

Proceedings of the 6th Seminar Emerging Infectious Diseases

Current trends and proposals
March 2017, 28th
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To understand and fight emerging infectious diseases, basic and clinical research, proactive and on-site, should be conducted in cooperation

Sub-title

Proceedings of the 6th seminar on emerging infectious diseases, March 28, 2017 - Current trends and proposals

Summary

We present here the proceedings of the 6th seminar on emerging infectious diseases (EIDs), held in Paris on March 28th, 2017, with eight priority proposals that can be outlined as follows:

Priority proposals

1. To have at our disposal dedicated reference centres, mobile units if necessary, in order to take care and treat EID patients, and to isolate them so as to protect the population at large
2. To provide these centres with appropriate means, in particular trained healthcare providers (with theoretical knowledge and practical hands-on training ...) capable of interacting closely
3. To create conditions allowing to start epidemiological-microbiological-clinical research from the beginning of an epidemic alert, as per the experience of recent epidemics in Southern hemispheric countries.
4. To prepare epidemiological-microbiological-clinical research during the intercrises period with a generic and interdisciplinary perspective, with pre-established coordination between epidemiological monitoring and patient care.
5. To reinforce the coordination of human health research with human and social sciences, and to develop it within animal, environmental, and political science fields.
6. To sensitize the general public to the importance of critical analysis of information sources, their origin and the veracity of statements in order to combat rumors and misinformation.
7. To reassess the role of rumor in its sociological context, remaining attentive to layman's experience and knowledge.
8. To combat misinformation by putting in place community management procedures with links to an official public health website of reference, in order to provide scientific fact-based answers

Key-words: emerging infectious disease, multidisciplinary expertise, national and international public health, national and international leadership, in crisis: mobilisation and action, community participation

1. Introduction

This 6th edition of the Val-de-Grâce School seminar on emerging infectious diseases (EIDs) had the encouraging of interactivity between healthcare agents and public policymakers. Its objective is to set forth leads to better link research to public action in the case of an emerging health crisis, and to connect the development of biomedical practices to the knowledge, practices and perceptions of the populations concerned. The 2017 seminar granted prime importance to interdisciplinary collaboration among experts, researchers and humanitarian agents in the field and issues of communication about EIDs in the face of misinformation.

2. Current trends: presentations and debates

2.1. Inaugural address - Emergence of Ebola virus in West Africa (2013-2016): from health crisis to humanitarian crisis

Speaker: J.-J. Muyembe-Tamfun (University of Kinshasa) Moderator: J.-F. Guégan

Jean-Jacques Muyembe was one of the first researchers to visit the Ebola virus (EBOV) epidemic sites in the Democratic Republic of Congo (DRC), and to have participated in isolating the virus. Even knowing that the Filoviruses circulate in Africa, the Ebola virus disease (EVD) had been found only in Central, East and Southern regions before more recently reaching West Africa. Since 1975 when it was first observed in Zimbabwe, the epidemics remained localized in the forested areas of the Nil and Congo river basins. Since the year 2000, the virus' epidemiology has tended to change, with more recurrent epidemics, geographic dispersion of sites, and new ecological conditions of appearance. Even if the animal origin of the virus has not been clearly identified so far, the infectious sources most often found have been the consumption or the handling of bushmeat, in particular that of bats. Up to now the epidemics in DRC have remained localized and short-lived, controlled through simple public health measures using a community approach.

The virus' emergence in West Africa took place in a different scenario, with the evolution towards a trans-border epidemic. Declared in March 2014, although the first case dated back to December 2013, the epidemic's end was announced by the WHO in March 2016. Certain weak points in the handling of this crisis become evident, and it took the realization of the epidemic situation by national health authorities, for there finally to be organized community sensitization and mobilization. One can only lament the belated reaction of the international community as well, particularly the WHO, in declaring a "public health emergency of international concern". Other institutional failures were also keenly felt, such as an insufficient coordination by the WHO of the various partners involved against EVD, as well as the disregard of international health regulations (IHR) by neighboring countries, who had decided to close their borders.

A certain number of priority actions become clear.

- Improving knowledge among primary care practitioners is a priority to facilitate early detection at the first appearance of symptoms.

