

LESSONS IDENTIFIED FROM BEFORE AND DURING THE PANDEMIC:**HOW THE OIE CAN SUPPORT VETERINARY SERVICES TO ACHIEVE ONE HEALTH RESILIENCE****Mariana Marrana¹, Daniel Donachie¹, Jennifer Lasley¹, Sophie Muset¹, Francois Diaz¹, Paolo Tizzani¹, Stefano Messori¹, Tiggy Grillo², Matthew Stone¹, William Karesh³ & Keith Hamilton¹**¹ World Organisation for Animal Health (OIE), Paris, France² Wildlife Health Australia, Hobart, Tasmania, Australia³ President of the OIE Working Group on Wildlife, EcoHealth Alliance, New York, USA

Summary: *The technical item draws on evidence gathered by the OIE, before and during the pandemic, to highlight important areas for the OIE's core programmatic work.*

The first section of this paper describes the OIE's international response to the pandemic. It summarises the results of an interim after-action review which the OIE undertook to learn about its contribution to the pandemic response, particularly its service to Members, and how it could improve.

The second section highlights three areas which have, in recent years, been identified as vulnerabilities in One Health resilience. For each of these three areas – wildlife health, emergency management and laboratory sustainability – the paper describes gaps that have been identified through evidence gathering and analysis. Each subsection also describes activities which the OIE is undertaking to address these vulnerabilities.

In addition to highlighting capacity needs, the paper aims to demonstrate the potential value of data, in driving policy direction and improving service delivery, that is either collected, systematically by the OIE through OIE-WAHIS and the Performance of Veterinary Services (PVS) Pathway; through publicly available information; and through ad hoc surveys and consultations.

A Resolution, accompanying this technical item, will be presented to the OIE World Assembly of Delegates and provides recommendations on what the OIE can do to address current vulnerabilities to One Health resilience.

Keywords: *emergency management – One Health, resilience – sustainability – wildlife health.*

1. Introduction

The definition and use of the word 'resilience' has evolved over time. It is now broadly accepted as a concept encompassing *the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events* [1].

Experience gained through working with Veterinary Services and OIE partners has identified the areas covered in this paper as being essential for supporting One Health resilience.

The purpose of this Technical Item is to learn from recent events, compile input from Members, and position the OIE and its Members to play a leadership role in improving global resilience to a range of future threats.

This Technical Item aims to inform Members of key actions undertaken and lessons identified before and during the global response to the COVID-19 pandemic; promote One Health as a fundamental competency for Veterinary Services and position Veterinary Services as leaders in One Health. It highlights a need to continue the integration of wildlife health, emergency management, and sustainability into the OIE's existing institutional networks, mechanisms, and platforms, while demonstrating progress in these areas to date.

To support the use of evidence to inform policy direction, the Technical Item draws on the OIE's COVID-19 interim after-action review [2], as well as evidence gathered during programme design and implementation, stakeholder surveys, scientific studies, literature reviews, and consultations undertaken by the OIE over the period covered by the Sixth Strategic Plan. It aims to maximise the use of these data and insights, and the time and investment spent generating them.

At the 87th OIE General Session in 2019, the Technical Item explored 'How external factors (e.g. climate change, conflicts, socio-economics, trading patterns) will impact Veterinary Services, and the adaptations required' [3]. A questionnaire sent to all OIE Members and to relevant stakeholders identified emerging infectious diseases and zoonotic epidemics among the top four external factors relevant to Veterinary Services. Only two years later, the world faced the most damaging pandemic since the 1918 Spanish influenza.

All evidence points to an animal origin for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [4] but we still do not know the exact route of spillover into humans; nor do we understand what other factors may have influenced its emergence, such as wildlife trade, climate change, land-use change, or even other animal disease outbreaks such as African swine fever [5]. Despite warning signs, in the form of several significant emerging disease events over the past couple of decades (H5N1, zoonotic H7N9 and pandemic H1N1 influenza; severe acute respiratory syndrome [SARS] and Middle-East respiratory syndrome [MERS]; and Ebola virus disease [EBOV]), two of which were due to betacoronaviruses, and a surge in interest in pandemic preparedness, the world was not prepared for COVID-19.

Although preliminary lessons are being identified, many countries are still in the response phase to the pandemic. In time, there will be a thorough review to understand how the international community can better prepare itself for future threats. High-level messages about One Health and 'predicting' and 'preventing' pandemics based on previous assumptions will need to be challenged and reframed in the face of what has been learned from the COVID-19 pandemic.

In addition to emerging disease risks, the Technical Item presented at the 87th OIE General Session highlighted several other external threats to which Veterinary Services will need to be resilient. [3] Some of these, such as climate change, represent existential threats which must be included in future holistic systems-based approaches to global health and threat reduction.

The COVID-19 pandemic has provided additional evidence that strong and sustainable One Health collaboration is needed at all levels.

Section 1. The OIE's role in a One Health response to the COVID-19 pandemic

1. Support to OIE Members and Partners

COVID-19 had powerful effects in nearly all countries; it challenged strategic leadership, medical and food supply chains, livelihoods, and economies, as well as animal production systems.

Panzootic and pandemic preparedness and biological threat reduction have been part of the OIE's core activities for several years, leading to the establishment of several global strategies, e.g. for African swine fever (ASF); the joint OIE-FAO network of expertise on animal influenza (OFFLU), which was established to support influenza pandemic preparedness [6]; a biological threat reduction strategy (supported by two global conferences [7]); and several projects supporting capacity building for emergency management and improved sustainability of laboratories. The OIE has a track record of responding to disease emergence at the human-animal interface, having mobilised for H5N1 avian influenza ('bird flu'), pandemic H1N1, MERS, and zoonotic H7N9.

Following a cross-organisation restructuring, which had been in preparation for several months, on 1 January 2020, the Preparedness and Resilience Department was created, and ‘Foresight’ was added to the OIE Headquarters (HQ) structure. These additions to the OIE’s institutional structure were a direct result of insights and reflections from the 2019 Technical Item. This demonstrates that Technical Items play an essential role in technical strategy formulation within the OIE.

Upon the first report from WHO to the OIE of a novel coronavirus emerging in humans in China with suspected links to animals, the OIE mobilised to support the work of its partners and to assist Veterinary Services across the world. An internal Incident Management System was established to coordinate the response of the OIE HQ and its communications with the regions. Existing Tripartite frameworks and relationships (for example with the Global Outbreak Alert and Response Network [GOARN],¹ the WHO Research and Development [R&D] Blueprint strategy [8], and the WHO International Health Regulations [IHR] Emergency Committee²) ensured timely collaboration between WHO, FAO and the OIE.

In January 2020, under the leadership of the OIE Working Group on Wildlife, and with the cooperation of FAO and WHO, the OIE mobilised an expert group (later designated as the ‘*Ad hoc* Group on COVID-19 at the Human–Animal Interface’) to provide scientific advice and to develop guidelines on a range of topics linked to aspects of the human–animal–environment interface of COVID-19. These included identifying research priorities, assessing and communicating results of continuing surveillance and research in animals, developing scientific opinions on the implications of COVID-19 for animal health and veterinary public health, and providing practical guidance for Veterinary Services. Through dedicated sub-working groups, the *Ad hoc* Group on COVID-19 at the Human–Animal Interface developed the following guidance, which was disseminated to its Members and the public, via the OIE web portal on COVID-19 [9]:

- Questions and answers on COVID-19
- Technical fact sheet on infection with SARS-CoV-2 in animals
- Guidance on veterinary laboratory support to the public health response for COVID-19
- Considerations for sampling, testing, and reporting of SARS-CoV-2 in animals
- Guidelines to work with farmed animals and wildlife species susceptible to infection with SARS-CoV-2.

Crises are times when innovation and resourcefulness are propelled to the fore out of necessity and generate opportunities for significant advances in science and technology. Taking advantage of this opportunity, the OIE was proactive in learning from innovation and applying it to the response to the pandemic. This included working with WHO to explore the use of dogs as bio-detectors for SARS-CoV-2 infection in humans; gathering experiences from veterinary laboratories which supported surge capacity in testing humans for SARS-CoV-2; and seeking innovative solutions to improve the sustainability of laboratories.

At a time when solidarity was crucial, and with the encouragement of the OIE, Veterinary Services supported the response capacity of public health services. In March 2020, the OIE and World Veterinary Association (WVA) drew attention to the roles and responsibilities of the veterinary profession in supporting public health, particularly with respect to business continuity in key areas such as food safety. The organisations issued a joint statement advocating that Veterinary Services be considered as essential businesses, due to their role in ensuring food safety and security, disease prevention and emergency management [10].

The safe trade of animals and animal products can be facilitated, and interruptions to food supply chains avoided, if science-based messages are well communicated and the principles of risk management (in line with OIE Standards) are applied. In April 2020, the OIE convened an *Ad hoc* Group on Safe Trade in Animals and Animal Products to monitor new knowledge related to SARS-CoV-2 and potential risks associated with international trade in animals or animal products. This Group issued ‘Considerations on the application of sanitary measures for international trade related to COVID-19’ [11], which were revised as new evidence became available. The Group was informed by the results of field observations and laboratory animal infection studies conducted in several OIE Reference Laboratories.

