Knowledge transfer for Ebola outbreak – production and use of OpenWHO.org online learning resources

Heini Utunen, Paula Christen, Dr Gaya M. Gamhewage, Ursula Zhao, Melissa Attias
Support for Response/Transfer of Knowledge
WHO Health Emergencies Programme
World Health Organization
Geneva, Switzerland
outbreak.training@who.int

***Abstract*— WHO's Transfer of Knowledge (TOK) Team under the Infectious Hazard Management Department of the WHO Health Emergencies Programme (WHE) aims to meet the evolving needs of frontline responders to the health emergencies of the 21st century. Epidemics increasingly occur in more complex, rapid and challenging contexts.**

Frontline workers and decision-makers need the latest science and knowledge to fight disease outbreaks and other health emergencies. This knowledge must be in usable formats and delivered via suitable channels, accessible even in remote areas. If possible, WHO health technical expertise materials in infectious disease outbreaks are also produced in local languages, given that knowledge acquisition in one's mother tongue is crucial to containing epidemics in vulnerable settings.

The Transfer of Knowledge team of the WHE launched in June 2017 an online learning platform for disease outbreaks, epidemics, pandemics and health emergencies: OpenWHO.org. The aim of the platform is to ensure that frontline health responders have access to lifesaving knowledge anytime from anywhere during public health emergencies. The Transfer of Knowledge team together with infectious disease expert teams adapt and customize key technical information and package it into usable products easily accessible in the field.

This knowledge transfer involves various product types and includes materials targeted for health-care and community workers on the front line of the outbreak response. Materials include epidemiological knowledge and health interventions on infectious diseases like Ebola virus disease (Ebola), yellow fever, plague and cholera. These materials are also produced in the local languages most commonly used by local responders in the outbreak areas.

Most recently, a number of materials were targeted, adjusted and translated for the 2018 Ebola outbreak in the Democratic Republic of the Congo. Key materials on Ebola, the production process and initial user analytics are presented in this article.

Keywords*— *Knowledge transfer, health emergencies, outbreaks, epidemics, pandemics, Ebola virus disease (EVD), knowledge to action, online learning, knowledge resources, outbreak response, OpenWHO, oral language cultures, Translators without Borders

I. INTRODUCTION TO OPENWHO.ORG

The online learning platform OpenWHO.org was launched in June 2017 by the Transfer of Knowledge team of the World Health Organization's Health Emergencies Programme (WHE).

The free, self-paced and open-access online learning platform allows for the transfer of the latest and most-relevant scientific, technical and operational knowledge to frontline responders. Planning for the worst-case scenario, a worldwide pandemic, the platform is designed to host millions of users at the same time. One year since its launch, the platform features more than 40 different courses which are being utilized by staff in ministries of health, health-care workers, other government personnel, UN staff, humanitarian organizations, non-governmental organizations, volunteers and students.

The courses have a diverse range: A Ready for Response channel with courses such as an introduction to the WHO incident management system, a Get Social channel offering social science approaches and risk communication materials, an Outbreak channel with disease-specific courses and a dedicated Preparing for Pandemics channel.

A partnership with Translators without Borders was launched to ensure timely local language translation of all key outbreak response materials when deemed necessary. During the past two years, almost 200 knowledge products for outbreak responses have been submitted by the Transfer of Knowledge Team to Translators without Borders for translation into more than 30 languages, including more than 20 underserved languages. This is critical as the research proves that frontline workers not only prefer material in their own languages, but their comprehension can increase up to 92% [1].

This article further explains the knowledge resource production and learning path created in response to the Ebola virus disease (referred shortly as "Ebola" in this article) outbreak in 2018. The importance of producing timely, correct materials in appropriate formats and languages at the right time is emphasized and an Ebola-specific learning path is now available on OpenWHO together with local language resources for responders on the front line.

II. Training needs In the Ebola Outbreak in May 2018

The Strategic Response Plan for the Ebola Outbreak in the Democratic Republic of the Congo (DRC) aimed to contribute to the reduction of avoidable mortality and morbidity related to the outbreak of Ebola in the Équateur province of DRC, and to prevent the spread of the outbreak to other provinces, and neighbouring and other countries. To this end, eight response objectives have been outlined, all of which require briefing, training and learning resources for all personnel. The target audiences for materials include both international deployees and national and local personnel working in the response, and the purpose of the training material production was twofold:

1. Personnel need to operate safely as they may be exposed to Ebola, which causes serious illness and death;
2. Personnel need to be updated on public health, operational, and leadership and management aspects of the response in order to meet the response objectives.