- Educating the population with information on potential sources of contamination and inter-human modes of transmission. Research is under way which seeks to identify potential host species among animals, and risk factors such as contact with bushmeat. In addition, sexual transmission, notably via recently cured patients, must not be underestimated.
- The initial care by hospitals also largely contributed to the epidemic's spread, and EVD should henceforth be considered a nosocomial infection which must be controlled through appropriate protective measures and elementary hygiene.
- Funeral rites for infected patients heavily contributed to the development of the epidemic's transmission. Burials must be secured while preserving the dignity of the deceased and his/her loved ones in order for this to be accepted by the community.
- In order to decrease community resistance and to encourage patient adherence to care, it is essential to preserve the individual caregiving and comfort of patients isolated in Ebola treatment centres (ETC). This goes as well for community participation, which is gained through dialogue and negotiation with community members and concerned families.
- On the ground, intervention by scientific and technical teams should be coordinated by a solid health system, and develop through shared, multidisciplinary expertise.
- Research also plays a primary role in the development of specific treatments, such as vaccines, antivirals and other innovative treatments.
- The proximity or mobility of a laboratory equipped with rapid, specific diagnostic testing would help accelerate the triage of suspected EVD patients, which is a key step in confirming diagnosis, but also for urgent differential diagnosis.
- Parallel to this, logistical means should be reinforced to facilitate rapid intervention at the epicenter, often located in remote, difficult-to-access areas. Finally, monitoring of the epidemic and of its resurgence must be maintained through active surveillance of contact and cured patients.

2.2. Interactive session - Interdisciplinary collaboration between experts, researchers and humanitarian workers on the ground in emergence zones

Moderators: P. Bienvault, M. Le Tyrant, F. Bricaire

2.2.1. In the humanitarian field of the "Ebola crisis"

Panel: P. Bienvault (La Croix), F. L'Hériteau (Red Cross – France), E. Barthe de Sainte Fare, (ALIMA), F. Le Marcis (ENS Lyon and LADEC FRE 2002)

La Croix newspaper journalist, Pierre Bienvault, described how the media seized upon the subject of Ebola, in France but also internationally. In France, this has been widely covered with a total of 52 articles printed on this West African epidemic. The topics did not hit the front page until August 2014, that is, five months after epidemic declaration. The precipitating factor which sets in motion an international mobilization response was the alarm raised by Doctors Without Borders (DWB), alone in battling against the epidemic on the ground. The media phenomenon took on an increasing, outsized dimension, once the hypothesis was raised of the risk of the epidemic spreading to Northern countries. The mistaken speculations proffered by the media, riding on the absence of communication notably on the part of French institutions, gave an impression of a snowball effect. Parallel

to this the public authorities in the affected countries firmly controlled the behavior of journalists, to the point of practicing censorship to counter the media frenzy. Faced with this type of health crisis, the media must better grasp and further contribute to an understanding of the socio-cultural context. Nevertheless, the media had a considerable influence on international mobilization, transmitting the alert sent out by DWB, then by the WHO. Certain journalists, in particular in the print press, also raised fundamental questions, scientific and ethical issues concerning patient treatment and collective management of this humanitarian crisis.

François L'Héritau, infectious diseases specialist, shared his experience as a doctor with the French Red Cross (FRC), on mission at the end of 2014 to the ETC in Macenta, Guinea. France's setting up of this ETC in November 2014 was one of the international bolstering measure by DWB and the Guinean government, and FRC operated the mission and around 250 healthcare workers (HCW) were recruited. Most of them were Guinean, and had gained experience of EVD in prior months. Some of the sensitizing agents were also cured Ebola patients, and helped infected patients in their adherence to treatment. The strength of this centre was the opening of a specific P3 laboratory which made possible the early diagnosis of EBOV by PCR as well as differential diagnosis of endemic infections (malaria, typhoid). Logistical means of supply, especially of medications, was insufficient notably due to the absence of regular air traffic connections. Beyond the language barrier, strict biosecurity measures mandatory for HCW considerably limited diagnostic measures for suspect, as well as the care of confirmed patients. The treatment plan essentially consisted in symptomatic treatment and support: massive rehydration, re-establishing electrolyte balance, systemic treatment of co-infections, and nutritional supplementation. Parenteral administration was reserved for those patients for whom oral administration was impossible.

Eric Barthe de Sainte Fare represented the NGO ALIMA, created in 2009 and specialized in operational research. He recalled ALIMA's purpose with policy being to intervene at crisis sites only if they possess operational intervention conditions, and the deployment of appropriate technical means. This policy was put into action late in 2014 with the opening of an ETC in Nzérékoré, Forest Guinea. The physical limitations imposed for healthcare providers in full personal protective equipment did not permit to provide the continual care indicated, nor to apply the therapeutic protocols initially planned, based on monoclonal antibodies (ZMAPP). The development of operational research in the context of public health emergencies requires practical experience of the concerned sites, capacity for quick reflection and decision-making, a grasp of sociocultural, political, medical, logistical and security issues within the crisis context, and finally the evaluation of operational protocols.