¹ GOARN: <https://extranet.who.int/goarn/about-us>

² IHR Emergency Committee: <https://www.who.int/groups/covid-19-ih-er-emergency-committee>

In April 2020, acknowledging the possible wildlife origin of SARS-CoV-2 and citing other recent significant disease spillover events at the human–animal interface, the OIE Working Group on Wildlife issued a statement on ‘Wildlife Trade and Emerging Zoonotic Diseases’ [12]. It highlighted that several recent disease outbreaks, including SARS and EBOV, had resulted in socio-economic crises as a consequence of spillover events from the poorly regulated wildlife trade. Wildlife trade is highly complex and carries both risks and benefits. Thus, the Group believes there is a need to support legal, sustainable and responsible wildlife use by providing sound guidance, standards, risk assessment and risk management tools. The Working Group on Wildlife called for action to reduce the risk of future spillover events, whilst promoting animal welfare and biodiversity.

The OIE issued high-level guidance on testing human specimens for SARS-CoV-2 in veterinary laboratories. This encouraged veterinary laboratories to support public health services in meeting the extraordinary surge in testing demand [13]. Several of the countries that were able to rapidly scale up their COVID-19 testing in the early days of the pandemic were those where veterinary laboratories were assisting the response by testing human samples for SARS-CoV-2. In December 2020, the OIE hosted two interactive global webinars for OIE National Focal Points for Veterinary Laboratories, OIE Delegates, and key partners to share the experiences of veterinary laboratories during the COVID-19 pandemic. During this webinar, it was found that 55% of the 167 participants polled had used the *OIE Guidance on Veterinary Laboratory Support to the Public Health Response for COVID-19* [13] and, of those who had used it, 76% found it very useful.

Throughout the pandemic, the OIE played a role in keeping Members and the international community up to date with the latest scientific and field findings on the susceptibility of animals to SARS-CoV-2, through the OIE’s COVID-19 portal. This was linked to clear risk communication messages: for example, that the risk to human health from companion animals was low, and the risk from food-producing animals was negligible; yet the risk from fur-producing animals, such as mink, was significant. Through the OIE web portal on COVID-19, the OIE advocated:

- that Members report SARS-CoV-2 infections in animals as an *emerging disease* (from March 2020 when the first SARS-CoV-2 infections were identified in animals);
- that inappropriate actions not be taken against companion animals or wildlife;
- against trade measures for food-producing animals or animal products;
- caution when handling animals susceptible to SARS-CoV-2 infection to avoid spillover into animal populations;
- that vigilance be increased in countries with fur-producing animals, by increasing surveillance among these animals, strengthening biosecurity, and rapidly sharing gene sequences to the public domain from viruses isolated in fur-producing animals.

In January 2021, a joint risk assessment was developed by the Global Early Warning System (GLEWS+), a Tripartite collaboration, of SARS-CoV-2 and animals used in fur farming [14]. This Tripartite assessment focuses on fur farms and the mammalian family Mustelidae (the only farmed animal species in which the presence of SARS-CoV-2 has been reported from the field to date). The assessment improved global understanding of the fur-farming industry, its species, distribution, and biosecurity practices. It is noteworthy that the fur-farming industry is a sector which, up until now, has been largely ignored in the animal demography data collection processes of OIE–WAHIS, a gap worth reconsidering.

The animal health sector contributed in numerous ways to building a One Health response to the pandemic in the field. The veterinary profession has shown its commitment to supporting the work of human health authorities. Whether by providing testing capacity in animal health laboratories, through donating essential materials such as personal protective equipment and ventilators, or through the direct provision of human resources and expertise, Veterinary Services have supported the response to COVID-19.

2. Learning from the pandemic to improve the OIE's service to Members

COVID-19 and the associated sanitary restrictions significantly impacted the OIE's ways of working. The OIE Director General requested an interim, high-level, after-action review of the OIE's institutional response to COVID-19 [2] to cover the period from 13 January to 21 August 2020. The aims were to improve the OIE's institutional preparedness and resilience to ongoing and future events which may impact business continuity by capitalising on experience gained from the outbreak itself and the Organisation's response. The review was completed in October 2020 and has been shared with all OIE staff. Moreover, an article was published in the *OIE Official* in February 2021. In brief, the review examined four components of the OIE's response: technical, events management, institutional communications, and human resources and logistics. In collaboration with the OIE Directorate, the Review Team identified 98 participants who should be interviewed, including OIE Delegates, Council Members, external partners, and OIE staff at both HQ and regional/sub-regional levels. Of the 98 people contacted, 55 provided feedback (written or oral).

The review demonstrated the agility and ability of the OIE to adapt to the pandemic and continue to fulfil its mandate to support its Members and partners. Risk-based technical guidance and recommendations were developed and updated, in response to the increasing amount of scientific evidence available on SARS-CoV-2 in animals, through the rapid mobilisation of expert groups using standard OIE processes. In addition, there was praise for the OIE's ability to digitalise its interactive events to continue to reach its Members and stakeholders. This included an adapted procedure to ensure key resolutions were passed in the absence of the 2020 General Session. Key partners and liaisons of the OIE also commented on the efficiency of collaboration and joint communication. The following challenges were identified, and recommendations have been provided to overcome these:

- A need to strengthen the OIE's relations with other international organisations, including the Tripartite, as well as non-traditional partners, and to consider the interface between Veterinary Services and the environment, wildlife, and biodiversity, e.g. the Convention on International Trade in Endangered Species (CITES) and United Nations Environment Programme (UNEP). This will support OIE Members' recognition of wildlife health as an important component of One Health;
- Make full use of partnerships to provide guidance or resources in response to requests from Members if they are not in the mandate of the OIE. This also relates to a theme identified in the review: avoiding the over-proliferation of tools that are duplicative or not complementary among organisations in the OIE's network;
- Improve the reporting process for Members to notify the OIE of animals infected with SARS-CoV-2;
- Develop a strategy for communications in case of disruptive events – to support spokespeople (staff, OIE Delegates, experts in the OIE network) and add value to being an OIE partner;
- Incident management systems are not yet integrated into the OIE's core business. The Organisation should develop a standard operating procedure for such a system and ensure that it is tested and validated through simulation exercises;
- Ensure that the virtual environment provides high-quality delivery of conferences, workshops, and webinars for all stakeholders (Delegates, Focal Points, experts, interested members of the public), and consider the right mix of virtual and in-person meetings to serve the purpose and objectives of any particular process, while delivering value for money;
- Consider how certain in-field activities can be adapted to the virtual environment in the long term.

During 2020, the OIE also undertook an internal review of the services currently offered and in development to support resilience in Veterinary Services, and presented this work to the OIE World Animal Health and Welfare Fund Advisory Committee in December 2020. The resulting catalogue presents a comprehensive overview of the OIE's services in a single document for reference by the OIE, its Members and Resource Partners, and will facilitate access, as well as helping to target gaps for new activities.

