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Point of view

Multi-sectorial research is paramount for preventing and controlling emerging infectious diseases

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ABSTRACT

The social, economic and political consequences of emerging infectious disease (EID) may escape the sphere in which they first arise. In recent years, many EIDs have revealed the close links between human, animal and plant health, highlighting the need for multi-scale, multisectorial EID management. Human beings play a dual role in EID because they can promote their development through numerous human-environment interfaces and expanding international trade. On the other hand, their ability to analyze, interpret and act on the determinants of EID allows them to access the expertise necessary to control these EIDs. This expertise must be constantly adapted to remain relevant as the EID evolves, particularly in its virulence or transmission channels. Flexibility should become an inherent part of the expertise-based decision-making process even if it means going backwards. A certain degree of transparency and feedback to citizens is necessary for the acceptability of political decisions basing on expertise. A key step in the management of EID is the appropriate management of the early signal of infectious emergence. This step combines multidisciplinary skills allowing access to the best pathway for containing EID by implementing early countermeasures adapted to the situation. New digital technologies could significantly improve this early detection phase. Finally, experts have a fundamental role to play because they are located at the interface between operational actors and decision-makers, which allows multidirectional feedback, ideally in real time, between professional actors and decision makers. To combat current and future EIDs, expertise should be based on a multi-sectorial approach, promotion of collegiality and continuously adaptation to the evolving nature of EIDs.

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R É S U M É

Les conséquences sociales, économiques et politiques des maladies infectieuses émergentes (MIE) peuvent échapper à la sphère dans laquelle elles surviennent initialement. Ces dernières années, de nombreuses MIE ont révélé les liens étroits qui existent entre la santé humaine, animale et végétale soulignant la nécessité d'adopter une gestion multisectorielle et multi-échelles des MIE. L'être humain exerce un double rôle dans les MIE d'une part car il peut favoriser leur développement du fait de nombreuses interactions homme-environnement et des échanges internationaux en pleine expansion. D'autre part sa capacité à analyser, interpréter et agir sur les déterminants des MIE lui permet d'accéder à l'expertise, capacité nécessaire au contrôle de ces MIE. Cette expertise doit s'adapter en permanence pour rester pertinente à mesure que les MIE évoluent, notamment dans leur niveau de virulence ou leurs voies de transmission possibles. La flexibilité devrait faire partie intégrante du processus de prise de décision dans l'expertise, même si cela signifie faire marche arrière. Un certain degré de transparence et

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de retour vers le citoyen est nécessaire à l'acceptabilité de certaines décisions éclairées par l'expertise. Une étape clé dans la gestion des MIE est la prise en charge adaptée du signal précoce d'une MIE. Cette étape combine des compétences pluridisciplinaires et permet au mieux de contenir les MIE en mettant en place des contre-mesures précoces adaptées à la situation. Les nouvelles technologies numériques pourraient améliorer considérablement cette phase de détection précoce. Les experts ont finalement un rôle fondamental car ils sont situés à l'interface entre les acteurs opérationnels et les décideurs, ce qui permet un retour d'information multidirectionnel, idéalement en temps réel, entre acteurs de terrain et décideurs. Pour lutter contre les MIE actuelles et à venir, l'expertise devrait s'appuyer sur une approche transversale entre les disciplines, favoriser la collégialité et s'adapter en permanence à la nature évolutive des MIE.

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1. Introduction

Some recent emerging infectious diseases (EIDs) have demonstrated their capacity for worldwide diffusion and, when others have remained confined to a region of the world, their social, economic and political consequences have sometimes taken on a global dimension [1]. Therefore, considering our inability to predict the next emergence and to contain its possible expansion and collateral effects, a better coordination must be implemented at all levels [2]. The global diffusion of highly resistant bacteria (HRTs) is favoured by large-scale movement of populations either human or animal, as observed for other EIDs such as influenza, but also by agro-food products transport [3]. Some projections suggest that notably highly resistant bacterial (HRB) strains could represent a major cause of global mortality by 2050 [4]. Consequently, the anticipation of emergence and its rapid control become obligations before the emergence reaches an advanced, irreversible and sometimes disastrous stage. The spread of certain EIDs, such as plant diseases and zoonotic infections, now raises fears of very significant international economic consequences and hard-to-control, and sometimes devastating, social consequences [5]. The acceleration of apparition of EIDs over the past 40 years, as a result of globalization, also reveals the strong interconnections that exist between human-, animal-, plant health and their social and ecological environment [6].