Frédéric Le Marcis, professor of Anthropology at the Ecole Nationale Supérieure - Lyon, re-centered the epidemic in the heart of the realities and the numerous tensions, be they historical, social or political. He warned Northern countries against a tripartite amnesia: amnesia of the colonial past, which underlies the present and rests upon an economy of resentment; amnesia of the history of public health next, epitomized by the resemblance between the ETCs and the "sleeping sickness" camps of the early 20th century in Togo and East Africa; last amnesia concerns the knowledge and practices acquired by the population during previous epidemics. These constitute the intellectual framework which cannot be ignored during international intervention anymore. Current preparedness logistics in

Guinea, in the case of EVD, appear on the other hand an utopia. They seek to improve the performance of the ETC model, in finding new auxiliary technologies without sufficiently questioning the effectiveness of the centres whose limitations were nevertheless apparent. International health governance also remains utopian, as long as certain populations do not undertake, or are not invited to take charge of surveillance programs. The author gave a final warning that “technology without technicians” is a dead-end. On the other hand the recent history of Ebola has engendered opportunities around the stakes involved in scientific diplomacy, as with the signature of a protocole between the US and Guinea on managing the samples from cured Ebola patients, or as with the return of the Pasteur Institute to Guinea.

2.2.2. Biomedical expertise in public health emergencies

Panel: H. Noël (French Public Health); I. Leparc-Goffart (French Army Health Services); B. Hoen (Pointe-à-Pitre Teaching Hospital)

Harold Noël, a medical doctor from French Public Health, reported on surveillance measures and public health actions put in place during recent EIDs, in France. National surveillance measures were actively organized to prevent any possibility of EBOV transmission and to protect the population. During this period, an average of six suspect patients per week were recorded, with peak periods during the season of return from holidays of travelers having stayed in West Africa, but also during the period following intensive media coverage of an imported case hospitalized in Texas (in March 2015), then that of a secondary case of a nurse's aid in Spain (October 2014). Two French patients declared an EVD during professional missions in West Africa, and they were repatriated and treated in a dedicated, secured circuit. The risk of transmission on French soil was perfectly controlled, at the cost of a massive public health mobilization effort.

A further illustration is a recent emergence of urogenital schistosomiasis in Corsica in 2013. The reporting of schistosomiasis in subjects never having traveled to endemic areas lead to the localization of the infection's source, the Cavu river in Corsica. Out of 37,000 people screened in 2014, 106 (0.03%) were identified as having been infected, of which two-thirds were asymptomatic. The parasite worm was identified as an hybrid between the human parasite *S. haematobium* and a ruminant parasite *S. bovis* imported directly from Senegal. Although the hypothesis of a parasitic cycle locally maintained in the animal stock was ruled out, the reseeding of the Cavu river must have occurred via infected subjects having slipped through the national screening process.

As a third illustration, the Zika virus worldwide spread exploded in 2015, reaching 70 countries according to WHO, 59 of which reached epidemic status. 770,000 infected cases were reported on the American continent. The French Departments in the Americas (DFA) were also affected, differently but all quite vastly: 35,000 cases in Martinique, 28,000 in Guadeloupe, 9,700 cases in French Guinea in a department with half the population of the two others.

The presentation by Isabelle Leparc-Goffart, director of the National Reference Center (NRC) on Arboviruses in Marseille, underlined the determining role of these centers, and the contribution of high-performance, valid diagnostic tests in the context of emergency. At the time of the Chikungunya virus epidemic (2013) and the Zika virus (2015) in the DFAs, the technical resources available were minimal with only RT-PCR kits. Other lacking resources also posed a problem: blood tests were not accessible to the laboratory network due to a lack

on investment on the part of industry, and the diagnostic tests were not covered by the French National Social Security system.