While some training material existed from the previous Ebola responses, which were delivered by WHO during the 2014–2016 Ebola outbreak in West Africa and the 2017 Ebola outbreak in the Likati province of the Democratic Republic of the Congo, the majority of that material needed to be updated and contextualized for the situation in Équateur province in DRC. Materials were also expanded to include new knowledge and interventions, such as the use of the experimental vaccine, to be useful for the 2018 DRC response.

The following three objectives guided the training material reproduction for the Ebola outbreak:

1) Ensure quality: WHO should ensure that Ebola response trainings contain the latest technical knowledge and operational knowhow, and integrate adult learning techniques into any learning material that is available.

2) Ensure cohesion: WHO should collaborate with all response partners to make learning and training material coherent and consistent across agencies.

3) Ensure access: WHO should ensure that learning and training material is translated into the educational levels and preferred languages of deployees and frontline local responders, and that it is accessible using low-bandwidth technology and other preferred channels.

The Transfer of Knowledge Team was in charge of producing materials in online learning formats for personnel requiring information and any interested practitioners or general audience members willing to enrol in the training resources.

The OpenWHO.org platform solution is provided by the Hasso Plattner Institute (HPI). Based on HPI's white-label software, an adjusted MOOC platform was established as an open and web-based learning platform for the World Health Organization (WHO). The practical deployment, technical architecture and OpenWHO platform adaptation were presented in a paper for a September 2018 conference [2] and thus are not discussed in this article.

III. Online learning material production

A. *Producing materials for health emergencies and outbreaks*

The OpenWHO team has established a production cycle for online learning materials in emergencies, as illustrated in Fig. 1.

This production timeline is established for simple knowledge resource production for outbreaks or health emergencies, and includes expert speeches or interviews and resource materials with supporting transcripts and quizzes.

For the Ebola response starting in May 2018, the OpenWHO team first explored which learning resources already existed on OpenWHO, on other learning platforms and on the internet, and assessed what was required to repurpose any of those materials for the outbreak. A revision of existing materials took place and some new content was produced.

The WHO expert technical team for Viral Haemorrhagic Fevers reviewed, updated and cleared any materials that were to be used in online and other material formats.

A number of materials were reproduced and updated based on previous response learning resources. Fig. 2 shows how earlier Ebola materials were repurposed and used in the 2018 response.

The crystals on the timeline show when the material was first launched and arrows show the reproduced versions of the same materials. For the 2018 Ebola outbreak, few completely new materials were produced but an effort was made to bring all necessary resources into one place, on OpenWHO.

The production times for the materials were very short. The WHE training lead for Health Technical Expertise announced the training material project on 23 May 2018 to revise and update both the GO training – WHO-specific pre-deployment training that contains modules on communications, ethics and similar subjects – from the WHO website resource, and the ePROTECT Occupational Health and Safety course from another learning platform. Following the inception meeting, courses were reproduced, adjusted and published on the following dates:

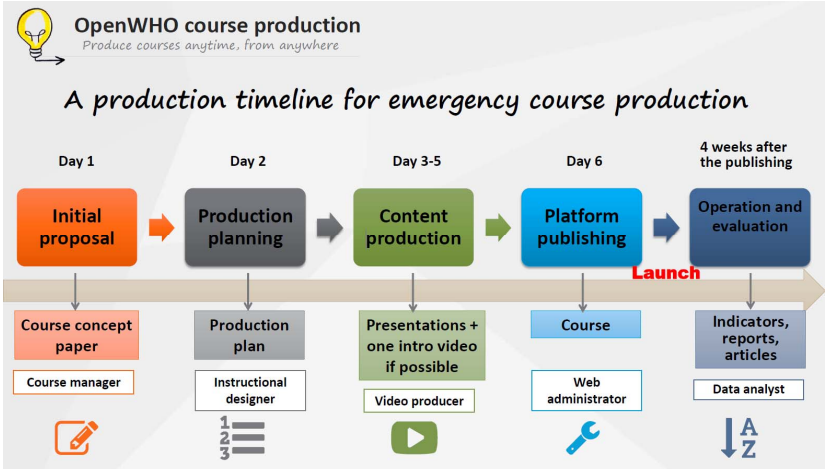


Fig. 1. OpenWHO emergency course production timeline.

