TECHNICAL REPORT

Towards One Health preparedness

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Expert consultation 11–12 December 2017

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Abbreviations

AMR	Antimicrobial resistance
EPIS	Epidemic Intelligence Information System
EU	European Union
EWRS	Early Warning and Response System
FAO	Food and Agriculture Organization
FWD	Food- and waterborne disease
IHR	International Health Regulations
MERS-CoV	Middle East Respiratory Syndrome
MLVA	Multiple-locus variable number tandem repeat analysis
OIE	Office International des Epizooties
RASFF	Rapid Alert System for Food and Feed
TBE	Tick-borne encephalitis
WGS	Whole genome sequencing
WHO	World Health Organization

Introduction

Climate change, increasing population densities, and intensified globalisation in trade, travel and migration are among the most important factors shaping the 21st century. Each impacts upon population health and the risk of infectious disease [1], particularly those originating at the human-animal-environmental interface. The recognition that many risk drivers of infectious disease fall outside of the typical domain of the health sector creates the challenge of identifying and pursuing priorities for cross-sectoral action aimed at strengthening global health security. In response, the One Health [2] concept has emerged, as have related initiatives addressing Planetary Health [3] and Biodiversity and Human Health [4].

From a public health perspective and operationally speaking, the One Health approach offers great potential, emphasising as it does cooperation and coordination between multiple sectors. Yet despite having been a focal point for discussion for over a decade, numerous challenges facing the implementation of One Health preparedness strategies remain. While some are technical, related to the requirement for innovative early warning systems or new vaccines, for example, others are institutional and cultural in nature, given the transdisciplinary nature of the topic. There have thus been calls to address One Health from multiple perspectives, from ecology to the social sciences [5,6].

In order to further explore this issue and to identify priority areas for action for strengthening One Health preparedness in Europe, ECDC convened an expert consultation on 11–12 December 2017. The consultation consisted of both plenary and parallel group work sessions. The latter focused in particular on addressing three key questions:

- Based on the key risk drivers and disease threats facing Europe, what sectors and disciplines should be prioritised for collaboration?
- What can be learned from the public health response to past zoonotic disease outbreaks?
- How can intersectoral preparedness strategies best be implemented in a One Health context (i.e. what operational and research priorities exist in Europe for implementing One Health preparedness)?

This report summarises the key conclusions from this consultation, structured around the questions noted above. Although some references are included, the text is predominantly based upon the oral discussion and the group work presentations. Following Chatham House Rules, statements are not attributed to individuals. Final recommendations to ECDC from this consultation will be considered by ECDC for inclusion into subsequent annual work plans in consultation with the European Commission, EFSA, WHO, the ECDC Advisory Forum, the ECDC Coordinating Competent Bodies and the ECDC Management Board.

Preparedness and One Health in context

Preparedness

Health experts and communities alike acknowledge the globally interconnected nature of communicable disease risks. Vulnerabilities in one part of the world can contribute to outbreaks in other parts of the world. The majority of emerging infectious disease risks originate at the human–animal–environment interface.

Preparedness can be defined as 'the knowledge and capacities developed by governments, response and recovery organizations, communities, and individuals to effectively anticipate, respond to, and recover from the impacts of likely, imminent or current disasters [7]'. Epidemics and pandemics constitute an important category of disasters.

The International Health Regulations (IHR 2005) define core capacities that countries should develop and maintain to strengthen global health security. Notably, international, regional and national entities have made efforts to enhance the contribution from the veterinary sector in IHR (2005) implementation [8]. Meanwhile, joint external evaluations are part of a voluntary, collaborative and a multisectoral process to assess country capacities to prevent, detect and rapidly respond to public health risks [9]. The Joint External Evaluation tool contains a specific set of indicators for zoonotic disease, antimicrobial resistance (AMR) and food safety, as well as for core capacities such as surveillance, emergency preparedness, and emergency response operations [10].