2. The place of human in the EIDs: from their origin to an adapted expertise

The place of humankind and human activities in the disease emerging process is fundamental. First of all, human may be responsible for these emerging issues, since EIDs often arise from human-environment interactions via agriculture practices and the agro-food industry for example, but also from population movements, wars, etc. He is also a victim of EIDs, with flagrant disparities between Northern and Southern countries in terms of access to knowledge, health care and expertise, high-tech technologies in a context of diminishing development aid funding. Finally, human is an actor through his capacity to develop research and expertise during an EID outbreak and inter-epidemic periods, namely his ability to understand, analyse, comment on the multifactorial determinants, including human behaviour and social attitudes that favour the development of an EID. All this will contribute to human decisions and actions to limit the consequences of EIDs. However, this expertise can be limited by the lack of precise and validated methodology, or when the involved experts limit their analysis to their own fields of competence without considering other relevant and sometimes key elements outside these fields. These elements, and in particular the notion of collegial expertise and structured-decision making, must be reinforced into the functioning of organisations

and agencies in charge of managing EIDs being institutional, associative, etc. [7].

In addition, the knowledge and experience acquired by experts during the management of EIDs crisis situations must be diffused to citizens for educational and transparency purposes. This is a major issue in order to obtain understanding, adhesion and support for the decisions taken and the resources allocated.

Better interactions between the different sectors of expertise (scientific, clinical, epidemiological, sociological, political, etc.) should also enable the different actors to progress. This transdisciplinary approach of expertise must be developed during inter-crisis periods but also during crisis on a daily basis through knowledge and mutual recognition. One of the objectives of these permanent interactions is to obtain reactive and efficient measures in the event of an alert.

The question of the evolution and the adaptability of expertise during EIDs crises management appears as a cornerstone and calls for the possibility of "going backwards". Indeed, the first decisions are often dictated by the experience of past crises, or based on the use of theoretical models or digital prediction tools, which may then prove to be more or less wrong. Therefore, the chosen options must be flexible, according to the evolution of the situation and the data acquired as the emergence evolves. This is particularly the case in situations of unprecedented emergence or in the event of unexpected changes in the situation (increase in virulence, new recognized transmission route, etc.).

Thus, in terms of health expertise in EIDs situations, it is necessary to avoid dogmatism, be flexible and be able to improvise in order to integrate the immediacy of a situation that has by definition uncertain, unpredictable dynamics and trajectories [8]. Building health management strategies during crisis or disaster situations must be a permanent and iterative process in order to obtain in fine the most relevant handling.

In inter-crisis situations health crisis management simulations (comparable to those developed by airline companies for airliner captains) could be useful to evaluate the behaviour of the different actors in response to the required preventive or therapeutic measures during a simulated crisis situation.

3. Management of the early emergence signal

The initial detection of an EID is often based on "clinical" aspects through the detection of suspected symptoms in human, animal or plant cases, with the causative agent secondarily confirmed in reference laboratories (less than 7 weeks in the case of SARS-Cov for instance). One of the limits of this scientific practise is that the detection of an emerging pathogen is directly correlated with the interest in its detection, which leads to the concept of "knowledge emergence". This approach has indeed shown its limitations in animal and plant health. Several examples in recent years have shown that the emerging infectious agent (or

its vector/host) has sometimes been established for a long time in a given region without any consequences being detected [9,10]. Another attitude, that still seems to be neglected, would consist in seeking, before the appearance of symptoms in populations, an asymptomatic carrier susceptible to trigger an EID. This ultra-early screening could be a tempting approach because it could potentially reduce the time between the period of “invisible” presence of an emerging pathogen and its recognition as an EID. However, this approach could be costly and ineffective in situations where a pathogen circulates for a long period of time without any significant consequences.

In all situations, microbiological diagnosis is crucial from the very beginning to confirm the clinical suspicion of EID, despite the costly technical resources and logistical difficulties involved. An essential element is then the ability of Reference Centres and any other organizations capable of issuing an alert to communicate quickly and effectively the signal of the emergence using pre-established channels [11]. The organisations responsible for implementing the response to this EID will thus be able to activate the necessary management measures. Those measures should take into account both existing references and newly acquired data at this stage of development of the emergence (dissemination mode, incubation time, necessary therapeutic resources, etc.) to try to control the dissemination of the EID during this early phase.

It seems that expertise in plant and animal health is built differently from that in human health, where the ultimate objective is to preserve the health and life of individuals. Nevertheless, some organizational aspects derived from expertise as practiced in animal and plant health could be transferable to human health expertise [6,12]. For example, in Europe the expertise and management in plant health often take place at the European community regional level, and are secondarily implanted at the national level. Animal and human health coordination and management appear to be less active, or less visible, at the European scale, even if it exists now for human health a European Centre for Disease Prevention and Control created in 2005 and located at Stockholm, Sweden.

