether the vaccine should be administered free of charge to recipients is controversial. Although charging for the vaccine will not be a major limitation for acceptability among HCWs, the issue of charging still needs further evaluation.

Received March 15, 2016. Accepted for publication May 23, 2016.

Published online July 5, 2016.

Acknowledgments: We appreciate all individuals who made this study possible. Our special thanks go to Lagos State's Health Services Commission (Lagos, Nigeria) for the approval to conduct the study in Lagos. We appreciate the efforts of Lateef Ayinde of Providence Hospital (Ikoyi, Lagos State, Nigeria) for his assistance with mobilizing the centers and participating in the conduct of interviews. The American Society of Tropical Medicine and Hygiene (ASTMH) assisted with publication expenses.

Authors' addresses: Dorothy O. Esangbedo, Pediatric Division, Providence Hospital, Lagos, Nigeria, E-mail: ederie@hotmail.com. Maduka D. Ughasoro, Department of Pediatrics, University of Nigeria Enugu Campus, Enugu, Nigeria, E-mail: maduka.ughasoro@unn.edu.ng. Beckie N. Tagbo, Institute of Child Health, University of Nigeria Teaching Hospital, Enugu, Nigeria, and Department of Pediatrics, University of Nigeria Teaching Hospital, Enugu, Nigeria, E-mail: tagbobeckie@gmail.com. Adebiyi Olowu, Department of Pediatrics, Olabisi Onabanjo University Teaching Hospital, Oshogbo, Nigeria, E-mail: adeowwu20@gmail.com. Chukwuemeka Anikene, Department of Pediatrics, University of Nigeria Teaching Hospital, Enugu, Nigeria, E-mail: emeka.anikene@gmail.com. Chimaobi C. Iwegbulam, Department of Pediatrics, Federal Medical Center, Umuahia, Nigeria, E-mail: iwegbulamchimaobi@gmail.com.

Reprint requests: Maduka D. Ughasoro, Department of Pediatrics, University of Nigeria Enugu Campus, P.O. Box 1093, Enugu, Nigeria, E-mails: kakatitis@yahoo.co.uk or maduka.ughasoro@unn.edu.ng, Tel: +2348060388863, Fax: 08060388863.

REFERENCES

1. World Health Organization, 2016. *Ebola Situation Report 20 January 2016.* Available at: http://www.who.int/csr/disease/ebola/situation-reports/archive/en/. Accessed January 28, 2016.