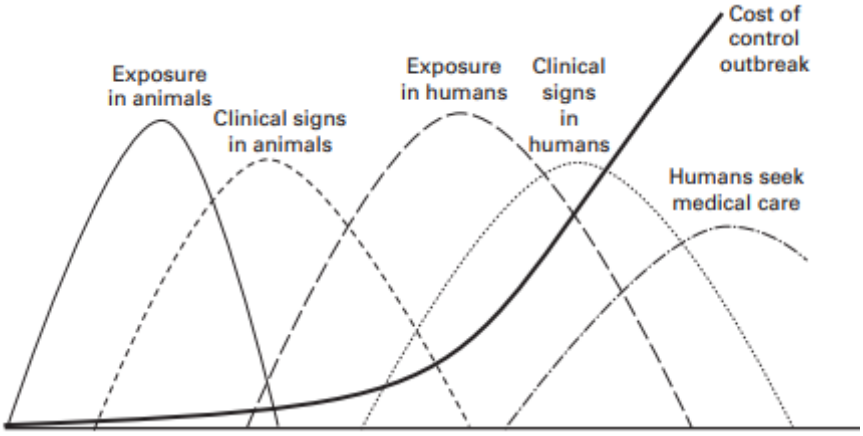
Under the EU Framework on Health Security, the European Commission works with EU Member States to enhance preparedness and response planning for serious cross-border threats to health, aiming also to implement the IHR (2005). Decision 1082/2013/EU [11] addresses serious cross-border threats to health in the EU. This Decision addresses surveillance, early warning and response, and preparedness and response planning, emphasising consultation and coordination between the Commission and Member States. Also relevant in the EU is Decision 1313/2013/EU [12] on a Union Civil Protection Mechanism, which aims to ensure a high level of protection against disasters, to enhance preparedness at Member State and Union levels, to facilitate rapid and efficient response in the event of disasters or imminent disasters, and to increase public awareness and preparedness for disasters.

One Health

One Health is a concept that has emerged from collaboration between the human health and veterinarian/food sciences sector and has developed to gradually include additional branches of science, notably the environmental sciences and social sciences. It is a constantly evolving concept and shares many similarities with emerging concepts such as Planetary Health.

Defined by the Wildlife Conservation Society in the Manhattan Principles (2004) as the 'One World One Health' paradigm [13], the One Health approach to global health security recommends a holistic view of the interface between human, animal and ecosystem health domains. One Health promotes an international, interdisciplinary, intersectoral perspective to disease emergence and control. A One Health approach can be used in designing and implementing programmes, policies, legislation and research where multiple sectors collaborate to achieve better public health outcomes. One clear advantage of implementing a One Health strategy is highlighted by the cost-effectiveness of early detection in animals, thus reducing the impact on human lives (Figure 1) and adding genuine value.

Figure 1. Relationship between time of detection of emerging zoonotic disease and total cost of outbreak.



Source: World Bank [14]

WHO describes One Health as 'an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes' [15], highlighting zoonotic disease, food safety, and antibiotic resistance as three particularly relevant areas.

Within Europe, the One Health aspects in the EU Health Security framework are legally grounded with Decision 1082/2013/EU [16]. Currently, key areas of focus include animal health and food safety, preparedness and response to zoonotic threats, and AMR. The European Commission adopted the European One Health Action Plan against AMR in 2017 [17]. The European Commission also supports simulation exercises and workshops, and promotes activities to improve coordination between sectors.

Future goals to enhance One Health within the EU include strengthened collaboration across public health and animal health sectors; improved use of the Early Warning and Response System (EWRS) and interlinking with other EU-level alert and information systems; proposal for new EU regulations on veterinary medicines and medicated feed; and a focus on research supported by the EU Framework Programme for Research and Innovation, Horizon 2020.

The One Health European Joint Programme (EJP) is a new initiative as part of Horizon 2020, involving 41 partners across 19 countries [18]. The EJP is designed to improve integration from different fields to address complex challenges with an end objective to generate a long-term partnering within research. The programme is also constructed to be policy-driven, generate extensive interaction between peers in Europe, and serve as incentive for collaboration across sectors within Member States. Priority domains for the first call include food-borne zoonoses, AMR and emerging threats.

Relatedly, the European Commission has published an Action Plan on the Sendai Framework for Disaster Risk Reduction 2015–2030 [19], the European Environment Agency has considered disaster risk reduction in the context of climate change [20], and the Disaster Risk Management Centre of the European Commission has published a report on Science for Disaster Risk Management, with one section specifically focusing on epidemics [21].

Key discussion points

Risk drivers and emerging threats

What sectors should the health sector collaborate with to optimise One Health preparedness strategies and better understand emerging risks?

Experts at this consultation considered the key risk drivers and emerging disease threats coming from the human–animal–environment interface. Today, approximately 60% of all human diseases have origins in animals [22,23]. The increasing human population and the related increased demand for animal protein, exacerbates the use of antibiotics in both humans and animals and, thereby, drives the risk of exponential rise of AMR.