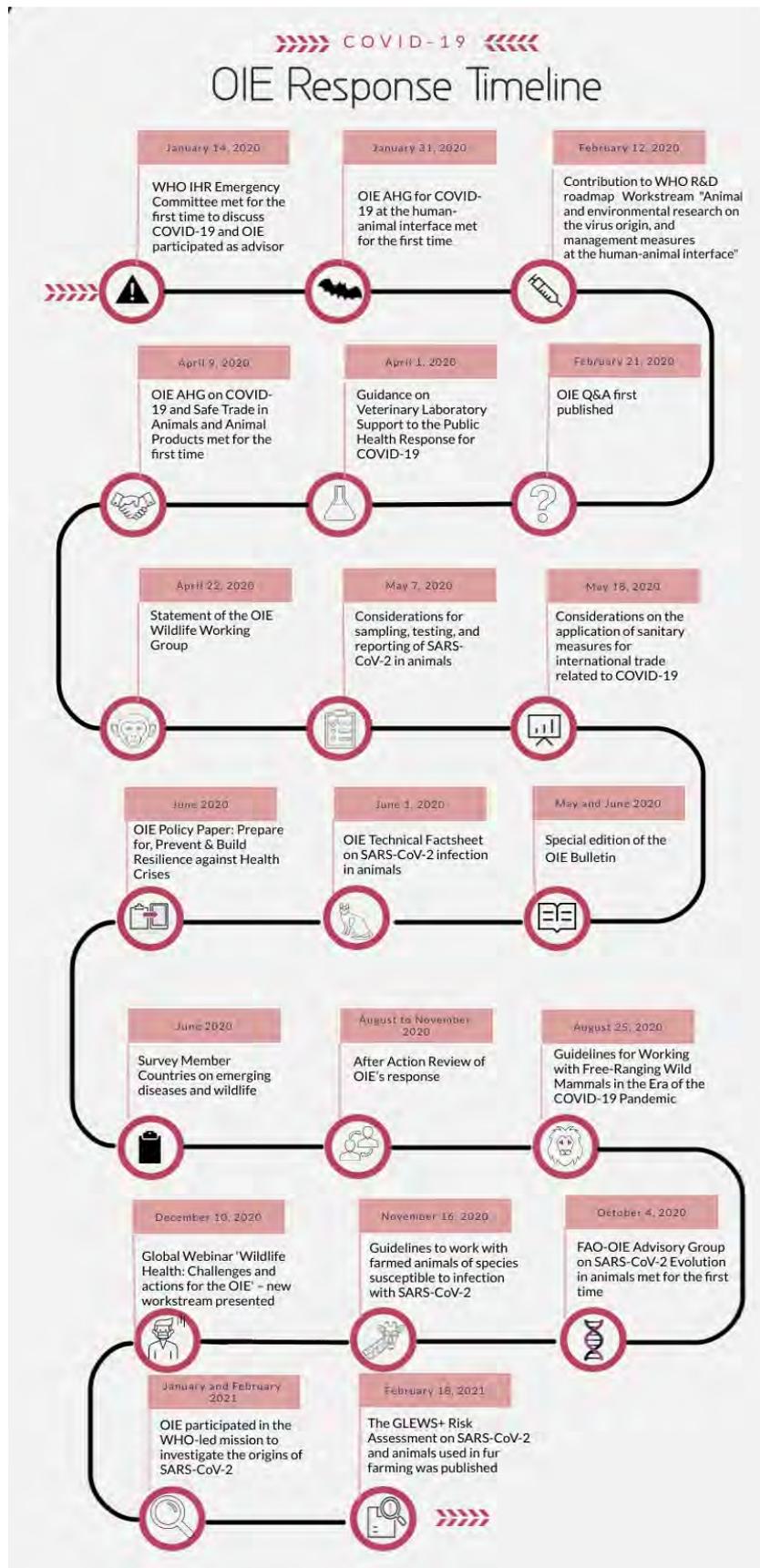


Fig. 1
Key events in the OIE's response to the COVID-19 pandemic

3. Systems for international reporting of emerging diseases in animals

One of the lessons learned from the pandemic was that the reporting requirements for SARS-CoV-2 infections in animals as an *emerging disease* were interpreted differently by OIE Members. Some Members immediately reported such events to the OIE as an ‘emerging disease’, and others reported these events as ‘other important information’ or ‘other relevant information’.

Emerging disease events are characterised by high uncertainty. The OIE system for emerging diseases ensures that all OIE Members can access official information and guidance that supports their risk management decisions. The system relies on all OIE Members contributing information towards an increasing global understanding of the distribution and impact of newly emerged diseases.

According to Article 1.1.4. of the OIE *Terrestrial Animal Health Code* (the *Code*) [15] and *Aquatic Animal Health Code* (the *Aquatic Code*) [16], Veterinary Authorities shall notify the OIE when an emerging disease has been detected in a country, zone or compartment, and send periodic reports after notification for the time necessary to have reasonable certainty that the disease has been eradicated or the situation has become stable. The Glossaries of the *Terrestrial Code* and *Aquatic Code* provide a definition for ‘emerging disease’.³

To guide Members in consistent interpretation of the definition of an emerging disease and in notifying such events, and to clarify the roles and responsibilities for tracking emerging disease events until one of the three end points is reached (i.e. the disease becomes eradicated, endemic, or OIE listed), the OIE developed a standard operating procedure (SOP) and accompanying guidance.

The SOP highlights the importance of reporting emerging disease events.

The SOP clearly describes the sequence of steps to determine an emerging disease, as well as the roles and responsibilities of relevant entities (Members, OIE HQ, Specialist Commissions) and follow-up actions. The SOP will be accessible from the OIE website and is expected to aid transparent and consistent reporting of emerging diseases of terrestrial animals by Members, ensure that Members issue timely notifications followed by periodic updates of emerging disease outbreaks, and enable the gathering of relevant information for effective response and risk management.

The SOP for Emerging Diseases becomes part of the growing body of quality systems documentation that provides guidance on implementation of the OIE’s International Standards.

Section 2. Vulnerabilities in One Health resilience and mitigating actions

During recent years the OIE has identified specific vulnerabilities which are likely to adversely affect One Health resilience. These vulnerabilities have become evident through analysis of Performance of Veterinary Services (PVS) and World Animal Health Information System (WAHIS) data; studies undertaken by OIE Collaborating Centres and academic partners; surveys and questionnaires sent to Members; previous OIE Technical Items; and through conversations with Members, partners, and stakeholders. There are, of course, numerous vulnerabilities that challenge One Health resilience which would be highlighted by a more comprehensive assessment, but the purpose of this paper is to report on specific areas identified through recent experience.

The OIE has been working to build an evidence base to identify areas of greatest need and to support the development, adaptation and targeting of interventions to support its Members.

The next three subsections describe the work to build this evidence base, summarise the key findings, and note preliminary progress towards finding solutions.

³ Emerging disease means a new occurrence in an animal of a disease, infection or infestation, causing a significant impact on animal or public health resulting from: a. a change of a known pathogenic agent or its spread to a new geographic area or species; or b. a previously unrecognised pathogenic agent or disease diagnosed for the first time.’

Critical vulnerabilities to One Health resilience that have been identified include a lack of attention to wildlife health management, and its inadequate integration into animal health and One Health strategies; weaknesses in countries' capacity to put emergency management measures into operation (leading to a lack of preparedness); and chronic systemic weaknesses in the sustainability of diagnostic laboratory systems. Across all three of these areas, One Health resilience is further weakened by deficiencies in the ability of Veterinary Services to access resources and to apply a truly multisectoral approach.

1. Better integration of wildlife health into animal health and One Health strategies

COVID-19 reinforced the need to better address risks from emerging diseases at the human–animal–environment interface to protect both humans and animals whilst avoiding massive socio-economic disruption. The pandemic has also highlighted the importance of sustainable and connected animal, human and environmental health surveillance systems. Integration of the environmental dimension into One Health has been at the centre of the discussion to take a holistic, systems-based approach to better address the roots of disease emergence.

The concept of One Health has been integral to the OIE's work, supporting cross-cutting initiatives on pandemic preparedness and antimicrobial resistance, and initiatives to tackle zoonotic diseases, such as rabies, tuberculosis, influenza, and brucellosis. It has also been addressed through partnerships, including the Tripartite (WHO, FAO and the OIE) and, more recently, the Tripartite plus UNEP. In response to global trends in disease emergence and biodiversity loss, the OIE has acknowledged the urgent need to further strengthen the wildlife component of One Health.

Wildlife health and biodiversity are solutions to support pandemic prevention, not problems. Yet, at present, wildlife health is not properly integrated into One Health discussions, and is still viewed as peripheral in overall animal health management procedures. Indeed, at the national level, epidemiological surveillance systems that integrate wildlife are often not functional or non-existent. The interplay between Veterinary Services and wildlife authorities in managing wildlife health is complex and diverse, particularly in terms of which body has the mandate to oversee wildlife health in any national setting. In fact, Veterinary Services are involved in wildlife health to varying degrees in different parts of the world, often in partnership with other government and non-governmental actors.

1.1. Evidence highlighting vulnerabilities

a) Capacity of Veterinary Services to support multisectoral wildlife health management and surveillance systems

A survey was sent to the 182 OIE Members in June 2020 to collect the views and perspectives of Veterinary Authorities on the role of Veterinary Services in wildlife health management, and especially in (i) surveillance of diseases in wildlife and (ii) health monitoring of wildlife in the context of wildlife trade, all along the supply chain [17]. The survey was answered by 151 OIE Members (see [Annex 1](#) for full report).

Veterinary Authorities are the National Competent Authority responsible for ensuring animal health and welfare and are often at the forefront of zoonotic disease management. While in general Veterinary Services were more focused on monitoring and reducing the risk of certain zoonoses and on diseases originating from domestic animals, 81% of respondents said that Veterinary Services were also involved in wildlife health management, mainly in wildlife health monitoring along the trade value chain: through import/export activities (including issuing health certificates) (30% of responses), inspection of wildlife products and by-products (10%) and transportation of wildlife (5%).

The vast majority of OIE Members agreed on the importance of the involvement of Veterinary Services in the establishment of wildlife health management and surveillance systems: 95% of survey respondents thought that Veterinary Services should be involved in the epidemiological surveillance of wildlife diseases at the human–animal–ecosystem interface, and 99% thought that Veterinary Services have a role to play in monitoring the health of animals in the wildlife trade and their use along the value chain.

However, 86% of respondents mentioned that wildlife was often under the responsibility of the environment sector (e.g. Protected Areas, Ministry of the Environment, environmental agencies, wildlife management agencies) when Veterinary Services were not involved. These results highlighted the importance of enhancing intersectoral collaboration to ensure that both sectors can pool their competencies to benefit wildlife health. Indeed, respondents worldwide identified Veterinary Services (95% of responses) and the wildlife/national park/environment sector (95% of responses) as key partners to involve in establishing an integrated wildlife health management system (including epidemiological surveillance in wildlife and health monitoring of wildlife trade and use).

With regards to zoonotic risk awareness, advocacy, and engagement in the establishment of an integrated wildlife health management system, the three key stakeholders that most OIE Members said should be a target were:

- national and local decision-makers on veterinary and public health policies (82% of responses)
- technical staff from other sectors (e.g. wildlife conservation, law enforcement; 81% of responses)
- hunters and poachers (67%).

Globally, high-level decision-makers, technical staff, and stakeholders who dealt directly with wildlife were identified as important groups to reach out to, in terms of communication and awareness activities. Communication and awareness-raising actions were needed to convey the message that wildlife provide tangible benefits, add inherent value to and perform necessary functions for the ecosystems we share, and to engage local communities in surveillance systems.