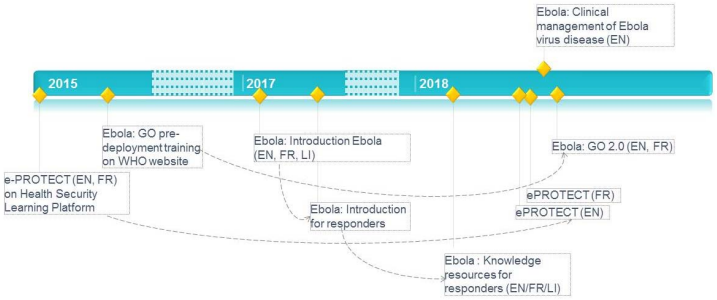


Fig. 2. Timeline of Ebola course productions and reproductions.

- 4 June: ePROTECT English (EN) published
- 5 June: ePROTECT French (FR) published
- 29 June: English GO 2.0 course received final clearance and was published
- 9 July: French GO 2.0 translation was language reviewed and published

The OpenWHO team was concurrently working on the GO and ePROTECT courses at the beginning of production and submitted all materials for technical clearances. The clearance and video-editing processes caused some prolongation of the production timeline.

For the GO 2.0 training, production included re-recording all video presentations, creating three entirely new modules and developing multiple-choice assessments.

Following the English versions, both the GO and ePROTECT courses were translated, reformatted and published in French. The GO training was published as downloadable French presentations.

While the OpenWHO team is fully capable of independently producing all materials and has mobile studio capacity for recording audio and video, there are still some capacities to be arranged through contracting, such as audio-visual editing, translations and language editors. In order to function efficiently in emergencies, these capacities should be arranged through pre-cleared contracts to ensure stand-by production capacity. The other option is to use the non-edited and less-polished presentation materials that the OpenWHO studio provides.

The learning resources and their uses are presented in more depth in the following chapter.

IV. Online Learning Resources for Ebola Responders on OpenWHO

Learning from the previous Ebola responses, the OpenWHO team has developed a learning path for frontline responders and the OpenWHO platform currently features five learning resources for Ebola responders (Fig. 3). Of the current materials on Ebola virus disease, the basic introduction to the disease and knowledge resources for responders are provided in three languages: English, French and in local language Lingala. English and French are the main languages of the international humanitarian response in DRC; Lingala is the main language of the area affected by the May 2018 Ebola outbreak. Other materials are available in English and French. During May–June 2018, there were more than 3300 course enrolments for these five resources, including the various language versions. All statistics refer to this approximate two-month period unless stated otherwise.

A. Ebola: Introduction

The 30-minute introductory or refresher pack on the disease is aimed at all response personnel. The presentation covers signs, symptoms and transmission of Ebola, preventive and control measures, as well as the main public health concerns during an outbreak, and is available in three languages: English, French and Lingala. This introduction is incorporated into the follow-up course, Ebola: Knowledge resources for responders.

By 15th July, a total of 1425 users had taken part in the English version, 823 users in the French version and 92 users in the Lingala version.

B. Ebola: Knowledge resources for responders

The knowledge resources for responders course contains an introductory module on Ebola virus disease, a module on building trust and engaging communities in Ebola outbreak response and a knowledge pack – an interactive pdf linking to the most up-to-date key technical documents for the response.

As of 15th July, more than 1764 users enrolled in the knowledge resources course. Among them, 30% of the users visited the community engagement module (144 English, 54 French), compared with 60% who visited the knowledge pack.

C. ePROTECT

ePROTECT is an occupational health and safety briefing that covers the basic information one needs to protect personnel when deploying to countries with Ebola. Those assigned to specialized tasks, such as working in direct contact with infected people, need more advanced-level training and coaching. Available in English and French, the course content focuses on completing the following learning objectives:

a) Describing the signs, symptoms and transmission of Ebola and listing preventive control measures

b) Using appropriate infection prevention and control precautions to protect oneself against Ebola and remain

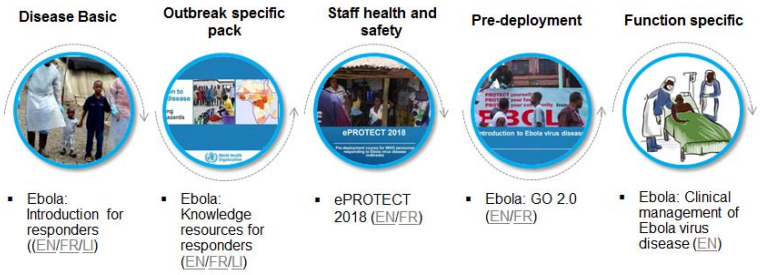


Fig. 3. Online learning path for Ebola responders on OpenWHO.

healthy during the mission

c) Protecting one's health before, during and after deployment

d) Describing the procedure to follow in case of sickness (related to Ebola or not) or/and accidental exposure to EVD, and listing the principles of medical evacuation and follow-up care

e) Recognizing and managing stress

770 users have enrolled into the English version, while 272 users have enrolled in the French version of the course as of 15th July.