Climate change is an important driver of zoonotic disease emergence and spread. Temperature, precipitation and seasonal cycles all influence distribution and migration patterns of plants and animals, and with great variability [24]. A recent systematic assessment of the current literature [25] revealed that climate change is an increasing threat to human health, food security, and food safety, in part through its effects on vector-borne diseases. As much as 63% of human and domestic animal pathogens are climate-sensitive, and 82% of emerging diseases are driven by climatic characteristics such as rainfall and temperature. Climate affects myriad aspects of disease transmission pathways [26]. Zoonoses appear to be particularly climate sensitive, influenced by multiple climate drivers, and associated with specific transmission routes (vector-, food-, waterborne). Participants highlighted as the most relevant threats driven by climate change in Europe: tick-borne diseases (Lyme disease and tick-borne encephalitis) and mosquito-borne diseases (including dengue, chikungunya, Zika, West Nile virus).

In a recent call for action on climate change [27], the need to develop policies on preparedness, initiate public health programmes for immediate risk response, and identify research gaps was highlighted as crucial. In addition, challenges such as unused political frameworks and unfavourable human attitudes must be addressed.

Following plenary presentations, four parallel working groups independently conferred and identified disease threats, relevant drivers, as well as sectors that should be involved in the implementation of a One Health agenda.

With an eye to identifying priority sectors for enhanced collaboration, expert participants recognised the following key sets of risk drivers, which correlate quite closely with the published literature [28,29]:

- Human population movements/displacements, including travel, tourism, mass gatherings and migration. Human behaviour also affects the risk for disease spread.
- Animal-dependent drivers arise from livestock via the farming industry, movement and/or trade of livestock, pets and wildlife, and food production imports and exports.
- Environmental drivers include climate change, urban planning and land use, pollution, and biodiversity promoting activities such reforestation, recreation of wetlands, and rewilding.
- Social factors such as inequality, political instability as well as loopholes or breakdowns in human-driven control processes (e.g. disease surveillance) also constitute drivers for disease threats. Cultural factors dictate beliefs about vaccine efficacy, access to antibiotics, or developments in human health delivery (e.g. web/app doctors), which alter potential disease risks.

Disease threats

The most prominent disease threats related to the One Health concept highlighted by participants included emerging disease vectors (zoonotic and human origin), AMR, and bioterrorism. Zoonoses such as Ebola, Zika, and avian influenza, leishmaniasis, West Nile virus, brucellosis, tularaemia, monkey pox, influenza, rabies, hantavirus were all highlighted.

Based on significant risk drivers and disease threats, experts identified the sectors and/or disciplines that should be prioritised for intensified collaboration with public health. These included:

- Veterinarian services
- Wildlife (e.g. entomologists)
- Transport
- Trade
- Media and communication
- Biosecurity
- Pharmaceutical
- Law enforcement, police, border control
- Environment (geological survey, land planning/development)
- Civil society (volunteers, citizen scientists)

- Risk management (insurance industries)
- Legislation (government, policy, NGOs)

During the discussion, experts also highlighted the need for cross-disciplinary research, particularly in relation to modelling research (involving big data and potentially artificial intelligence for compiling and analysing disparate datasets) and historical research because historical perspectives, they said, were essential for fully understanding the long-term impact of changes in infectious disease drivers.

What can be learned from past zoonotic disease outbreaks?

Many barriers exist to implementing the One Health concept. As participants noted, due to the interdisciplinary nature of the One Health concept, each sector views One Health through its own lens. A lack of common understanding can impair the implementation of the One Health agenda due to different priorities in different sectors. Structural barriers within the political landscape, including the lack of a cohesive governmental framework, different strengths between national and local levels, varying hierarchy of ministries, funding barriers, and perceived absence of concrete evidence of the added value of the One Health approach all contribute to conceptual challenges. Moreover, diseases affect humans and animals differently, which influences strategies, policies, and the timeframe for response. This makes it necessary to account for multiple perspectives, ranging from human and animal health to ecology and social sciences [30].

The experts discussed key factors that impair the development of One Health preparedness strategies in several plenary presentations on zoonotic disease outbreaks: Ebola, MERS-CoV, *Salmonella* enteriditis, West Nile virus, malaria, and influenza A(H1N1) (see chapter on 'Zoonotic case studies').