The chronological comparison of the steps toward test availability shows that the Zika virus epidemic clearly benefitted from the experience and practice acquired during the previous Chikungunya virus epidemic. The procedure for registry of biological tests for National Social Security coverage was accelerated, and mobilization of the industry for developing serological tests was expedited. Coordination with the laboratory network, already well-rehearsed, could be made operational immediately. NRC research also made it possible to improve knowledge of the evolution of the infection by the Zika virus as well as of its means of transmission. Thanks to research on the prior epidemic in New Caledonia, genome detection via RT-PCR in urine could be validated, lengthening the diagnostic window as compared to that of RT-PCR via serum. The NRC also isolated the viral genome in other liquids or biological tissues of infected subjects, i.e. sperm, cerebrospinal fluid, milk, amniotic fluid, placenta, vaginal samples and saliva.

Bruno Hoen, infectious diseases specialist at Pointe-à-Pitre Teaching Hospital, shared with the audience the methodology of projects carried out during these Chikungunya and Zika epidemics. Based on strategies defined by the national consortium REACTing, it was activated from the start of the Chikungunya virus epidemic in the French West Indies announced in December 2013, and had already identified priorities within the first 15 days following the first cases. A month later working groups had been put in place and research projects drafted. One of these concerned the setting up of therapeutic trials in newborns from mothers affected by the virus at the time of delivery. Its objective was to prevent serious forms of the disease in newborns. The research protocol was transmitted to biomedical research evaluation agencies three months after the epidemic's beginning, with a request for an accelerated review process. Authorization was obtained within the next two months, and the project was able to begin in August 2014, just eight months after the beginning of the epidemic in the DFAs. It was unfortunately unable to reach its inclusion goals, as the epidemic had begun to wane at the time of the launching of the protocol.

Another research programme was put in place upon the reporting of the Zika virus epidemic, and the experience of Brazil already oriented researchers toward two axes: one related to pregnant women, the other toward newborns exposed during a pregnancy. The research protocol concerning pregnant women was drawn up within 15 days of the appearance of the first Zika virus cases. Requests for authorization were submitted to review agencies in mid-February 2016 and were granted three weeks later, that is two months after drafting. This was the case as well for the research proposal on newborns of mothers exposed during pregnancy. In this study, 546 women presenting with symptomatic Zika virus infection documented through RT-PCR were monitored from the inclusion date (from March 2016) through their pregnancy¹. A pre-existing cohort (CARBO) concerning the endemic and emergent arboviruses in the DFAs surely facilitated research implementation.

2.3. Interactive session - Communicating on emerging diseases under the strain of misinformation

Panel: G. Dagorn, Les Décodeurs du Monde ("Les Décodeurs", Le Monde daily newspaper); S. Délouvé (Rennes 2 University), D. Heard (French Public Health), A. Lantian (Reims University), J. Ward (Aix-Marseille University)

Moderators: J. Raude, S. Sargueil, P. Zylberman

2.3.1. Educating toward knowledge of sources and critical reception of news

Gary Dagorn works for the newspaper *Le Monde*, in the section “Les Décodeurs”, which commits to fact-checking and hunting down rumors which abound on the net. “Décodex” is founded on a base of six hundred websites, allowing *Le Monde*'s readers to consult original sources, as well as to have access to information and trustworthiness on these sources. The idea is to educate readers with a critical eye, and to fight against fantasized views of journalists and scientists. These two professions face a greater and greater level of mistrust on the part of the population, which is mainly founded upon factors of behavioral psychology. Décodex is an extension, a pop-up window, which opens in all browsers when the reader is consulting a site with an information sourcing method which is recognized as problematic. It makes it possible to classify sites according to a color code depending on the veracity of information. While Décodex has been widely criticized, it nevertheless represents an initiative which makes it possible to confront the real problem of shaping public opinion. It attempts to deal with the root of the problem through education, by informing the reader on the functioning of the media, as well as on journalistic and scientific writing.

2.3.2. Communication on emerging infectious diseases under the strain of misinformation

According to social psychologist Sylvain Délovée, during the 1980s, a paradigm called into question the supposed irrationality of the layman as opposed to the rationality of experts. At the foundation of EID risk perception lies knowledge, familiarity with or a feeling of justice or injustice raised by the disease. This approach underestimates two elements: the history of the disease, and that of the group. Before a multitude of sources of information, individuals are incapable of creating a hierarchy to prioritize the information. An individual will always tend to seek information which confirms his or her own beliefs (confirmation bias); the social status of the person also plays a role, as in the “similarity effect” (one trusts the person who provides the information more than its source). The social position of individuals also conditions the differential manner in which they interpret the disease. Faced with the unknown, we feel compelled to theorize, to create a “naïve” explanation of the object with which we are confronted. Two processes are required to develop a social representation: objectivity and anchoring. When faced with something which we do not know, we will make the abstract concrete, transform a concept into an image in order to produce a figurative core. In work on the ZIKAlliance consortium, it was clearly apparent how the Zika virus was transformed into the image of the mosquito, then into that of microcephalic infants.