D. *Ebola: GO 2.0*

Ebola: GO 2.0 is a revised version of the Ebola: GO 1.0 training, which was published for the 2014–2016 Ebola outbreak in West Africa. Ebola: GO 2.0 was developed in 2018 for WHO deployees to work safely and effectively as part of teams bringing Ebola outbreaks under control. The learning material is designed to complement the updated ePROTECT training.

All personnel responding to Ebola outbreaks need to have basic knowledge and skills in order to mount an effective response. The learning package consists of 7 modules, which include video lectures and downloadable presentations that have been updated with the latest information and developments. It begins with an introduction to Ebola virus disease before moving to the response strategy and essential information related to working in a WHO-led emergency response.

E. *Ebola: Clinical management of Ebola virus disease*

The course Ebola: Clinical management of Ebola virus disease is based on the WHO Viral Haemorrhagic Fever pocket guide (February 2016) and adapted from materials developed by The WHO Emerging Diseases Clinical Assessment and Response Network (EDCARN) network member IMAI-IMCI Alliance. The course includes modules on: screening and triage, infection prevention and control (IPC) standard precautions, personal protective equipment (PPE) use for Ebola, environmental cleaning and waste management, safe and dignified burial, laboratory diagnostics, clinical care in Ebola treatment centres (ETCs) and therapeutic options for Ebola patients. This course is an intermediate-level course that targets frontline health workers. It provides practical information for clinicians providing direct care.

Since its launch on 22 June 2018 until 15 July, a total of 705 users have enrolled in the English version of the course. The first 500 of them enrolled within five days of the course launch. A French language version was also made available.

V. USE OF EBOLA LEARNING MATERIALS

A. *Overall enrolment*

One of the key performance indicators (KPIs) for all courses on OpenWHO.org is the number of enrolments over time. Fig. 4 visualizes how courses were taken up by platform users since the launch and throughout the first 2.5 months of the response under review in this article.

The figure shows the demand for and the use of the courses and related materials. While this article only provides quantitative figures, further work will be undertaken to look at the qualitative side, such as usefulness, relevance, etc. Each of the materials had impressive enrolment over a very short period of time, as seen in Fig. 4.

The visualization shows that all courses experienced rapid growth in enrolment within a few days of their launch. New courses were announced to the existing OpenWHO users as they became available.

Three weeks after of the launch of the Ebola knowledge resources in English, the number of enrolments started to plateau. The French version of the knowledge resources course is the only course within this analysis that does not follow the same pattern. One plausible reason was due to the fact that the Ebola introduction in French was also included under the English resource, accounting for 1400 users' visits with the use increasing steadily. Furthermore, the most-used language of the Ebola courses is English.

When looking at the three courses that provide a certificate, as in **Error! Reference source not found.**, it can be summarized that the completion rates of the ePROTECT Occupational Health and Safety courses in both English and French are very high, at approximately 50%.

During the response, ePROTECT was made mandatory online learning prior to deployment to DRC for WHO deployees, following the example from the 2014–2016 West Africa response. A number of non-WHO-affiliated staff has also enrolled and completed the course. The fact that it became a prerequisite for WHO deployment may explain the higher completion rate compared to the other certificate-producing course, Ebola: GO.