It is important to stress that new technologies, particularly digitalized ones, can facilitate the diffusion of different signals during EIDs through the rapid transmission of information (e.g. social networks and influenza epidemics). Finally, big data analysis can also allow the detection of indirect (“surrogate marker” or “proxy”) or weak signals through massive and rapid data processing as generally done in environmental sciences. These new methods could revolutionize the detection of future EIDs (see Graham et al., 2019 [13] for a recent illustration). However, it seems necessary to integrate anthropological, sociological and economical elements into massive data analyses in order to make them more in line with the reality of emerging issues and thus more relevant. The use of massive data from digital technologies has already been implemented in the field with strategies based on mobile phone geolocation data during the Ebola virus crisis, which have enabled vaccination campaigns to be optimized, for example.

4. The expert at the interface between actors and decision-makers

The experts should be located at the interface between the field actors on the one hand, whose concrete vision must be integrated into the expertise, and the political decision-makers who coordinate the response basing on the recommendations formulated by the experts, and decide on the resources to be allocated to it.

The observations and realities faced by actors in the field may be different from those perceived by decision-makers, and vice versa. These differences can result in misunderstanding and

operational dysfunctions. They can also allow reinforcing complementary interactions. A real-time feedback from operational actors to decision-makers via experts is necessary to increase the efficiency of the response. Indeed this feedback enables to modulate certain recommendations and thus better adapt political decision-making. The feedback from political decision-makers to operational actors seems also important to take into account in the fight against EIDs so that operational actors understand the measures taken by decision-makers, which are sometimes compelling and difficult to implement the field.

When an EID is reaching even slightly national borders, as was the case with Ebola virus disease, the political response is most often to focus the operational response on the own national territory rather than on where the phenomenon emerges. Today, expertise must take into account this new situation, where the perception of seriousness of the illness by decision-makers can sometimes be strongly influenced and sometimes guided by the public's perception of it.

One of the experts' missions is to offer decision-makers all the available knowledge and recommendations for crisis management options integrating several scenarios. Significant progress remains to be made in many countries in terms of health crisis management preparedness, if we consider what is currently being practiced in animal or plant health, or internationally.

In addition, it is important to keep a critical eye on health expertise and the proposals that emanate from it. Indeed the contribution of new data, new methods or new approaches in a new expertise can lead to deep changes with previous orientations and decisions. This temporality of expertise, which is one of its inherent limitations, raises the problem of the gap between the progressive and evolutionary scientific approach during the EID and the necessarily more immediate political decision. More generally, better explaining the progressive and iterative aspects of the scientific and medical approaches to the general population can be considered as a current challenge.

The question of the transmission of expertise from North to South is an additional element to be better considered. A shared expertise that would better integrate teams from the South and the North seems to be a next logical step in the management of EIDs. By considering the cultural diversity from the outset and simplifying the approach, this translation of expertise to the South could lead to more fluidity, efficiency, relevance and adequacy of the means implemented and the decisions taken towards local populations. Indeed, the perception and integration of cultural elements into the very early phase of managing an emergence, such as the Ebola virus, may have posed difficulties in deploying diagnostic and care devices in the field. Thus, the use of local channels and organizations familiar with the specificities of the concerned region and population seems essential to promote the proper functioning of local interventions and subsequent control measures.

5. Priority proposals

From this synthesis seven priority proposals can be outlined as follows:

- encourage better transversality and intersectoriality between sectors – plant, animal, human – in health expertise, and promote collegial expertise with learning methods and self-questioning as new information and data become available;
- consider the international consequences of EIDs and adjust the mesh of the organization, management and expertise with a multiscale approach: from the local to the global level by avoiding the lack of structuring at certain levels;

- evaluate and strengthen the watch and monitoring systems in the South where EIDs first develop;
- in many countries, better articulate the evaluation of the risk of EIDs and the management of the EIDs crisis favouring interactivity and exchanges between the various implied sectors;
- integrate the data issued from new digital tools in the EIDs monitoring systems and as part of the anticipation scenarios taking into account necessary and complementary socio-economic and political aspects;
- implement, after each situation of EIDs crisis management, a systematic transparent multidisciplinary review of the implied actors, taken decisions and allocated resources;
- consider a higher level of adaptability of political decisions to data from the field of emergence. This could be favoured through a dynamic process of expertise based on multidirectional interactions between professional actors and decision makers.

6. Conclusion

Taking into account the globalized aspect of EIDs and their consequences, the health expertise in EIDs should be based on better transversality between disciplines before, during and after the crisis. A constant adaptation of the expertise to the evolving nature of EIDs, through real-time self-questioning, feedback from the field and integration of the big data signals, could lead to propose better options to the political decision makers and better control of EIDs in the future.

Disclosure of interest

The authors declare that they have no competing interest.

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