In addition, the most important enabling factors identified by survey respondents for an optimal wildlife health surveillance and monitoring system were:

- a) sustainable government funding
- b) direct and continuous collaboration with stakeholders working in the wildlife sector
- c) a relevant legislative and/or regulatory framework to enable Veterinary Services to carry out disease surveillance in wildlife and monitor the safety of live wildlife and wildlife products in markets and on game farms (Figs 2 and 3).

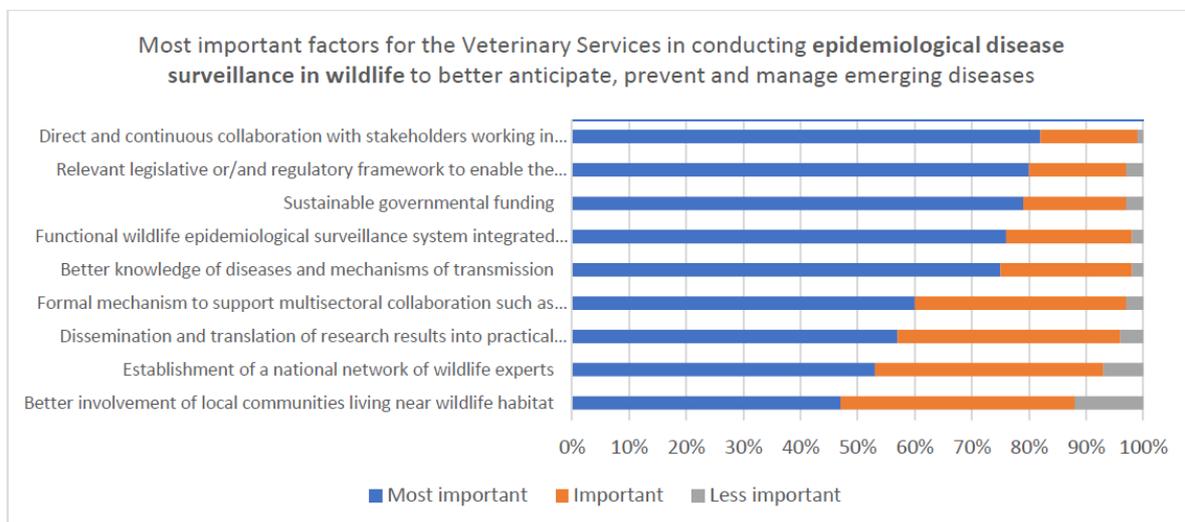


Fig. 2

What are the most important factors for the Veterinary Services of your country in conducting epidemiological disease surveillance in wildlife to better anticipate, prevent and manage emerging diseases?

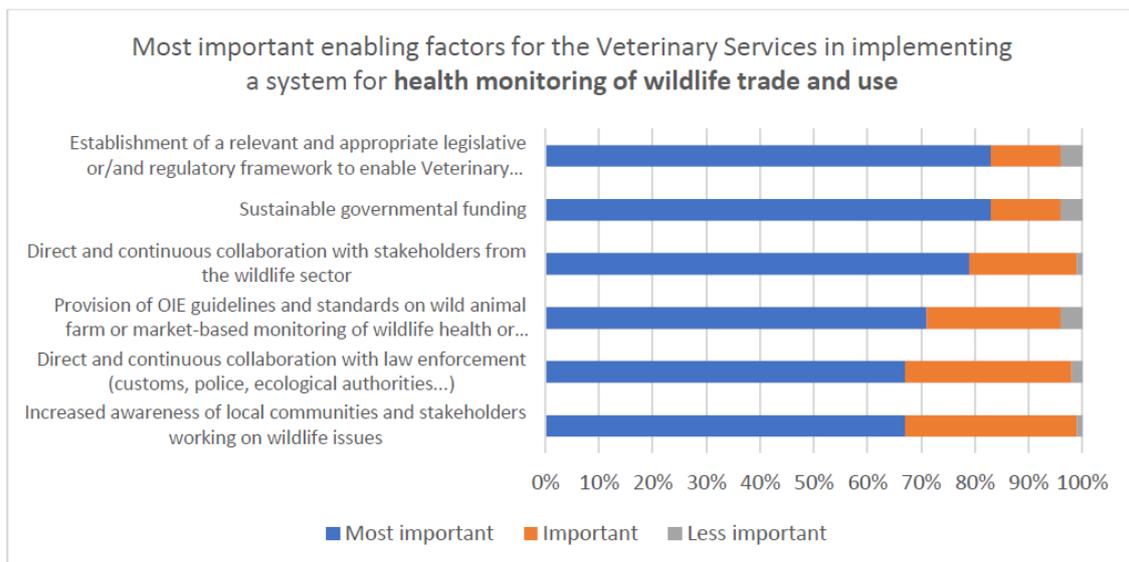


Fig. 3

What would be the most important enabling factors for the Veterinary Services of your country in implementing a system for health monitoring of wildlife trade and use ('trade' includes capture, handling, transport, wild animal farming, marketing, export/import)?

However, many Veterinary Services around the world lacked the capacity and resources, as well as the appropriate regulatory and multisectoral One Health collaborative frameworks, to establish sustainable, intersectoral surveillance systems: out of the 81% of respondents who said that their Veterinary Services were involved in wildlife health management, only 15% said that they collaborated with conservation organisations, charities, non-governmental organisations and/or other government departments, such as the Ministry of Agriculture, Public Health Authority, State Forestry Department or the Ministries of Environment, Wildlife and Tourism. In addition, most respondents (91%) stated that there was a need to have a legislative framework to support the implementation of veterinary best practices in wildlife trade and use.

b) Critical weaknesses in international reporting of wildlife diseases

Despite the vast majority of OIE Members agreeing on the importance of Veterinary Services involvement in wildlife health surveillance systems, the reporting of disease occurrence in wildlife to the OIE through various channels has been decreasing since 2012, and remains low, especially for non-OIE-listed diseases. Members should report information on the occurrence of diseases in wildlife for 81 out of 90 of the OIE-listed diseases in terrestrial animals, and they can report information on a voluntary basis for more than 50 non-OIE-listed diseases in wildlife.

In 2018, OIE Members were not able to provide any information for a mean of 29% of the OIE-listed diseases (Fig. 4). The region with the best reporting behaviour was Europe (no information reported for a mean of only 15% of the OIE-listed diseases), while in Africa, countries were not able to provide information for a mean of 45% of OIE-listed diseases.

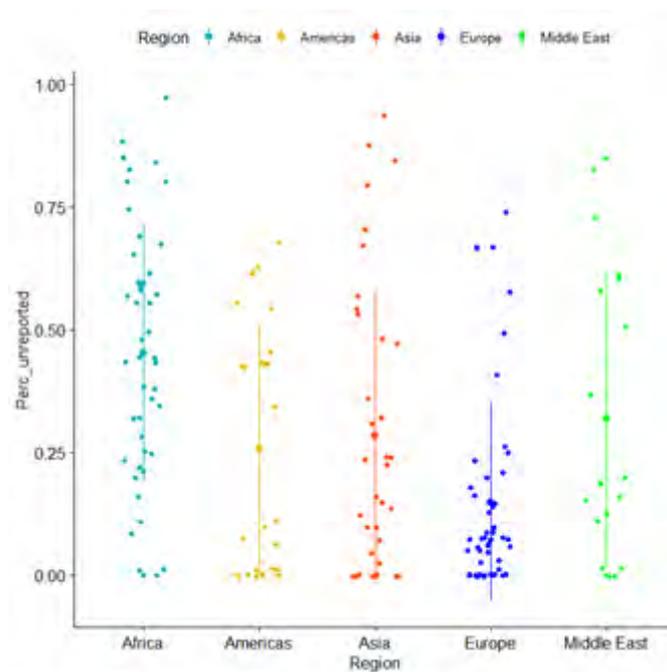


Fig. 4

Percentage of unreported OIE-listed diseases in wildlife by region (reference year: 2018)

Each dot represents the percentage of unreported diseases (i.e. where no information at all was provided about that disease) at country level. The average regional value is represented by the larger dot overlapping each line

Temporal trends show a peak of reporting in 2011, which coincides with the launch of the online reporting system for non-OIE-listed diseases in wildlife in 2012 [18]. This peak in the number of disease reports for 2011 corresponds with the OIE’s increased efforts to encourage Members to report with the launch of the online system (in 2012, countries submitted information for the previous year). The reporting of non-OIE-listed diseases in wildlife then showed a decreasing trend until 2014, and stabilisation (Fig. 5) to 2018. In 2018, Europe was the region with the highest number of countries submitting voluntary reports (20 countries), followed by Africa (8 countries), America, and Asia and the Pacific (8 countries each), and the Middle East (2 countries). From those reporting countries, approximately 50% of the reports stated that there were no occurrences of the non-OIE-listed diseases to report.