2.3.3. The measles epidemic: creating a “community management” tool on French Public Health social media

David Heard, communications director for the French Public Health, reminds us that in 2010-2011 a vast measles epidemic in France caused 15,000 cases, with 16 involving neurological complications, 649 cases of serious pulmonary illness, and 10 deaths. This epidemic was due to insufficient vaccination, in particular in adolescents and young adults. Former INPES as its first act was to carry out a radio communication campaign, targeting in particular mothers of families with children born before 1981, to encourage to consult a doctor.

Many people have called into question the vaccination process on social media. Forums such as <doctissimo.fr> or <aufeminin.com> have taken up the question, and the concept “vaccine

hesitation” was set in motion. Of course there were some people who responded to these questions by encouraging vaccination, but many others spoke of the “danger” of the ROR vaccine (autism), for example. The French Public Health service recruited a community manager, that is, a digital “community” organizer. “Nicolas”, the community manager, has the site <inforougeole.com> where he can respond to anyone posing a question, and encourage them to get informed and to go to the reference site. The community manager introduced himself, measure the degree of self-regulation of a discussion. Once Nicolas arrives on the forum he always introduces himself as “Nicolas from <inforougeole.com>, and attempts to enrich or reframe the discussion. Over a period of six months Nicolas carved out a niche in the midst of these forums to react, argue his point. The goal was not to convince the “anti-vaccinationers”, but to redirect in an effective way those who asked questions. In the case where an answer was not available, the community manager called on the expertise of an infectious disease specialist.

2.3.4. Conspiracy theories

A conspiracy is defined as a more or less reprehensible plot, an action taken collectively, often secretly. A conspiracy refers to an explanation formulated by individuals, accusing an individual or group of having organized a plot which is presented as an alternative to the established version of a given event. Anthony Lantian, lecturer in social psychology at Paris-Nanterre University, studies the beliefs involved in conspiracy theories. Conspiracism should not be reduced to a dichotomy opposing conspiracists and non-conspiracists, but should instead be considered as a graduated characteristic, i.e. ranging from rejection to unconditional latching onto conspiracy theories. The higher the person’s level of education, the less likely he or she will be to believe conspiracy theories. Analytical thinking is also stronger the higher the level of education. A defining trait of conspiracy theorists is mistrust of others, and generally speaking, uncertainty feeds conspiracy theory.

We can also note two types of cognitive bias involved in belief in conspiracy theories: intentional bias, which involves attributing intentions to inanimate objects; and proportion bias, which leads to the idea that an event is of great importance, and that therefore the cause of said event is necessarily proportionally as important. Conspiracy theoretists set themselves forth as “truth seekers”, “free thinkers”, and engage in forms of proselytizing and activism. Simply reading the conspiracy theories around vaccines affects the reader’s intention to have his/her children vaccinated. On the contrary, reading arguments in contradicting conspiracy theories on vaccination helps to reduce the impact of these theories.

To date, means of action are relatively limited. Nevertheless, several leads could pay off, such as focusing on analytical thinking, raising the education level, developing critical thinking, directly deconstructing conspiracy theories and insisting on the scientific value of facts.

2.3.5. Rethinking the concept of the “anti-vaccine movement”: the A-virus flu vaccine

For Jeremy Ward, from Aix-Marseille University, the “Anti-vaccine movement” is a murky concept which covers a range of extremely different positions, notably in the case of the controversy in France around the H1N1 (A-virus) flu vaccine (2009-2010). The anti-vaccine movement is heterogeneous, and it concerns both the arguments used to “demonstrate” that the vaccine was dangerous, and the propensity of those concerned to get involved in a vast array of vaccine-related controversies. A small minority rejects the notion of vaccines in

general, and grasp at every opportunity to criticize vaccination. Most only get involved sporadically in order to defend causes which go far beyond the simple subject of vaccination. Among these, some reject all vaccines, others not. They also limit their criticism to certain vaccines in particular, without attacking the principle of vaccination. J. Ward suggests that in order to better understand how vaccine controversies emerge, and why people dedicate time and resources to disseminating criticism of vaccines, one must use three distinct concepts to designate vaccine critics: “the anti-vaccine movement”, “marginally anti-vaccine movements”, and “movements occasionally critical of certain vaccines”.