2. U.S. Centers for Disease Control and Prevention (CDC), 2003. *Guidelines for Environmental Infection Control in Health-care Facilities*. Available at: www.cdc.gov/hicpac/pdf/guidelines/eic_in_HCF_03.pdf. Accessed July 12, 2015.
3. Henao-Restrepo AM, Longini IM, Egger M, Dean NE, Edmunds WJ, Camacho A, Carroll MW, Doumbia M, Draguez B, Duraffour S, Enwere CG, 2015. Efficacy and effectiveness of an rVSV-vectored vaccine expressing Ebola surface glycoprotein: interim results from the Guinea ring vaccination cluster-randomized trial. *Lancet 386:* 857–866.
4. Savas E, Tanriverdi D, 2010. Knowledge, attitudes and anxiety towards influenza A/H1N1 vaccination of health-care workers in Turkey. *BMC Infect Dis 10:* 281.
5. Maltezou HC, Dedoukou X, Patrinos S, Maragos A, Poufta S, Gargalianos P, Lazanas M, 2010. Determinants of intention to get vaccinated against novel (pandemic) influenza A H1N1 among health-care workers in a nationwide survey. *J Infect 61:* 252–258.
6. Chor JS, Ngai KL, Goggins WB, Wong MC, Wong SY, Lee N, Leung TF, Rainer TH, Griffiths SC, Chan PK, 2009. Willingness of Hong Kong healthcare workers to accept pre-pandemic influenza vaccination at different WHO alert levels: two questionnaire surveys. *BMJ 339:* b3391.
7. Ugwu EO, Obi SN, Ezechukwu PC, Okafor II, Ugwu AO, 2013. Acceptability of human papilloma virus vaccine and cervical cancer screening among female health-care workers in Enugu, southeast Nigeria. *NJCP 16:* 249–252.
8. GhanaWeb, 2015. *Doubts over Integrity of Ebola Trials*. General News of Sunday, 5 July 2015. Available at: http://www.ghanaweb.com/GhanaHomePage/NewsArchive/Doubts-over-integrity-of-Ebola-trials-366573. Accessed May 4, 2015.
9. Tagbo BN, Ughasoro MD, Esangbedo DO, 2014. Parental acceptance of inactivated polio vaccine in southeast Nigeria: a qualitative cross-sectional interventional study. *Vaccine 32:* 6157–6162.
10. Hoenen T, Feildmann H, 2014. Ebola virus in west Africa and the use of experimental therapies or vaccine. *BMC Biol 12:* 80.
11. Qiu X, Wong G, Andet J, Bello A, Fernando L, Alimonti JB, Fausther-Bovendo H, Wei H, Aviles J, Hiatt E, Johnson A, Morton J, Swope K, Bohorov O, Bohorova N, Goodman C, Kim D, Pauly MH, Velasco J, Pettitt J, Olinger GG, Whaley K, Xu B, Strong JE, Zeitlin L, Kobinger GP, 2014. Reversion of advanced Ebola virus disease in non-human primates with Zmapp. *Nature 514:* 47–53.
12. Bisgard KM, Rhodes P, Hardy IR, Litkina IL, Filatov NN, Monisov AA, Wharton M, 2000. Diphtheria toxoid vaccine effectiveness: a case-control study in Russia. *J Infect Dis 181 (Suppl 1):* S184–S187.
13. Deivanayagam N, Nedunchelian K, Ahamed SS, Rathnam SR, 1993. Clinical efficacy of trivalent oral poliomyelitis vaccine: a case-control study. *Bull World Health Organ 71:* 307–309.
14. Strategic Advisory Group of Experts Working Group, 2014. *Report of the SAGE Working Group on Vaccine Hesitancy.* Available at: www.who.int/immunization/sage/meetings/2014/october/1_Report_WORKING_GROUP_vaccine_hesitancy_final.pdf. Accessed April 12, 2013.
15. Larson HJ, Jarrett C, Eckersberger E, Smith D, Patterson P, 2014. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature, 2007–2012. *Vaccine 32:* 2150–2159.
16. Williams SE, Rothman RL, Offit PA, Schaffner W, Sullivan M, Edwards KM, 2013. A randomized trial to increase acceptance of childhood vaccines by vaccine-hesitant parents: a pilot study. *Acta Paediatr 13:* 475–480.
17. Constantine NA, Jerman P, 2007. Acceptance of human papillomavirus vaccination among Californian parents of daughters: a representative statewide analysis. *J Adolesc Health 40:* 108–115.
18. Information Nigeria, 2009. *The Nigerian States by Population*. Available at: www.informationng.com. Accessed November 23, 2015.
19. Ughasoro MD, Esangbedo DO, Tagbo BN, Mejeha IC, 2015. Acceptability and willingness-to-pay for a hypothetical Ebola virus vaccine in Nigeria. *PLoS Negl Trop Dis 9:* e0003838.
20. Cutilli CC, 2010. Seeking health information: what sources do your patients use? *Orthop Nurs 29:* 214–219.
21. Redmond N, Baer H, Clark CR, Lipsitz S, Hicks LS, 2010. Sources of health information related to preventive health behaviors in a national study. *Am J Prev Med 38:* 620–627.
22. Puts MT, Tapscott B, Fitch M, Howell D, Monette J, Wan-Chow-Wah D, Krzyzanowska M, Leighl NB, Springall E, Alibhai SM, 2015. A systematic review of factors influencing older adults' decision to accept or decline cancer treatment. *Cancer Treat Rev 241:* 197–215.
23. Kong KA, Yoon SH, Cho SJ, Kim HW, Kim KH, 2014. Public acceptance and willingness to hepatitis A vaccination in children aged 7–18 years in Republic of Korea. *J Korean Med Sci 29:* 1528–1535.
24. Hadisoemarto PF, Castro MC, 2013. Public acceptance and willingness-to-pay for a future Dengue vaccine: a community-based survey in Bandung, Indonesia. *PLoS Negl Trop Dis 7:* e2427.
25. Onwujekwe O, Hanson K, Uzochukwu B, 2012. Are the poor differently benefiting from provision of priority health services? A benefit incidence analysis in Nigeria. *Int J Equity Health 11:* 70.
26. Zhou F, Shefer A, Wenge J, Messonnier M, Wang LY, Lopez A, Moore M, Murphy TV, Cortese M, Rodewald L, 2014. Economic evaluation of the routine childhood immunization program in the United States, 2009. *Pediatrics 133:* 1–9.
27. Enugu State Ministry of Health (EMOH), 2007. *Pricelist for Services in Public Health Facilities in Enugu State*. Ministry Enugu, Nigeria: EMOH.
28. Wagstaff A, van Doorslaer E, Paci P, 1991. On the measurement of inequalities in health. *Soc Sci Med 35:* 545–557.