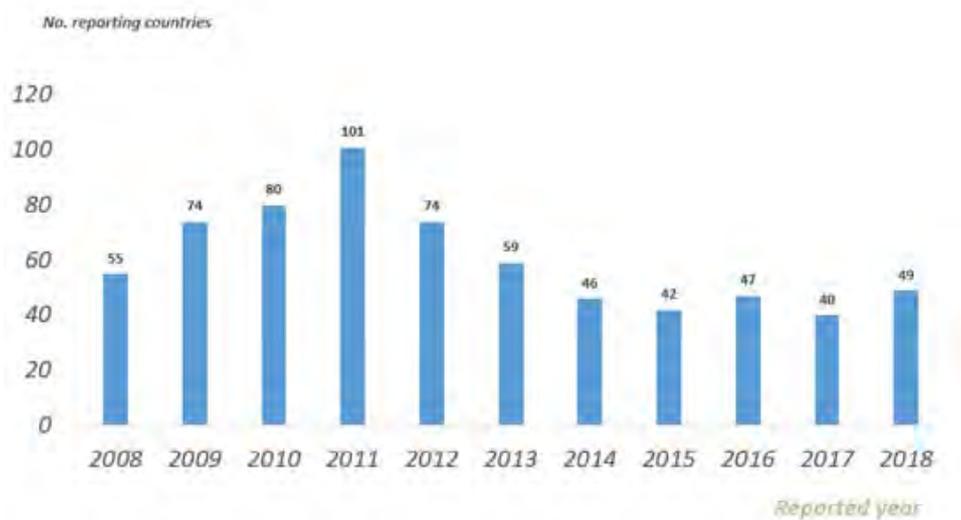


Fig. 5

Trend in the number of countries submitting voluntary reports on non-OIE-listed diseases in wildlife during the period 2008–2018

The key figures provided above were useful indicators that highlighted reporting issues in wildlife, and areas in which the OIE should provide support to countries to improve the quality of monitoring and surveillance. During the 2020 survey, OIE Members' expectations of the OIE, in terms of support for actions related to epidemiological surveillance in wildlife and health monitoring of wildlife trade and use, were most frequently reported as:

- a) standards and guidelines (reported by 76% of respondents)
- b) legislation support (48%)
- c) training/capacity building (36%).

Measures taken by the OIE to date, to improve disease reporting in wildlife, include the following.

- Since 1992, the OIE has been collecting data about diseases in wildlife on a voluntary and annual basis, using an Excel form.
- During the 76th General Session in May 2008, the OIE invited Delegates to nominate a National Focal Point for Wildlife in each country and then offered training in surveillance of wildlife diseases and reporting through OIE WAHIS.
- In 2009, the OIE started collecting disease information separately for domestic animals and wildlife through the six-monthly reports for each OIE-listed disease.
- In 2012, the voluntary report on diseases in wildlife was launched online. Reporting systems were further streamlined in 2016, after which countries reported on OIE-listed diseases in wildlife via WAHIS and on non-OIE-listed diseases in wildlife via WAHIS–Wild.
- In 2017, the Working Group on Wildlife updated the list for voluntary reporting of non-OIE-listed diseases in wildlife. A number of diseases were removed and others were added to the list [19].
- From 2017, the OIE reinforced disease intelligence through collaboration with the Australian international biosecurity intelligence system (IBIS) Intelliriver programme and with WHO's Epidemic Intelligence from Open Sources (EIOS) system.
- Since 2019, the OIE has drafted and disseminated technical cards for most non-OIE-listed diseases. These cards provide information on diagnosis and epidemiology for each disease.
- In March 2020, the Working Group on Wildlife revised criteria to include or remove diseases from the list of non-OIE-listed diseases voluntarily reported to the OIE.

However, to date, these measures have had little or no sustained impact on the level of reporting.

There are good examples where the reporting of non-OIE-listed diseases through WAHIS–Wild has provided the opportunity to gather crucial evidence to inform future evaluation of a disease against the criteria for listing. In May 2008, the OIE World Assembly of Delegates unanimously approved the addition of infection with *Batrachochytrium dendrobatidis* and infection with ranavirus to the OIE List of Aquatic Animal Diseases. These diseases are a threat for amphibians and their inclusion in the OIE List of Aquatic Animal Diseases supported attempts to control their global spread. In 2013, a novel chytrid fungus, called *Batrachochytrium salamandrivorans* sp. Nov. (*Bsal*), was isolated from salamanders following a population decline in the Netherlands. *Batrachochytrium salamandrivorans* in amphibians was added to the non-OIE-listed diseases of wildlife in 2014, as recommended by the OIE Working Group on Wildlife. Subsequent scientific evidence highlighted the serious negative impact of this fungus on wild amphibian populations and the high likelihood of spread via international trade. In May 2017, the OIE World Assembly of Delegates unanimously approved the addition of *Bsal* to the OIE List of Aquatic Animal Diseases. In 2016–2017, the Scientific Commission evaluated chronic wasting disease (CWD) of cervids against the criteria in Chapter 1.2. of the *Terrestrial Code* and considered that, at the present time, no country was yet able to credibly demonstrate freedom or impending freedom from this disease (Article 1.2.2., para. 2). Chronic wasting disease remains on the WAHIS–Wild list for the time being. Being on the WAHIS–Wild list highlights the importance of a disease during consideration of its potential listing.

c) A rapid review of evidence on managing the risk of disease emergence in the wildlife trade

In early 2021, the OIE commissioned a consultant-led review to use evidence from peer-reviewed literature to inform the process for developing guidance to reduce the risks of disease emergence through wildlife trade: ‘A rapid review of evidence on managing the risk of disease emergence in the wildlife trade’ ([Annex 2](#)). The review highlighted the benefits (national revenue, personal income, food security, cultural integrity) and potential harms (emerging disease, crime, animal welfare impacts, species depletion) associated with the wildlife trade. It found that the current evidence base to inform risk mitigation strategies for wildlife trade was weak. There was a very limited body of evidence (only 1% of papers systematically studied determinants of emerging pathogen spillover within the wildlife trade supply chain). Much trade is unexamined, with biases towards zoonoses, certain geographical regions, and specific activities (animals for food and live animals); and existing studies provide only weak or case-specific causal evidence for the link between wildlife trade and disease emergence and the effectiveness of interventions (e.g. evidence provided by cross-sectional and/or case series studies). Most evidence relates to hazard identification, rather than to risk mitigation. In view of the scarcity of evidence, the review was required to consider experts’ opinions and experiences. Even so, it was not possible to identify a single ‘best approach’ or combination of approaches to manage health risks throughout the wildlife trade. It was also not possible to do a thorough risk–benefit analysis, because the nature, magnitude, and likelihood of unintended or unanticipated consequences are poorly quantified.

The review concluded that:

- It is uncertain how future pandemics might be affected by alternative decisions (i.e. ‘something must be done, but it is not clear what must be done’).
- Wildlife trade is heterogeneous and complex, therefore interventions must be multifaceted and adaptive.
- Drivers of risk are connected to local and global processes; therefore, interventions must be integrated with and sensitive to efforts to cope with other threats.

1.2. Mitigation steps

a) An OIE Wildlife Health Management Framework to better integrate wildlife health management into the OIE's core activities and strategic plan

The OIE's international guidelines and standards provide a global framework to support the establishment of robust wildlife health surveillance and management systems at the regional, national and local level and to guide Veterinary Services and their partners. These systems support the implementation of best practices to reduce disease risks in the context of wildlife trade and the supply chain.

In response to an evolving landscape, and the needs of its Members, the OIE has developed a framework aimed at improving wildlife health and embracing a One Health approach – the OIE Wildlife Health Framework [20] ([Annex 3](#)).

The Wildlife Health Framework was developed in a collaborative manner in 2020, and includes inputs from Members, collected through a survey, and from the Working Group on Wildlife, OIE staff and international conservation organisations. It is also informed by lessons learned during the EBO–SURSY Project.⁴ The Wildlife Health Framework aims to protect wildlife health globally to achieve One Health. Two main priorities have been identified and will contribute to public health and conservation objectives, respectively:

- a) to improve OIE Members' ability to manage the risk of pathogen emergence in wildlife and transmission at the human–animal–ecosystem interface, while taking the protection of wildlife into account;
- b) to support OIE Members to improve surveillance systems, early detection, notification and management of wildlife diseases.

To achieve these objectives, a coordinated set of actions will aim to:

- a) foster multisectoral collaboration to strengthen wildlife disease surveillance and health management;
- b) create an enabling environment to promote the role of Veterinary Services in wildlife health management;
- c) raise awareness of risk pathways and best practices in wildlife health and One Health management. Six work packages have been identified to support the achievement of the objectives. These work packages are integrated into the core activities of the OIE; namely, disease notification, guidelines and standards, multisectoral collaboration, communication, scientific knowledge, and capacity building.

b) Improving reporting of wildlife diseases to the OIE

The Wildlife Health Framework specifies as one of its outputs that: 'Veterinary Services improve the collection, analysis, reporting and utilisation of good quality wildlife health data at national and global level'.

To initiate this work, with the collaboration of the Working Group on Wildlife, the OIE has developed a Wildlife Disease Reporting Action plan. This includes:

- a) reviewing the framework for reporting
- b) simplifying the reporting mechanisms and providing incentives
- c) facilitating communication and awareness
- d) reinforcing capacity building
- e) improving sensitivity and efficiency of reporting.

⁴ <https://rr-africa.oie.int/en/projects/ebo-sursy-en/>

c) Recommendations from ‘A rapid review of evidence on managing the risk of disease emergence in the wildlife trade’

The OIE-commissioned scientific review (mentioned earlier), which assessed the evidence for disease emergence and risk mitigation through trade in wildlife, made specific recommendations to the OIE, based on its findings and on an analysis of the OIE’s mission. These recommendations include the following.