2.4. Closing address - Health in cities: from a geographic approach to collaboration between researchers and policymakers

Speaker: G. Salem

Moderator: J.-P. Boutin

In 2016, over 50% of the world’s population lived in cities. Cities are very heterogeneous, and there are also cities within cities. To treat a city from one global approach makes no sense given this vast disparity which leads to inequality and of access to care.

The impact of the urbanization process, both as living space and lifestyle, on non-infectious diseases has produced well-documented trends: a change in eating habits along with a net decrease in physical exercise relative to rural settings, with implications of overweight, and potentially obesity along with its string of related pathologies. There are also risks linked to air and water pollution, industrial risks, noise, accidents with all the known consequences such as disabilities and cancer. In big cities in the South, such as Bangkok or Manaus, new EID risks are currently appearing on the outskirts of cities, in peri-urban zones with concentrations of agriculture and livestock production to feed urban populations. Because it is difficult to obtain a characterization of urban health, it is useful to explore the link between urban dynamics and public health changes, examining the socio-spatial inequalities within cities and disparities in health. In order to understand the public health dynamics within a city, one must understand the links between territorial dynamics and access to health services, and environmental quality. It is thus necessary to develop approaches across sectors within a city, which means working with factors which determine health such as housing, schooling, green spaces. When a decision is taken for a city, one would thus reflect on what consequences such a choice would have for public health. In promoting the concept of ‘Health in all urban policy’, we should therefore better associate research on these themes with policies to aid public health decision-making.

3. Synthesis and proposals

Starting from lessons learned from recent epidemics, from actors in the field and from information specialists, we underline here the processes which might improve global health strategies in the case of new EID events and, secondly, inform worldwide management of EID associated crises.

3.1. Epidemic crisis management

3.1.1. In crisis: mobilisation and action

Deploy the most of response measures favoring local resources. Response measures must be reactive, thanks to the quick deployment of suitable means and measures that will guarantee taking care of patients and fighting the spread of EIDs. Biomedical action should take precedence. Paramount are those public health strategies that have obtained the trust-based acceptance of the community.

✓ *Measure to fight the spread of the epidemic.* Based on epidemiological knowledge provided by national and international operational surveillance systems, these must make possible the detection and rapid communication of the first signals of epidemic. They concern educating the population, and require limiting and securing practices which risk causing contamination. Dialogue and negotiation with affected communities is essential in order for them to understand and fully assume that necessity. Personnel training, particularly of frontline staff, and adequate supply of protective gear aim to reduce as far as possible healthcare-related transmission. Appropriate patient treatment in adapted conditions is a key strategy for limiting the transmission. The development of shared, collective, multidisciplinary expertise, and a system of active surveillance put in place at local, national, and international levels to assist governing bodies are the guarantee of a more just and better-accepted response.

✓ *Organization of healthcare.* To intervene in sites, particularly difficult-to-access and isolated zones, mobile treatment centres supplied with medical equipment and logistical means prepared in advance must be developed. The involvement of local healthcare providers is indispensable, contributing to cultural and linguistic proximity and psycho-social support which facilitate patient adherence to treatment. In order for isolation, with its restriction on individual liberty, to be accepted, treatment procedures must be clear and clearly explained to family members. International, humanitarian and institutional interventions should, for their part, occur on demand to contribute expertise and operational reinforcement to local care teams. The speed of microbiological confirmation is essential in order to treat affected patients, and to correctly direct non infected suspect patients outside the isolation area. For the diagnosis of new agents, new valid tools and more or less complex safety procedures should be developed, then distributed to local laboratories as soon as possible. The pharmaceutical industries producing diagnostic tests need to adapt their production capacity in reaction to the epidemic context.

✓ *The socio-cultural impact of the crisis: encouraging community participation.* The epidemiological and biological response that can foster incomprehension and lead to harmful tension should therefore be accompanied by socio-anthropological approach on site. Yet the intervention of humanitarian workers can be experienced as intrusive; it can be misunderstood, or even rejected, all the more so if the intervention appears to be ineffective. New models of humanitarian intervention should be sought out, and lessons learned from the latest EBOV epidemic confirm this. Community involvement in fighting and preventing EIDs should be considered a strategic issue. Despite the urgency, sensitization campaigns must be adapted to the local cultural context in order to win the population's trust. They should also include community knowledge

and norms related to prevention, which the international disease management plans do not sufficiently take into account generally.