Other interesting findings from the users were captured in a short user survey targeting Ebola knowledge resources users. 44% of the enrolled participants who answered the survey had not worked in a disease outbreak and 42% had. OpenWHO

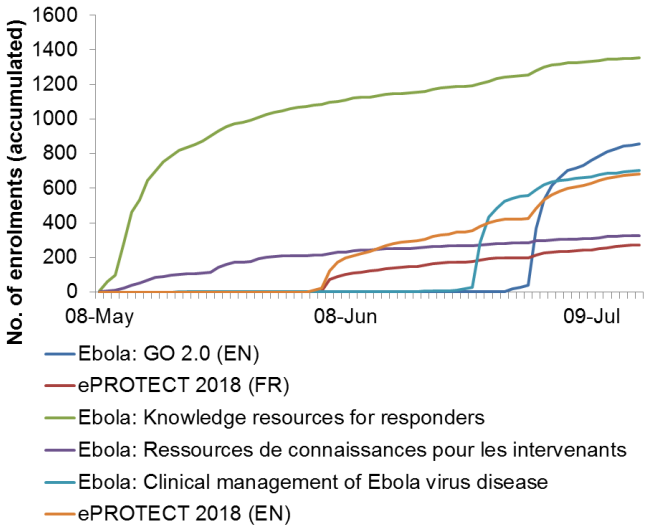


Fig. 4. Use of online resources for Ebola responders.

knowledge resources provide outbreak- specific additional

Table 1. Completion rates of the three learning resources for Ebola providing a certificate.

Course name	Total Enrolments	Total certificates issued	Completion rate
ePROTECT (EN)	733	364	50%
ePROTECT (FR)	251	134	53%
GO (EN)	788	166	21%

learning for response personnel who already have professional expertise in their respective areas. The courses provide a common ground for everyone working in an outbreak response. It is particularly encouraging that newcomers to outbreak response have also found the courses and used them as a knowledge resource for this outbreak response.

Further, the survey asked if the enrolled participants had taken other online courses in the past six months; a majority (51%) answered that they had not, while approximately one-fifth of the respondents said they were currently enrolled in other trainings and another fifth said they had previously taken courses (Fig. 6).

The OpenWHO team also asked for the organizational affiliations of learners enrolled in the Ebola knowledge resources course and the variety of organizational affiliations is visualized in Fig. 5. Organizational affiliations span 11 categories ranging from WHO staff to UN staff, students, staff from different ministries and health institutes, individual experts and volunteers.

When examining other parameters of user background for the Ebola knowledge resources course, interesting findings could be made: A majority of English resource users are in the age range of 20-40 years, whereas a majority of French resource users are between 30-50 years of age (Fig. 7). Overall, there are significantly fewer users in the 50-60 and 60-plus age brackets than in all but the youngest age group.

Findings were also made regarding the gender of the users,

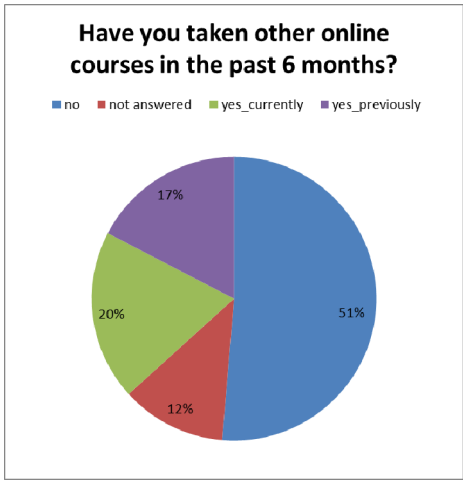


Fig. 6. User survey on Ebola knowledge resources (other online learning attended in the past 6 months).

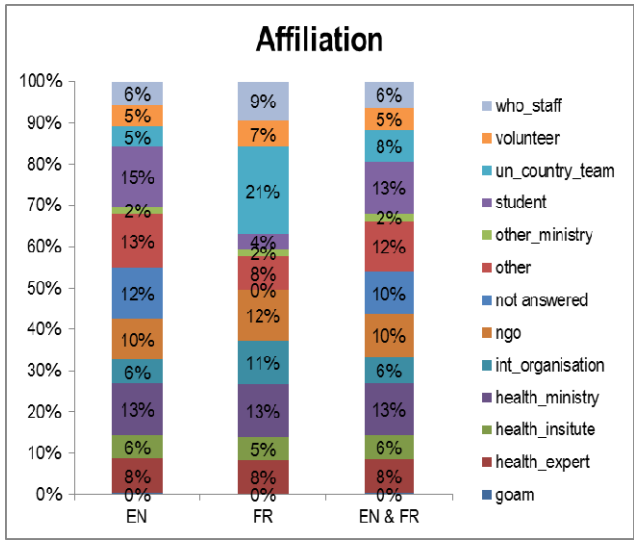


Fig. 5. User survey on Ebola knowledge resources on the professional background of the users.

as visualized in **Error! Reference source not found.**. Of the course-enrolled participants who identified their gender, more users stated they were male in both the English (45%) and French (55%) courses.