Working groups identified and discussed topics that emerged from the case studies. The four working groups independently identified the following topics as barriers to the implementation of a One Health agenda:

- **Communication/coordination** was identified as a major barrier for One Health implementation by all working groups. Without effective communication channels across sectors, the potential for response is limited. Moreover, the reporting of outbreaks is often culturally and politically charged, due to factors such as the lack of clear compensation schemes or stigmatisation. Communication mechanisms and frameworks should therefore be established during non-emergency periods, and always with a focus on One Health aspects. The following aspects are in particular need of improvement:
  - **Surveillance and early warning systems across sectors.** A mechanism for joint situational awareness is urgently needed, as is a platform to share early signals with a low threshold of interaction. Identification of an appropriate system is necessary so that all sectors (e.g. public health and animal health) are alerted with impending threats.
  - **Coordinated response plans.** Mechanisms are needed to harmonise diagnostic laboratory tests and to clarify roles during outbreaks.
  - **Joint public outreach and education.** There is a lack of awareness at the community level; the communication of scientific findings to scientific community and general population is difficult. Use of social media should be examined.
  - **Identification of cross-sector contact points.** Roles, responsibilities, and contact points, while clear for some sectors, are unclear for others (environmental).
- **Data/sample sharing** was also identified by all groups to be a barrier to One Health. National and regional sharing of biological samples between agencies is problematic and reflects a lack of in-country capacity and coordination between sectors. Suggestions for improvement are as follows:
  - **A joint database for data sharing.** Current interoperability of datasets between human and animal sectors requires amelioration for optimal One Health application.
  - **Protocols and frameworks for sample sharing.** Sample ownership issues and feelings of autonomy undermine sharing. Alternatives (sharing DNA, not samples) raise questions of trust in methodology across sectors and country borders. The Nagoya protocol [31] and PIP framework [32] provide frameworks for collaborative sample sharing.
  - **Improved testing procedures.** Data quality issues arise when not all countries are testing for a given pathogen. Solution is to find funding for testing systems.
- **Capacity building:** all working groups said that gaps in capacities were detrimental to One Health implementation. Since outbreaks must be fought where they occur, the general lack of local capacity could be overcome by investing in the following:
  - **Local human resources** who cover risk assessment, laboratory skills, diagnostics, vaccine purchases.
  - **Reference laboratories.** For sites where capacities are low or unavailable, a reference laboratory network is essential.

- **Risk perception** was recognised to play a role in the impairment of One Health. The level of acceptable risk differs between public health (precautionary) and animal health (less stringent). There is a need for improved communication and agreement on the level of acceptable risk. An examination of the following could improve the current status:
  - **Recognition of cultural tendencies.** Different countries may employ different strategies to tackle infectious diseases (e.g. influenza vaccination of the public in Scandinavia). Acknowledgement of these cultural tendencies and open discussions across borders should be encouraged.
  - **Overlap of prediction modelling.** Lack of collaboration in the area of prediction modelling for risk assessment across different sectors (i.e. meteorological sector).
- **Other barriers** were identified to play a role in hindering One Health implementation. In addition to major themes, working groups identified the following factors:
  - **Financial responsibility** and funding challenges arise at all levels, and can be exacerbated by industry influence or animal rights issues (i.e. if animal vaccinations are needed for human health, who funds it?)
  - **Intellectual property** issues for technology or vaccine development requires examination and clarification.
  - **Career constraints** in the academic system can affect collaboration activities. Scientific staff is not necessarily rewarded for publishing in cross-disciplinary journals or collaborating across sectors; funding streams tend to be restricted to one sector.
  - **Leadership issues** impact interpretation and consistency to act upon early signals.

Proposed solutions to these cross-cutting barriers to One Health implementation could include more direct funding (sample testing, vaccine development), a timely exchange of samples, and a focus on horizontal preparedness. Moreover, collaboration across sectors that will ultimately lead to disease prevention will give added value to these efforts.

Zoonotic case studies

Disease outbreak response provides examples of how One Health has been approached by expert teams in different contexts.

Box 1. Ebola

By Kathryn H. Jacobsen, George Mason University

The response to the Ebola outbreak in 2014 in Sierra Leone highlights the significance of a One Health approach to urgent disease threats in low-income areas. A call to action published in The Lancet just one week before the first Ebola case was reported from that country underscored four critical gaps, including the need for 1) improved access to diagnostics in order to track disease, 2) strengthened disease surveillance (including the use of social media) and data sharing so that the cases can be identified and mapped, 3) a stronger health workforce, including more healthcare providers and reliable access to essential supplies, and 4) better communication between government officials, health professionals, and community members to build trust and minimise misinformation.

Following the outbreak, an after-action analysis was performed and published by an interdisciplinary team. Three priority areas were proposed for improved response: early warning systems that use predictive modelling to integrate data from human, veterinary, wildlife, and ecological sectors; strengthened local and national public health systems that are equipped to deploy effective risk communication strategies; and improved translational medicine practices.