- Implement a multifaceted approach to managing risks within the wildlife trade, which includes implementation assessment and programme evaluation, i.e. a knowledge-to-action framework (Fig. 6).
- Become the internationally recognised source of high-quality information about the effectiveness, efficiency and sustainability of programmes and policies.
- Become a knowledge broker, linking knowledge producers and knowledge users, and develop the international capacity to enable emerging information to be swiftly and effectively interpreted, adapted, and applied.
- Champion the development of health intelligence.
- Track changes in vulnerabilities that affect emerging disease threat levels so that nations or regions can proactively tailor their actions to their circumstances (including remedying deficits in wildlife surveillance and reporting).
- Define ‘health’ to empower the OIE to act on determinants that affect vulnerability and resilience and not simply respond to diseases after the event.
- Promote an assets-based approach (i.e. ensure that strategies promote mobilisation at the local/community level) to reduce vulnerability and increase resilience.
- Integrate emerging disease risk reduction with efforts to manage other global risks at the human–animal–ecosystems interface.
- Create a Global Issue Working Group to guide transformative solutions for the 21st century.

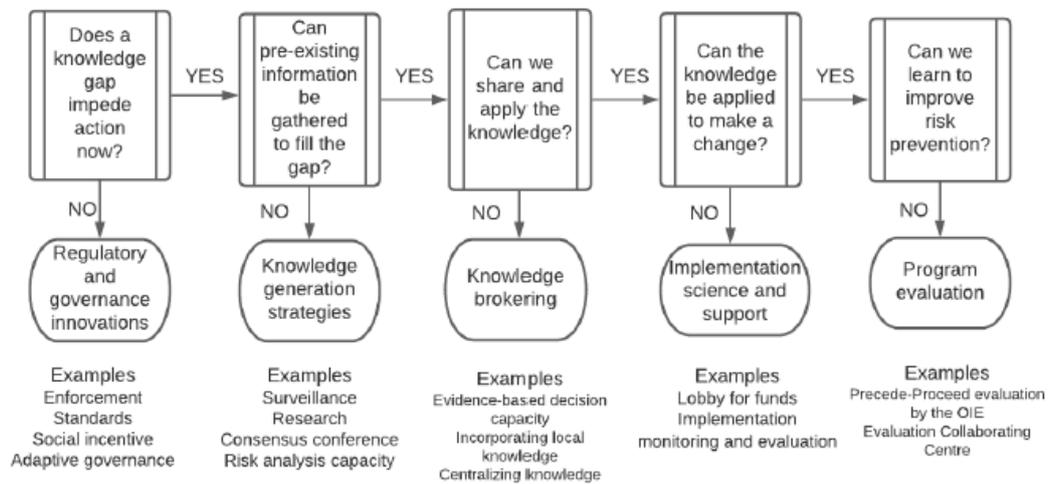


Fig. 6

A knowledge-to-action framework (reference Craig Stephen)

d) The OIE EBO–SURSY project: a One Health approach to improve capacity for disease surveillance and preparedness

Following the 2013–2015 Ebola virus disease outbreak in West Africa, which highlighted the risks associated with inadequate disease detection, prevention and response mechanisms and the importance of strengthening public and animal health systems, the European Commission signed a Delegation Agreement with the OIE for the implementation of the EBO–SURSY project: ‘Capacity Building and Surveillance for Ebola Virus Disease’ in 2016. The multiple outbreaks of Ebola virus disease in the Democratic Republic of Congo in 2017, 2018 and 2020, as well as the COVID-19 pandemic at the end of 2019, led the European Union (EU) to propose an extension of the project for an additional two years, allowing the pursuit of scientific activities involving coronaviruses and, in particular, SARS-COV-2, and to consolidate actions already undertaken.

The EBO–SURSY project, now lasting seven years, aims to improve early detection systems in wildlife in West and Central Africa⁵ using the One Health approach to more effectively prevent outbreaks of Ebola virus disease; other haemorrhagic fevers, including Rift Valley fever (RVF), Crimea-Congo haemorrhagic fever (CCHF), and Marburg and Lassa fever; and coronavirus zoonoses in Africa. To achieve this objective, the OIE has established a partnership with the Centre de coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), the Institut de Recherche pour le Développement (IRD), and the Institut Pasteur (IP) and its international network. This multidisciplinary team, with competencies covering the whole spectrum of One Health, will be able to ensure the implementation of a multisectoral and multidimensional project at the animal–human–environment interface, focusing on three key thematic areas:

- Improve the capacity of Veterinary Services and other stakeholders involved in surveillance systems, to detect, control and prevent zoonotic disease outbreaks through capacity building;
- Increase community awareness of the risks associated with zoonoses through communication and outreach to key stakeholders;
- Strengthen surveillance protocols and risk management of zoonotic diseases by improving knowledge of the viral cycle and animal–human transmission mechanisms.

After four years of implementation, the project has achieved several outcomes, as shown in Figure 7. It also highlights that:

- a) since wildlife health is not always included in the mandate of Veterinary Services of the ten targeted countries, engaging and sustaining intersectoral collaboration through a One Health approach will be key to improving wildlife surveillance systems;
- b) building national capacity for all actors of surveillance systems will greatly contribute to the sustainability of national expertise and therefore improve preparedness and reactivity;
- c) scientific findings must be translated into practical recommendations and policies to benefit Veterinary Services and key stakeholders in improving their processes and surveillance systems involving both livestock and wildlife.

⁵ Cameroon, Côte d’Ivoire, Gabon, Guinea, Liberia, Central African Republic, Democratic Republic of Congo, Republic of Congo, Senegal and Sierra Leone.

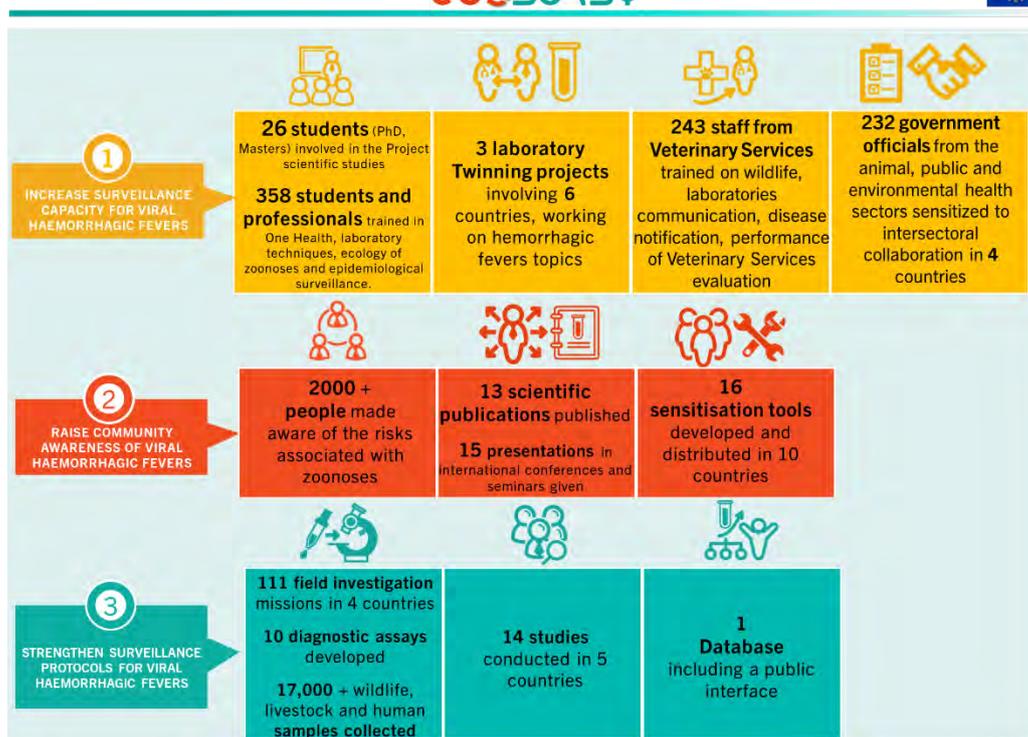


Fig. 7

EBO-SURSY Project results as per January 2021

2. Sustainable emergency management systems

Veterinary Services can face a wide range of emergencies due to hazards such as the incursion of a transboundary animal disease, emerging and re-emerging diseases, natural disasters, and chemical, biological, radiological, and nuclear hazards [21]. The COVID-19 pandemic has greatly disrupted activities and systems across the whole of society, including the work of Veterinary Services. Emergency management is the organisation and management of roles and responsibilities, resources and capabilities and actions required for all aspects of the emergency management cycle.