B. Enrolments from the current and previous Ebola outbreak affected countries

A separate analysis of African region use was conducted based on course enrolments. The analysis looked at user statistics from the affected countries from both current and previous Ebola outbreaks.

The analysis focused on DRC and nine WHO regional strategic priority countries on the Ebola virus disease operational readiness plan, in which the nine countries are divided into three priority categories [2]:

1. Priority 1: Central African Republic and Republic of

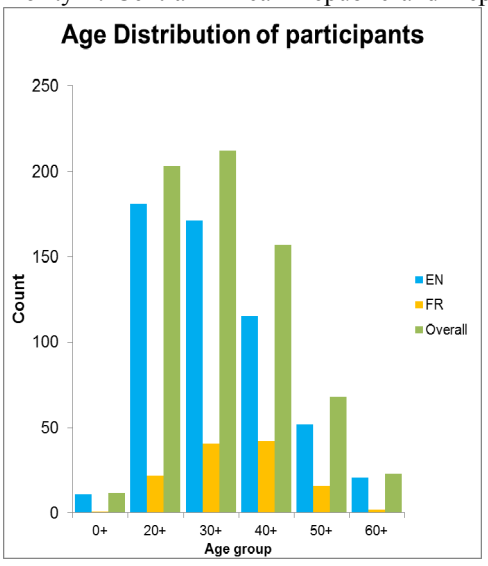
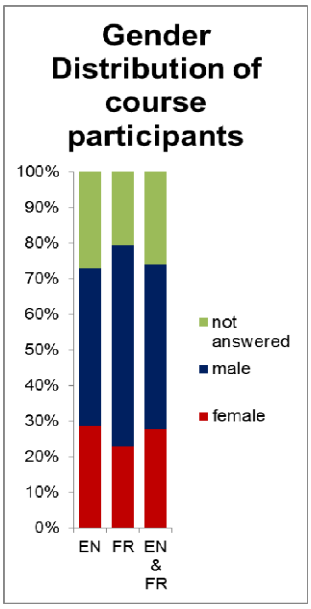


Fig. 7. Ebola knowledge resources use by language of the material and by age group.



Congo

Fig. 8. Ebola knowledge resources use by language of the material and by gender.

2. Priority 2: Angola, Burundi, Rwanda, South Sudan, Tanzania and Zambia
3. Priority 3: Uganda

Fig. 9 displays user enrolment data from DRC and neighboring EVD readiness priority countries. Overall, 408 users enrolled in at least one of the five courses from these nine countries.

Additional survey questions on user background were analyzed, namely:

"What is your affiliation?"

"Which areas of learning interest you the most?"

Among the EVD readiness priority countries, a total of 46 users (16%) came from the Ministry of Health (MoH) of the country, followed by 54 staff from UN agencies and 28 from WHO. More than 40% of the users considered capacity building as their preferred area of learning, followed by emergency operations (21%) and managing epidemics (7%).

The team also analysed enrolment data from the three countries with widespread transmission (Guinea, Liberia, Sierra Leone) and other affected countries in West Africa (Mali, Nigeria, Senegal) during the 2014–2016 Ebola outbreak.

As shown in Fig. 10, a total of 120 users of the Ebola knowledge resources originated from Guinea, Liberia and Sierra Leone. 470 additional users came from three other West African affected countries: Mali, Nigeria and Senegal. A high level of buy-in can be seen from these six countries, with almost 600 users participating and 20% of them from the Ministry of Health.

It is particularly interesting to note the high use in Nigeria, where nearly 400 users took part in the courses. The platform currently has more than 2000 users from Nigeria, one of its fastest growing communities.

The areas of learning interest for West African users remains similar, with the top three comprising capacity building (44%), emergency operations (20%) and managing epidemics (5%).