In low-income countries, efforts to build local preparedness and response capacity often are impeded by insufficient resources. There is a critical need for additional financing and support for One Health programmes in low-resource settings. Sustainability will be a challenge, but local leaders, advisory boards, universities, and additional partners can work with the medical, public health, veterinary, agricultural, and other sectors to support research, training, and implementation activities.

Box 2. Middle East respiratory syndrome

By Bart Haagmans, Erasmus Medical Centre

The incidence of MERS-CoV in Saudi Arabia and Qatar highlights the need for a One Health approach, given the role of animal reservoirs in human disease transmission. Middle East respiratory syndrome (MERS-CoV) is a coronavirus that causes cough, fever, and renal dysfunction in humans. The first human cases were detected in Saudi Arabia in 2012. Upon development of serological assays, dromedary camels were tested positive and subsequently identified as the primary reservoir for MERS. Camels infected with MERS-CoV do not exhibit signs of disease.

Work to identify and detect MERS-CoV was a collaboration between the Qatar Ministry of Health, WHO and Erasmus Medical Centre (surveillance function). This collaboration increased the knowledge of MERS-CoV, further defined incidence and transmission, and enhanced awareness from a One Health perspective with FAO and OIE. Despite the fact that MERS is geographically limited, challenges in One Health preparedness include insufficient support from the animal health sector, limited cooperation from governments, lack of universal reporting of MERS-CoV across countries, incomplete understanding of transmission behaviours in camels and humans, insufficient screening of animal exports/imports, and the lack of coordination when submitting samples to testing facilities.

Testing of MERS and other coronaviruses has been discussed at WHO. A laboratory network is needed so new viruses can be identified quickly. Shipping limitations should be addressed so that samples can be shipped domestically and internationally. Vaccine candidates are under development by several biotech companies, and initiatives (CEPI) have publicised a call for vaccine development proposals. However, questions arise regarding the practicality and cost-efficacy of a vaccine to protect humans versus a vaccine that reduces the transmission of MERS-CoV from dromedaries to humans.

Box 3. *Salmonella* Enteriditis

By Ettore Severi, ECDC

Salmonella Enteriditis is the most common *Salmonella* serotype reported in Europe. In order to tackle the burden from this pathogen, a One Health approach would be beneficial. *Salmonella* incidence in the EU has steadily decreased since regulations were implemented under the EU General Food Law in 2002, but the number of reported cases has remained at the same level since 2010.

In response to an outbreak alert in 2016, ECDC formed an outbreak investigation team. With a One Health approach, human, food, environment, and veterinary sectors performed collaborative investigations that identified the source as three egg packing centres and 52 laying hen farms. At the country level, analytical testing (MLVA and WGS) on food isolates, national trace-back investigations, and veterinary inspections were carried out. ECDC offered WGS services to those countries not performing sequencing routinely. The Commission, in collaboration with EFSA, collected information in RASFF to trace the point of contamination. The European reference laboratory for *Salmonella* provided sequencing services for non-human isolates and the Directorate-General for Health and Food Safety (G4) was in charge of risk management at the EU level. More than 97 000 000 eggs were recalled in Europe, and the Polish competent authority implemented restrictive measures on 20 October 2016 to further reduce the distribution of contaminated eggs.

After a peak in September 2016, outbreak cases have strongly decreased, although new cases were still reported in the following months, particularly in summer 2017, indicating the persistence of the outbreak strain in the food chain. Although molecular surveillance provides strong evidence to identify and delineate molecular clusters, reporting across countries was not homogenous due to different national capacities; the highly specific outbreak case definition suggests an underestimation of cases. Strengthening One Health preparedness with foodborne diseases in the EU is essential to prevent resurgence. Efforts should be geared toward improving intersectoral collaboration at local, national and EU levels. Equally important is improved reporting in EPIS FWD, EWRS, and RASFF. The use of MLVA and WGS as analytic tools should continue as these techniques are becoming essential in outbreak investigations. Setting up a European reference laboratory for *Salmonella* in the human sector, as already established for the food and animal sector, should be considered.

Box 4. West Nile virus

By Johanna Young, ECDC

The repeated emergence of West Nile virus in Europe and the disease's ability to spread to new geographical areas raises the need for improved surveillance and enhanced interaction with the veterinary sector. West Nile Fever (WNF) is a mosquito-borne zoonotic viral disease with birds as a reservoir; it infects humans and horses. The virus is transmitted by mosquitos and is also transmissible between humans through blood products. While the majority of cases are asymptomatic, the elderly and immunocompromised are at particular risk of illness. WNF is a notifiable disease at the EU level. Surveillance is implemented for humans (TESSy) and animals (Animal Disease Notification System).