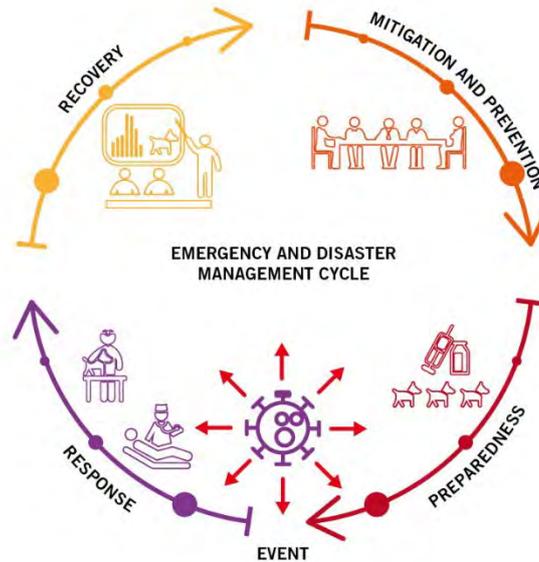


Fig. 8

Emergency and disaster management cycle

An animal health emergency can cause major economic losses for OIE Members, both from the costs of response and the effects of the actual disease itself as depicted in Figure 8. The costs of the emergency can also branch into other economic areas such as tourism and travel [22]. Preparedness for animal disease emergencies is too often shown to be inadequate and current approaches to emergency management are not sustainable in many settings. The wide range and diversity of the characteristics of OIE Members (physical, biological, and socio-economic) suggest it is unlikely that one emergency management model will be fit for purpose in all settings, and OIE Members need to tailor strategies to suit their own specific circumstances and risks.

To sustainably build and improve capacity to address animal health and welfare emergencies arising from all hazards, it is essential to understand the challenges that OIE Members and regions face.

2.1. Evidence highlighting vulnerabilities

An all-hazards approach to emergencies is essential for Veterinary Services and this was recognised in the OIE 2019 Technical Item report into how external factors impact Veterinary Services and the adaptations required [3]. It was found, from the OIE Members surveyed, that the top four priority factors of importance and concern to Veterinary Services were:

- a) pandemics of disease affecting livestock (panzootics)
- b) emerging diseases
- c) emerging antimicrobial resistance
- d) a human zoonotic epidemic.

However, OIE Members and stakeholders consider that the capacity of Veterinary Services to respond to external events is often weak and it was found that fewer than two-thirds of OIE Members assess these external events.

In 2018 and 2019, the OIE conducted a review of national contingency plans and the capacity of Veterinary Services to implement them. The review used publicly available information (from national Veterinary Services websites and WAHIS), national contingency plans shared with the OIE, and data from OIE PVS Evaluation and Gap Analysis reports [23]. It found that approximately 90% of OIE Members have some type of contingency plan: 78% of OIE Members had a plan for highly pathogenic avian influenza, 75% for foot and mouth disease, 58% for classical swine fever and 25% for Newcastle disease. At the time of the review, 24% of OIE Members surveyed had a specific plan for African swine fever (ASF), although this percentage may have increased since the study was undertaken, given the further spread of ASF in Europe and Asia. Of the 602 plans that were analysed, 96% were for terrestrial animals and 4% for aquatic animals. The national contingency plans analysed almost exclusively addressed OIE-listed diseases; however, it is uncertain whether these were based on national or regional risk assessments.

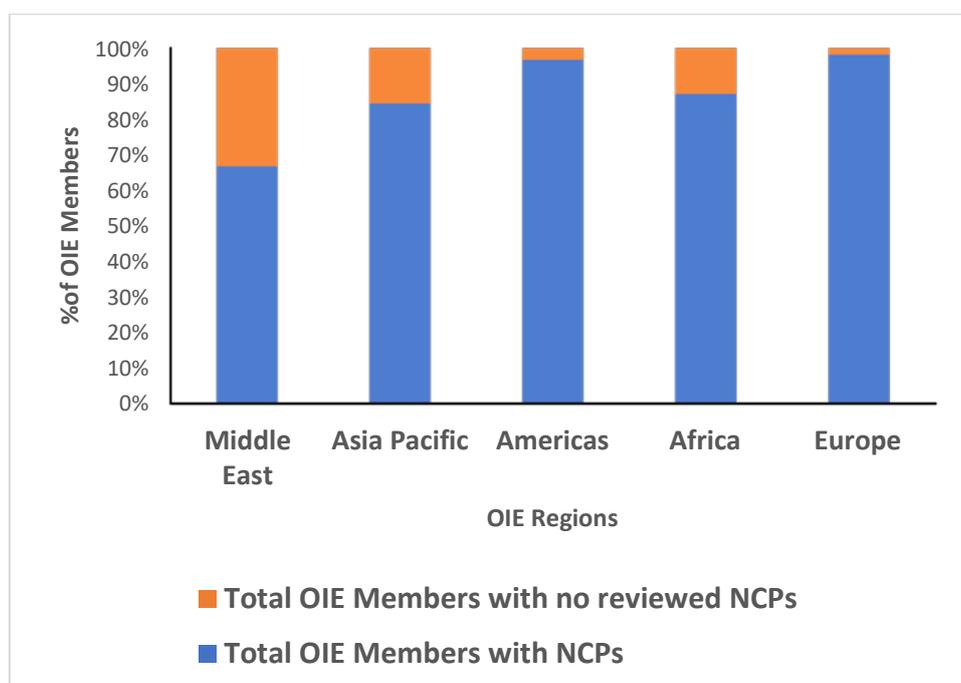


Fig. 9

Identified national contingency plans in each of the five OIE regions, 2018

The review found that, based on notifications sent to the OIE of the intention to hold a simulation exercise, of the 163 OIE Members which had national contingency plans, only 44% reported holding at least one simulation exercise in the previous ten years. Although this percentage may be an under-representation, and may not include all exercises undertaken by OIE Members, it probably indicates an important gap in emergency preparedness.

It is essential that contingency plans are matched by adequate resources (human, financial, legal, and material). The OIE review analysed 125 PVS Evaluation reports from OIE Members participating in the PVS Pathway, specifically the two critical competencies of the OIE PVS tool that relate directly to emergency management: CC II-6 on emergency response and CC I-9 on emergency funding [24]. For emergency response, only 53 OIE Members were at level 3 or above, and for emergency funding, only 55 Members were at level 3 or above, meaning that they had the legal and financial support to respond to an emergency.

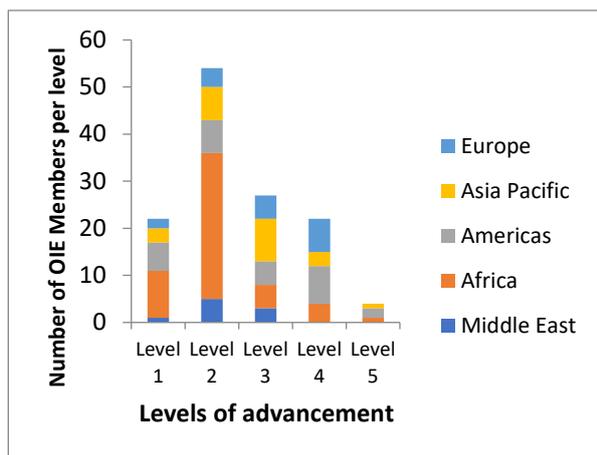


Fig. 10 (a)

Summary of regional results showing levels of advancement for emergency response (CC II-6)

Levels of advancement	
II-6 Emergency response The authority and capability of the VS to respond rapidly to a sanitary emergency (such as a significant disease outbreak or food safety emergency)	1. The PVS have no field network or established procedure to determine whether a sanitary emergency exists or the authority to declare such an emergency and respond appropriately.
	2. The VS have a field network and an established procedure to determine whether or not a sanitary emergency exists, but lack the necessary legal and financial support to respond appropriately.
	3. The VS have the legal framework and financial support to respond rapidly to sanitary emergencies, but the response is not coordinated through a chain of command. They may have national contingency plans for some exotic diseases but they are not updated/tested.
	4. The VS have an established procedure to make timely decisions on whether or not a sanitary emergency exists. The VS have the legal framework and financial support to respond rapidly to sanitary emergencies through a chain of command. They have national contingency plans for some exotic diseases that are regularly updated/tested.
	5. The VS have national contingency plans for all diseases of concern, including coordinated actions with relevant <i>Competent Authorities</i> , all producers and other interested parties through a chain of command. These are regularly updated, tested and audited.

Fig. 10 (b)

Criteria for Critical Competency II-6 in the 2013 OIE PVS Tool

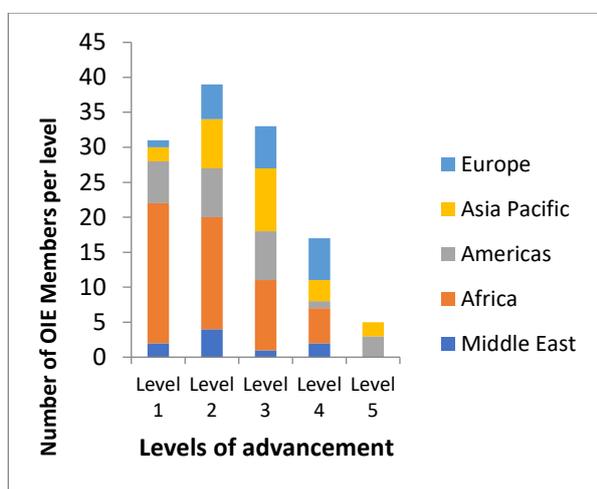


Fig. 10 (c)

Summary of regional results for emergency funding (CC I-9)

Levels of advancement	
I-9 Emergency funding The capability of the VS to access extraordinary financial resources in order to respond to emergency situations or emerging issues, as measured by the ease with which contingency and compensatory funding (i.e. arrangements for compensation of producers in emergency situations) can be made available when required.	1. No funding arrangements exist and there is no provision for emergency financial resources.
	2. Funding arrangements with limited resources have been established, but there are inadequate for expected emergency situations (including emerging issues).
	3. Funding arrangements with limited resources have been established; additional resources for emergencies may be approved but approval is through a political process.
	4. Funding arrangements with adequate resources have been established, but in an emergency situation, their operation must be agreed through a non-political process on a case-by-case basis.
	5. Funding arrangements with adequate resources have been established and their rules of operation documented and agreed with interested parties.