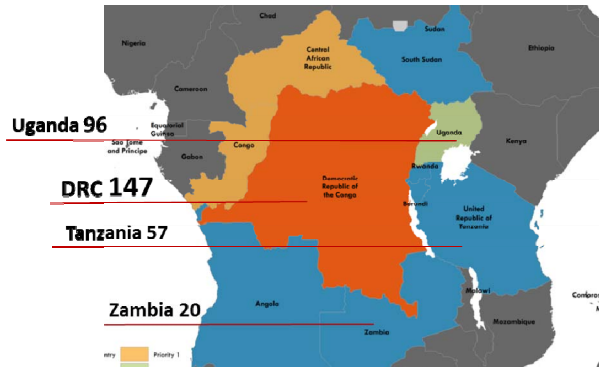
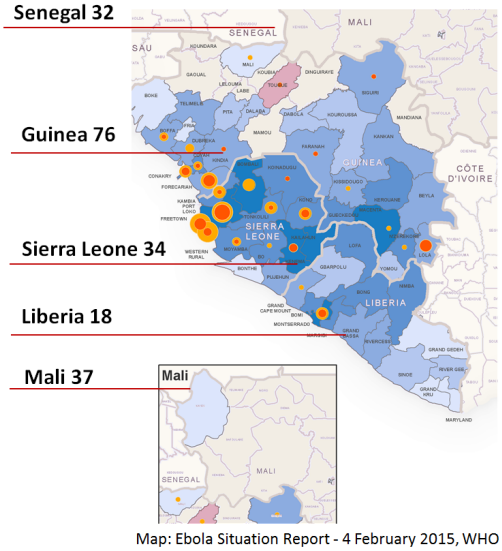


Fig. 9. Total enrolments from DRC and neighbouring countries (Map: WHO EVD readiness priority countries [3] with OpenWHO user figures added).

Overall, the enrolment results show that 70% of users already started using OpenWHO prior to the outbreak. It is critical to have a centralized place to host online learning activities for outbreak, epidemic and pandemic response with an established, routine and familiar location where practitioners quickly access and retrieve lifesaving information and knowledge when a new outbreak such as Ebola emerges. The readiness and rapidness of knowledge access is critical for WHO's leadership in health emergency response and any similar responses in vulnerable settings.

VI. MATERIAL PRODUCTION INTO LOCAL LANGUAGES

Health workers need to access knowledge in their own languages to protect themselves and stay safe. Material in one's own language significantly increases comprehension.



Map: Ebola Situation Report - 4 February 2015, WHO

Fig. 10. Ebola material enrolments from West African countries.

Language mapping and local language translation are critical and the Transfer of Knowledge and OpenWHO team works with Translators without Borders (TWB) in this process. TWB conducts a language mapping and, where feasible, determines together with the TOK team the appropriate communication means *for predominantly oral language cultures*. Translated materials are then produced into learning resources in suitable formats in as short production time as possible. In this response, key information was produced in audio files based on a request from the field.

To date, the health technical expertise materials for different outbreaks have been translated into more than 30 languages and most of them have been uploaded to OpenWHO. A standard production process for local language materials has been established and follows general production with the stated steps:

1. Identify what technically cleared and relevant materials already exist
2. Determine which languages are most commonly spoken by the affected communities
3. Prioritize what essential knowledge is needed by responders
4. Scope the means of communication and distribution
5. Repurpose and adapt existing materials/add outbreak-specific materials and recommendations
6. Get adapted materials cleared by technical teams
7. Translate materials with the support of TWB
8. Get translation proofed by country-level health officers to adapt to local use
9. Package in online and other formats and disseminate
10. Identify local language speaker for audio recording

The entire process above was implemented for the production of the Ebola knowledge resources. The process involves many steps and potential delays, but OpenWHO has been able to expedite the translations, reviews and clearances into as short as 3-4 days combined.

A. Language mapping

In the case of the Ebola outbreak in the Équateur province of the Democratic Republic of the Congo, Translators without Borders provided the initial language mapping as in Fig. 11.

The Democratic Republic of the Congo is one of the most linguistically diverse countries in the world. The 2018 Ebola outbreak was first detected near Bikoro town in Équateur province of DRC. According to Translators without Borders, residents within a 300-kilometre radius of Bikoro town speak over 40 languages. Literacy levels are low. It is therefore recognized that affected communities need to have access to health information in a language and format that they can understand. TWB recommends a systematic assessment of language and communication preferences as part of first-phase risk communication and community outreach efforts.

In the absence of detailed language and communication assessments on the ground, it was assumed by TWB that for most of the people in the Équateur province of the Democratic Republic of the Congo, the language used in their daily communication is Lingala.

Core materials (Introduction to Ebola and Ebola: Knowledge resources for responders) were translated into Lingala by TWB.

B. First-ever local language audio recording

The OpenWHO team has been exploring different options to produce audio material in local languages, particularly to target oral cultures with low literacy rates, such as Équateur province in DRC. Many communities also have community radio stations, through which the audio materials can be transmitted. For the production of audio recordings, there are not yet standard solutions other than identifying a local language speaker who could record the audio. The work is ongoing to use artificial intelligence, such as automated voiceovers, to produce the audio, but solutions are not yet fully developed.