To ensure blood transfusion and organ transplant safety, the question of whether, how and when detection in animals could act as a trigger for a public health response is a relevant One Health matter. Challenges arise with incomplete and inconsistent reporting in the Member States and issues of asymptomatic cases in humans and horses that go unreported. Any interpretation of risk should be done with caution because reporting maps reflect presence, but do not confirm absence.

Since 2011, ECDC has been publishing weekly epidemiological updates. Since 2017, updates also include real-time data on WNF in horses (through collaboration with the Directorate-General for Health and Food Safety and EFSA). Comprehensive sero-prevalence studies across species are required to use horse surveillance as a complementary trigger for blood safety measures.

Following a One Health approach, WNF maps could help raise awareness among experts for public and veterinary health and lead to enhanced surveillance. To gain a full understanding of prevalence, future preparedness planning for WNF based on a One Health approach should include combined surveillance systems (humans, horses, mosquitos, and birds).

Box 5. Community engagement

By Daniel de Vries, University of Amsterdam

Community engagement plans in Haiti and pilot interventions in Uganda illustrate how a One Health strategy can provide the flexibility needed to implement community engagement strategies. Community engagement is a dynamic, adaptive process, based on general principles. Because communities already have their own histories, cultures, practical expertise and priorities, imposing rigid, preconceived health strategies to address complex socially determined issues may fail to broadly engage local support. Experience from malaria eradication planning in Haiti shows community prioritisation of sanitation (environmental health) over direct malaria interventions.

The mainstreaming of malaria eradication into sanitation strategies illustrate how a One Health approach enables the flexibility to shift gears between environmental, animal or human framing of health priorities to obtain community support. A pilot intervention in Uganda (part of the CoHeRe study) together with Makerere University shows that community engagement may even emerge when goals are left completely unspecified, if an external party takes time to care, listen, and be interested in the needs, stories and wishes of community actors. In this pilot project, villagers from the small trading centre of Dekabusa initiated the building of a latrine after anthropology students merely listened to their stories. This community initiative emerged without external support and motivated by community priorities, yet achieved a health goal that falls within the One Health domain.

Finally, ongoing studies of community engagement in zoonotic outbreak events in the Netherlands and Spain point at the importance of attention to intersectoral collaboration between different communities of practice. Preliminary findings show that at the governance level, the One Health approach offers a strategy able to build mutual understanding of intersectoral linkages and trust building, which is necessary for a quick response to complex zoonotic outbreak events. In all cases, community engagement here follows the 'whole community' notion that does not define a community as a fixed entity, but rather a dynamic one that changes and adapts with variations in environmental, social and political factors. One Health facilitates this dynamic conceptualisation of community engagement.

Box 6. Translating knowledge into policy

By Erik Baekkeskov, University of Melbourne

The translation of expertise into public policy remains a challenge across all public health fields. Outbreak case studies provide examples of One Health implementation in the field and emphasise One Health relevance at the community level. However, from a broad perspective, translating knowledge and collaboration efforts into public policy should be an overarching goal. Policymaking is greatly affected by silo thinking, i.e. the physical and political borders between countries as well as the perceived boundaries between sectors or disciplines. Breaking down divisions requires pooling resources and knowledge so that the actions of one country or agency do not undermine the work of the others. Biomedical experts and networks serve as a credible science-based knowledge source with the ability to influence policy.

An example of how fundamental ideas by experts can shape policies but can differ between silos is evident from the pandemic H1N1 influenza outbreak in 2009. A comparison of vaccination availability in Sweden – which acquired a stock for the entire population – versus Denmark – which obtained a stock sufficient for risk groups only – highlights that different assumptions equal different policies. Sweden's decision was taken from a business continuity standpoint to minimise sick leave, while the Danish focused on saving lives. Facing the same event, the Netherlands changed its policy following expert advice, and adjusted vaccination measures from general population to risk-group focused.

To overcome barriers between silos and divisions going forward, expert groups should be acknowledged as key resources and counselled on national public health decisions. These groups should engage in science-based debates with other sectors and across borders, in order to clarify and share the fundamental assumptions that shape preparedness and response measures. While policy-makers desire rapid expert advice during outbreaks, peacetime provides an ideal opportunity for ECDC, WHO, and professional networks to engage experts in such transboundary discussions about critical preparedness and response assumptions, with a goal of more effective, compatible, and complementary actions during crises.

Recommendations on strengthening One Health preparedness

Recommendations for ECDC

The consultation led to specific recommendations for action to be taken by ECDC. These recommendations will be further explored by ECDC for their feasibility and relevance to the ECDC mandate, but can only be considered for the ECDC annual work plans after consultations with the European Commission, the ECDC Advisory Forum, the ECDC management board, the ECDC Coordinating Competent Bodies and ECDC's partners, including WHO and EFSA.