3.1.2. Establishing national and international leaderships

Political management of risk should be re-thought, at the national and international levels. Inter-epidemic periods should be taken advantage of in order to develop a centralized, coordinated, decision-making help system. Leadership at state level is a determining factor in guaranteeing the effectiveness of public health crisis management, while maintaining collective trust.

International governance should also be re-thought². The WHO is expected to reinforce its leadership at the international level and its role as frontrunner in the management of public health emergencies of international scope. WHO's means and authority should be reinforced to oversee the implementation of the IHR by the member-states. WHO's reactivity should be augmented, and the threshold for the official declaration of a "Public Health Emergency of International Concern" lowered, so that mobilization can be organized and international solidarity expressed.

3.1.3. Inter-crisis, post-crisis: preparedness and resilience

Whereas it is difficult to predict EIDs, to anticipate risk of epidemic propagation remains possible, as well as to learn from past crises. The task rests first and foremost on those countries exposed to EID risk, primarily those in the Southern Hemisphere and other tropical regions. A culture of prevention is needed in these countries. Far greater than in the past is the probability that an epidemic could then reach national or even international proportions. Concerning Northern countries, vigilance has been organized already for the last few years in terms of defining procedures for prevention and protection, due to the risk of importation of an epidemic pathogen through globalization.

Controlling transmission risk zones. Whereas the Ebola virus infection had been known to circulate only in forested regions, it showed in West Africa its ability to flare up along vast communication axes, touching high-density cities or zones rich in economic resources. Increasing urbanization and means of communication facilitated the transmission. These demographic and urban developments require a better coordination of these components into public health policies for preventing EIDs. What is more, the demographic and agricultural pressure to which natural habitats are progressively subjected increases the contact between humans and animal reservoirs, which are potential hosts for new pathogens, and require us once again to include these developments in the understanding and management of new public health crises.

Reinforcing capacity for resilience in affected countries. Ebola has weakened systems already made fragile by years of civil war and the persistence of social and territorial healthcare inequalities. Long-term support proves indispensable for consolidating healthcare systems, and international aid has already been committed to addressing this. Additional resources are mobilized in order to develop a response capability to future epidemics in the short and longer term. For countries which are less well-equipped, or less prepared, aid provided by neighboring countries in the sharing of expertise and of highly-specialized structures would make it possible to guarantee a timely and effective reaction. Following a crisis, it is called for to provide psychological support, and rehabilitation measures for patients within their

community in order to avoid people being marginalized due to “stigmatization”. It should be emphasized that rebuilding healthcare systems must not distract attention and money from other public health needs which are permanent factors of vulnerability for these populations.

Promote the preparation of research, development of medications, diagnostic measures, and vaccines. It is expected that research, fundamental but also epidemio-microbio-clinical and in social and human sciences, will contribute urgently to improving knowledge of the pathogen, the disease, the diagnostic and therapeutic means, allowing for determining strategies to fight the epidemic. However, the desired operational research runs up against major obstacles in this instance, notably those connected to the length of time design, development, decision making, and carrying out of research projects take.

A major issue in clinical research is its close connection to epidemiological surveillance and treatment. Advanced preparation, including field personnel and pre-established interdisciplinary collaboration, of generic “prototype” research protocols easily adaptable in case of an alert, has been supported by various international consortiums such as ISARC, or REACTing in France. The preparation of time-consuming steps, e.g. promoter authorization, funding, regulatory and ethics bodies, has considerably progressed over the recent period. This should be maintained in periods in-between crises, in view of accelerated authorization procedures in the case of an alert. Pre-existing generic cohorts are tools for integrating appropriate complementary studies with new questions generated by the epidemic situation. Creating “bio-libraries” and stores of other research data, allowing their remote analysis, is another crucial measure to resolve difficulties. Action plans, allowing collaboration between public and private partners, should be anticipated to facilitate the production and availability of diagnostic tools and of existing or experimental medications, under rigorous conditions for use.

3.2. Information management during an epidemic crisis

International institutions practice may worsen the politico-cultural context of a public health crisis, when it brings out an attitude of rejection on the part of the public. Group representation should be the object of close attention, since erroneous beliefs are likely to extend to the entire population. “Shock” images showing persons suffering from spectacular hemorrhages or infant victims of malformation can reawaken old images and myths fed by past epidemics. News about repatriation to Europe or the US of professionals infected on site spread a sort of panic in the global North. Irrational behavior, such as social distancing or stockpiling medication and/or food, may appear in the population. Social psychology has shown that the unpredictable nature of a threat to health tends to amplify group anxiety in complete disconnection with expert advice.