For this response, the OpenWHO team was able to find a Lingala native speaker in WHO. The staff member supported the effort by proofreading the translations and voice recording the training materials in Lingala. They can now be downloaded and utilized through the OpenWHO site and accompanying OpenWHO mobile application. These materials have been used in frontline training to help local health workers better protect themselves and stay safe.

VII. CONCLUSIONS

The keen use and fast uptake of health technical expertise materials in online formats for the 2018 Ebola outbreak in DRC show that there is demand for knowledge transfer as produced and disseminated on the OpenWHO platform. Responding to outbreaks such as Ebola requires very specialized expertise and in a geographically limited response the number of personnel is not very large. This is reflected in the user figures, which reach into some thousands. OpenWHO has the capacity to host up to millions of users if needed, but the number of response personnel can be very small if the

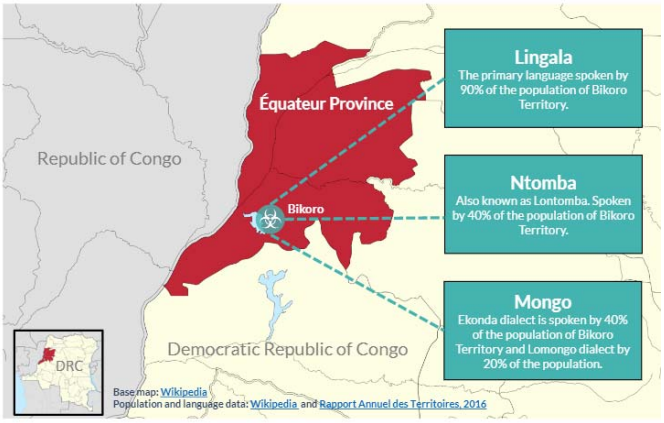


Fig. 11. Ebola outbreak language map by Translators without Borders [4].

event is not a pandemic, larger epidemic or public health emergency. The materials were, however, used efficiently by the staff on the ground.

Knowledge resources included both mission-related staff preparatory materials and Ebola virus disease materials. The only technically specialized material produced was the course on clinical management for clinical responders. All materials were actively used by personnel from various organizational backgrounds not limited to WHO. Users varied from Ministry of Health officials, health experts and health institute staff, to UN country teams, volunteers, students and international organization personnel. The response involves many organizations and the same can be seen from the OpenWHO user audience.

Along with the use in the Democratic Republic of the Congo, the OpenWHO team is also positively surprised by the vast use of materials in neighbouring countries and West African countries that were impacted by the larger 2014–2016 Ebola outbreak. This shows that knowledge resources are not only used for response purposes, but also for readiness and preparedness in other countries.

Findings from the production process show that materials can be expedited and published very quickly on OpenWHO. This is critical for supporting the response when it begins. The knowledge resources for responders course was online the day following the outbreak announcement.

Producing versions in multiple languages takes more time as it requires appropriate review and clearance, but an already established process and collaboration with Translators without Borders makes even local language resources possible and speedy to acquire. The production of key materials in the languages spoken by local responders has proven to be necessary and will be continued. User statistics suggest that user groups and use vary between English and French materials, constituting a necessary area for follow-up analysis and research. Additional research on the user experience on the front line is anticipated to improve the packaging of materials in order to provide the support best suited for responders on the ground.

The OpenWHO team also acknowledges how simple it is to repurpose existing materials from other platforms onto OpenWHO. It only took days to reproduce online storyline formats into shorter, individual learning elements for the platform, a functional model allowing optimized accessibility in low-bandwidth contexts and for offline use.

Following the production of materials, future work would ideally include more in-depth analysis of the learner experience and learning analytics in general, including qualitative surveys. A post-ante evaluation of the use and impact of the learning resources is suggested along with research and analytics on user engagement, dropout triggers and other participation-related topics. As the materials are developed for emergencies and are largely utilized through downloads and offline use, a detailed method of assessing the materials is not yet established. Finding a suitable way to collect evaluations from course users is still to be defined. A section on knowledge transfer could be added to the standard WHO after action review for a response.

After the outbreak is over, OpenWHO knowledge resources will remain available on the platform as educational resources. In the case of a new outbreak, they will again be repurposed and adjusted to meet the needs of the response.

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