An overall consensus from the expert consultation is that ECDC should continue to function as a hub for information exchange, ranging from the coordination of surveillance data to the management of response activities. To strengthen ECDC's role in supporting a One Health concept, the following activities were proposed to ECDC and the Member States:

- **Improved coordination** and synergy with EFSA and other agencies to strengthen the effects of ECDC's overall output and to avoid parallel efforts. For example, ECDC could work support the development of **national preparedness and response plans across sectors**, and ECDC should continue to work with EFSA in development of Joint Rapid Outbreak Assessments.
- ECDC could also promote the **exchange of best practices** from those countries that have a common 'standard operating procedure' when a human/animal health threat is identified.
- Outside Europe, ECDC could explore **collaboration** with initiatives such as the FAO/OIE/WHO tripartite collaboration.
- ECDC, EFSA, and other agencies could support the development of **One Health action plans** at national levels and encourage national authorities to undertake the OiE Performance of Veterinary Services (PVS) and Joint External Evaluations (JEE) to assess IHR core capacities.
- **Simulation exercises** to improve coordination and networking across sectors.
- **Integrated risk assessments**, such as those that integrate data from existing surveillance systems (such as at ECDC and EFSA). The linking of epidemiologic and meteorological data was highlighted; the ECDC E3 (European Environment and Epidemiology) geoportal was mentioned as a potential repository for One Health data.
- **Outbreak events.** Support outbreak investigation upon request of a Member States and during multi-county outbreak by developing case definitions, tools, methodologies within a One Health framework by involving other sectors. Stress the importance of timeliness during outbreaks.
- Finally, it was suggested that ongoing work between ECDC and EFSA continues to develop solutions for **next generation typing methods** for food- and waterborne diseases in the EU and EEA countries [33].

General recommendations for strengthening One Health Preparedness in Europe

Many additional activities were identified during this consultation, some of which may be considered by ECDC for further action; some fall outside the ECDC mandate but other organisations or research centres may consider them meaningful and relevant to their work. The participants also identified a number of research gaps.

Early warning and surveillance

The working groups said that One Health implementation was made more difficult by poor communication of early warning signals and surveillance results. The experts said that collaboration was not sufficiently intersectoral and lacked a clear definition of roles. Suggestions for improved surveillance from a One Health perspective focussed on faster sample collection and the provision of data through common resources that all sectors can access during public health crises. Examples include the following:

- **Support the development for cross-database communication.** Investigate universal data access by the different sectors to integrated databases; this would support the development of technical guidance for a One Health network which would enhance data exchange on priority zoonotic diseases (e.g. human cases, animal cases, presence/absence of disease vectors). Encourage the reporting of vector absence data – in addition to data on vector presence. Align priorities (e.g. for AMR surveillance) across sectors and explain the need for benchmarking to Member States and enlargement countries.

- **Early warning systems.** Flag up infectious agents for real-time surveillance. Clearly define early warning and surveillance signal thresholds and red-flag thresholds. Provide technical guidance on integration/interpretation of early warning and surveillance across sectors.
- **Syndromic surveillance.** Explore the viability of standardising practices for syndromic surveillance for certain disease categories such as food- and waterborne diseases, both in human and veterinarian services. This should be done well before an emergency.
- **Reference laboratories and sample testing.** Increase the number of samples taken and analysed, for example through developing new *in silico* data extraction and sharing laboratory information systems. Perform combined human–animal data analysis for specific zoonotic topics. Participants also identified the need for a reference laboratory network for public health similar to the one for animal health; this approach could build on a number of initiatives [34].
- **Incorporate climatic/meteorological data into epidemiologic surveillance.** Better integration of health topics with meteorological services (i.e. climate change prediction); this has been explored by ECDC's E3 geoportal [35].

Preparedness and response

The effective application of a One Health approach would bring together European 'response networks' to map the activities of the various players and thus avoid the duplication of efforts/activities. Times without public health emergencies should be used to build networks to improve all aspects of One Health preparedness and response. The following preparedness and response activities should be considered:

- **Risk assessments.** Support the development of national intersectoral risk assessment and response plans across sectors.
- **After-action reviews (AARs).** After an outbreak event, problems with coordination and risk communication should be analysed and addressed. Affected countries should conduct AARs to identify research gaps from a One Health perspective, inform research agendas, improve surveillance strategies, and develop innovative One Health surveillance strategies. Lessons learned and best practices in event response should be documented across borders in the framework of a One Health approach. This should also cover the interoperability of plans and procedures. Lessons learned can even be used to inform research agendas.
- **Strengthen the recovery phase and evaluate actions to build resilience.** Encourage and perform more recovery evaluations from a One Health perspective.