In such a context, communication is a delicate matter. Its importance is frequently underestimated (by biomedical scientists), but it may also be overstated (by social science scientists). The matter is still little-known³. At the time of the latest epidemics of the Ebola or Zika viruses, certain media relay information they have been given by a source the credibility of which they do not necessarily verify. On the other hand, during an epidemic crisis, data and knowledge are constantly changing. The time lag between media time and the length of time necessary for collecting trustworthy data is a major problem in crisis communication. Under these circumstances, national and international public health authorities must be completely transparent, if one wishes to avoid public reaction blowing up all out of proportion. Unfortunately, the said authorities are not always aware of this need, or they lack the necessary competence to meet it, as evidenced by some misguided statements the Director General of the WHO uttered during the flu pandemic of 2009-2010⁴. The authorities are more and more aware of the fact that rumors on the Internet are likely to disorient the population. They can also shake people trust in measures put in place to combat the disease. Some of these social networks attempt to reestablish the correct messages in responding to critics on social media via community managers. Putting in place warning systems about sources of information and rumors circulating on the net is a welcome attempt to reestablish critical thinking among internet users.

Misinformation can take a more structured and systematic form, in particular when it bases itself in conspiracy theory. This can however be disarmed if the homophily of opinions characteristic of social networks is disrupted by dissident opinions coming from the group, as in West Africa, when upon returning to their community, cured Ebola patients gradually dispelled rumors accusing treatment centers of organ or blood trafficking, through testifying before the group about the good care they had received there. The issue of hunting down the rumors and the conspiracy theories is an important one, because its social consequences can be serious, such as refusing to follow public health recommendations, or even mounting violent opposition to them.

Notes

1. Hoen B, Schaub B, Funk AL, Ardillon V, Boullard M, Cabié A et al. Pregnancy Outcomes after ZIKV Infection in French Territories in the Americas. *New England Journal of Medicine* 378: 985-994; 2018.
2. See *Actualité et dossier en santé publique*, n°98: March 2017.
3. But see Glik DC. Risk Communication for Public Health Emergencies. *The Annual Review of Public Health* 28: 33-54; 2007. doi: 10.1146/annurev.publhealth.28.021406.144123. See also Tabbaa D. Emerging Zoonoses: Responsible Communication with the Media-Lessons Learned and Future Perspectives. *International Journal of Antimicrobial Agents* 36: S80-S83; 2010. doi:10.1016/j.ijantimicag.2010.06.028
4. We refer to the affair of the definition of “pandemic” by the WHO in May 2009. Up until May 4, the WHO site posted this “definition” of flu epidemic as being responsible for “an enormous number of deaths and illnesses”. Later withdrawn, this web page by their general directorship created considerable confusion.

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Speakers:

Jean-Jacques Muyembe-Tamfun (Université de Kinshasa)
Pierre Bienvault (La Croix)
Frédéric Le Marcis (ENS, Lyon)
Eric Barte de Ste Fare (ALIMA)
François L'Héritau (Croix Rouge française)
Bruno Hoen (CHU Pointe-à-Pitre)
Isabelle Leparc-Goffart (Service de Santé des Armées)
Harold Noël (Santé publique France)
G. Dagorn (Les Décodeurs du Monde)
Sylvain Delouée (Université de Rennes 2)
David Heard (Santé publique France)
Anthony Lantian (Université de Reims)
Jeremy Ward (Aix-Marseille Université)
Gérard Salem (Universités de Nanterre et de Berkeley)

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Scientific Committee :

Corinne Alberti (AVIESAN - SP), Henri Bergeron (Sciences Po Paris), Didier Che (Santé publique France), Jean-François Guégan (IRD), Catherine Leport (Université Paris Diderot), Marion Le Tyrant (Doctorante Aix - Marseille Université), Jean-Claude Manuguerra (Institut Pasteur), Paul Martin (ANSES), Jean-Baptiste Meynard (EVDG - SSA), Charles Persoz (AVIESAN - SP), Jocelyn Raude (EHESP, IRD), Sylvie Sargueil (Journaliste indépendante), Gaëtan Texier (EVDG - SSA), Yazdan Yazdanpanah (AVIESAN - I3M), Patrick Zylberman (EHESP)

Contacts : jean-francois.guegan@ird.fr
catherine.leport@univ-paris-diderot.fr
patrick.zylberman@gmail.com

Website address: <http://www.malinfemerg.org>