Partner coordination and capacity building

Several barriers in coordination and capacity building were identified by the working groups. Training and capacity building is essential for preparedness, e.g. joint training sessions with the different sectors (veterinarians, human health, and environmental health) involved in One Health. With regard to outbreak investigation and response, it is essential to clarify the roles, responsibilities, and competencies of the different sectors.

- **Structural imbalances.** Address structural differences between public health and animal health. The former was perceived by participants to be more 'top-down'.
- **Expert lists and knowledge exchange.** Develop a One Health expert list with medical anthropologists, epidemiologists, laboratory staff, entomologists, etc. Promote more expert exchange programmes within the EU. Conduct more country visits geared toward One Health activities. See the EJP as an opportunity to have countries working together to improve all aspects of One Health (risk assessment, response, surveillance, etc.).

Risk communication

Improved communication is a recurring theme in this context. Communication should be improved across sectors; external communication, i.e. to and with the public and with policymakers, is equally important.

- **Public information.** Improve communication with policymakers and the public to improve risk management. Digital and social media channels should be examined in a cultural context.

Research gaps

The following research gaps – both biomedical and operational/societal in nature – were identified as topics for which research might yield results that would facilitate a One Health approach.

- Risk assessment
  - Understand difference in perceived risks between sectors including financial aspects.
  - Improve understanding and impact of climate change through modelling analyses

  - Improve identification of data gaps and employ creative methods to attain data (e.g. citizen science, or surveillance systems in the supermarkets to research relation between diet and lifestyles).

- Methodology
  - Continue to assess Whole Genome Sequencing-based genotyping methods for detection of ID clusters and source trace-back [36]
- Surveillance
  - Map the extent of existing surveillance system of pathogens within vectors (e.g. collecting ticks and testing for tick-borne encephalitis) and of different diseases in order to introduce the One Health perspective
  - Improve opportunities for sero-surveillance, possibly utilising spatial analysis tools (GIS) to fill gaps and provide stronger evidence regarding intervention efficacy.
  - Build up the structure for reference laboratories across Member States.
- Investigate why some countries do not report animal data and propose a solution.
- Antimicrobial resistance (AMR)
  - Invest on 'resistome'-related research in Europe to inform AMR policies from a One Health perspective.
  - Identify new ways to measure AMR, both in animal and humans, to impact policy, especially infection prevention and control, and water and sanitation to support One Health.
- Social science
  - Explore effective ways to better integrate social sciences into research on One Health.
  - Community engagement: investigate the value of an integrated approach on human, animal and environmental health on behaviour change efforts (e.g. anti-vaccine movement and GMOs); research on how to best engage the community in scientific research or emergency preparedness or response
  - Historical perspectives could be useful as emerging threats and risk are not easily understood by a 'snapshot view'
- Policymaking
  - Estimate effect of simulation exercises in order to evaluate prioritisation among decision makers
  - Maximising use of political frameworks in analyses of decision-making and key drivers related to One Health
  - Explore the possibility of collaborating with additional players in the social research domain, e.g. International Labour Organization (ILO), as well as civil society.
  - Analyse the potential impacts of post-factual media approaches within society and how these might impact public health messaging and the public understanding of public health sciences

Conclusions

The One Health concept faces a number of challenges. For one thing, One Health, does not have a single strategy. The concept also lacks support from a sufficiently large number of initiatives that engage in a unified effort.

Now is the time to embrace One Health as a framework for public health action: climate change and the spread of zoonotic diseases speak a clear language. The successful implementation of the One Health concept – and, arguably, progress in fighting zoonotic diseases – requires coordination and collaboration across the entire human–animal–environmental interface, right where infectious disease risks originate. This requires better networks, increased awareness, overcoming silo mentality, clear roles, collaborative actions, and clearly defined preparedness methodologies within coordinated frameworks.

This consultation identified many potential action points. These action points are relevant for ECDC, the public health community, animal health organisations, and the research community. ECDC's forthcoming actions related to One Health preparedness will focus on methods on how to enhance cross-sectoral preparedness planning. ECDC will also consider some suggestions for inclusion into future annual work plans, but can only do so in consultation with the European Commission, EFSA, WHO, the ECDC Advisory Forum, the ECDC Coordinating Competent Bodies and the ECDC Management Board.

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