Fig. 10 (d)

Criteria for Critical Competency I-9 in the 2013 OIE PVS Tool

In addition to the animal health contingency plan, Veterinary Services and animal health may be referenced in higher-level national emergency management plans (NEMPs) that cover the whole-of-government response to an emergency or disaster. A review for the OIE, led by Georgetown University Center for Global Health Science and Security, analysed the NEMPs that were publicly available from 86 countries and found that two-thirds mentioned animals to some extent, 60% mentioned animal diseases (including zoonoses) as a concern or hazard, but only a third mentioned Veterinary Services [25]. There was a positive correlation between the size of the agricultural contribution to the gross domestic product (GDP) and the inclusion of animal health in the NEMP. It was noted that 22% of the NEMPs analysed did not mention Veterinary Services, animals or animal diseases at all. The omission of Veterinary Services in NEMPs is a missed opportunity for resource mobilisation, and also in terms of the expertise and resources that Veterinary Services can bring to the whole of Government. Whilst the gaps are disappointing, it is promising to see that, in some countries, there is some incorporation of animal health into these plans. This provides encouragement that the One Health concept is being considered. However, as with national contingency plans, having a NEMP (which may or may not include Veterinary Services) does not necessarily equate to having the resources to implement that plan in response to an emergency.

In summary, while it is encouraging that 90% of OIE Members have some sort of national contingency plan, almost half of the 125 OIE Members assessed by the OIE PVS Evaluation Tool had inadequate or no resources to respond to an emergency. A plan must be ‘fit for purpose’ by being based on local risk, accompanied by adequate resources (including trained personnel, equipment, and finances) and regularly assessed through simulation exercises. Veterinary Services and animal health are not adequately represented in whole-of-government frameworks and NEMPs and thus more work is needed to advocate for this, to provide more support from a greater number of stakeholders for animal health emergencies, mobilise resources, and allow Veterinary Services to contribute their expertise to national emergencies.

2.2. Mitigation steps

a) Engagement, networking and solidarity

In its work programme, the OIE promotes a holistic, multisectoral and multilateral approach to all stages of the emergency management cycle.

In terms of capacity building, the OIE does not impose a top-down approach but aims to provide guidance and tools, access to knowledge and shared experience, to support Members in their own efforts to improve their national emergency management systems in a way that can be adapted to their specific context. This includes sharing the latest knowledge to inform the development of risk-based national contingency (or emergency) plans that Veterinary Services can use for preparedness against all hazards – disease emergencies (including both accidental and deliberate-release scenarios), natural disasters, or chemical, technological, and/or radiological emergencies. It also includes facilitating the exchange of knowledge, ideas and resources among Members, whether through the platform for sharing national contingency plans, workshops, or dedicated emergency management exchanges (a new programme based on the ‘twinning’ principle). These are described below.

Although there are no internationally recognised standards for the development of contingency plans, Article 3.1.2. of the *Code* [14], on the fundamental principles of quality of Veterinary Services, states that: ‘Veterinary Services should develop and document appropriate procedures and standards for all providers of relevant activities and associated facilities’, which includes ‘emergency preparedness for disasters which could have impact on animal health and animal welfare’. In addition, Article 3.2.8. on animal health controls states that veterinary legislation for emergency preparedness should be part of an evaluation of Veterinary Services when analysing quality.

To further support OIE Members in the development of national contingency plans by sharing ideas, and to inform capacity building efforts, the OIE actively encourages its Members to share their plans with the OIE and to grant authorisation for the OIE to host them on an online platform that is publicly available [26]. To date, 34 Members have shared their plans on this platform.

b) Guidance on simulation exercises

An important tool used to improve preparedness for emergencies is a simulation exercise. Through regular exercises, plans and relevant SOPs can be refined to ensure they remain fit for purpose. To this end, the OIE, with the support of the OIE *Ad hoc* Group on Veterinary Emergencies and in collaboration with WHO and FAO, developed the OIE Guidelines for Simulation Exercises, a set of good practices for Veterinary Services to prepare, deliver, and learn from exercises [27]. The OIE also continues to encourage its Members to notify the OIE of the intent of Veterinary Services to hold a simulation exercise, whether it is at the national, regional, or international level. The information shared is posted as a web announcement on the OIE website and shared with OIE Delegates and the subscribers of the OIE-Info Distribution List.

c) Integrating competencies for emergency management into education curricula of veterinarians and para-veterinarians

An essential component of emergency preparedness is to have trained and competent staff in an emergency. In 2020, the OIE *Ad hoc* Group on Veterinary Emergencies reviewed the *OIE Recommendations on the Competencies of graduating veterinarians ('Day 1 graduates')* to assure *National Veterinary Services of quality* to address this gap. The *Ad hoc* Group developed an emergency and disaster management competency with learning objectives and a skills matrix, according to the varying levels of proficiency of a veterinarian in emergency management. The OIE intends to refine this work to integrate it into the OIE Competence-Based Training Platform and develop e-learning in an emergency management package for OIE Members.

d) Seeking innovative approaches to improve the sustainability of emergency management

Recognising the importance of sustainability in emergency management, the OIE facilitated a dynamic two-day global dialogue in November 2020 to identify novel approaches, opportunities, and innovations in emergency management which could help OIE Members to develop their own sustainable approaches [28]. This multisectoral and interdisciplinary workshop was focused on information sharing, with presenters asked to describe an innovative approach or model. After discussions, conclusions were drawn on where the greatest gains could be made to achieve sustainable emergency management.

The workshop participants agreed that there is no 'one size fits all' for emergency management and sustainability is a challenge in both low- and high-resource settings, but innovative approaches could offer solutions. Approaches identified included:

- Inter-country agreements to share human resources for emergency response, such as the International Animal Health Emergency Reserve, a non-binding international cooperation arrangement to share personnel between countries to meet surge capacity in the event of an animal disease emergency;
- Public-private partnerships, such as the strategic partnership in Namibia between the Directorate of Veterinary Services and the Meat Board of Namibia;
- Novel assessment and prediction models using climate data, such as the NASA Rift Valley fever monitor, and the use of 'big data' through artificial intelligence and automation to relieve pressure on public emergency systems, which the digital health firm BlueDot has harnessed;
- Financial resource mobilisation mechanisms, including the integration of Veterinary Services into wider whole-of-government frameworks, insurance and re-insurance policies, and contingency funds such as African Risk Capacity;
- Emergency response networks, including WHO GOARN and the Biosafety Level 4 Zoonotic Laboratory Network;
- Mechanisms to fast track the development of pharmaceutical interventions, such as the vaccines that have been strongly supported in the COVID-19 pandemic, in the WHO R&D Blueprint strategy and by the Coalition for Epidemic Preparedness Innovations (CEPI);
- Networking to support resilience, in which OIE Members can learn from one another (especially in the context of planning or participating in multi-country exercises), and share personnel to support an emergency response, or expertise in the field of research and development;
- Multisectoral collaboration is also essential for emergencies and an example shared was between law enforcement and Veterinary Services to prevent and respond to agro-crime and agro-terrorism. Preparedness against these threats should be integrated into emergency management planning and include raising awareness with stakeholders, establishing roles and responsibilities, joint training and exercises, and seeking the input of stakeholders and other agencies when developing contingency plans.

e) Multisectoral working (an agro-crime roadmap)

To further strengthen multisectoral collaboration, since October 2018 the OIE has been partnering with FAO and the International Criminal Police Organization (INTERPOL) in a project to sustainably build resilience against animal health emergencies resulting from agro-terrorism and agro-crime. Although the project focuses on North Africa, the Middle East and South-East Asia, the project's outputs are relevant to all OIE Members. As part of the project, in July 2020, the OIE and INTERPOL co-hosted a workshop on agro-crime with the purpose of bringing law enforcement authorities and Veterinary Services together to share their experiences of dealing with agro-crime and to identify opportunities for collaboration between the two sectors [29].

The participants proposed a working definition for animal agro-crime as 'a deliberate or accidental criminal act or omission against, involving or impacting (whether directly or indirectly) animals, the inputs used to raise them, or their products'. Agro-crimes have the potential to cause emergencies or exacerbate their impact through illegal activities undertaken when the attention and capacities of the authorities are diverted and may already be stretched. Agro-terrorism events are typically targeted for maximum impact, with motivations centred on political or social ideology rather than the financial or personal gain motives of agro-crime. A wide range of agro-crimes were identified, including falsified veterinary and animal products, food fraud, non-compliance with disease control measures, illicit wildlife use, smuggling, theft, poaching, and animal welfare crimes. These crimes have the potential to impact human health, animal health and welfare, livelihoods, economies, biodiversity, and reputations. Agro-crime may also occur in synergy with other areas of crime, such as organised crime operations, including weapons and drugs. The participants identified the need for there to be a shared common understanding of agro-crime and to have collaborative frameworks in place to share intelligence, information and experience; conduct joint training and operations; and together undertake joint risk assessments. By working together, law enforcement authorities and Veterinary Services can benefit from each other's expertise, thereby strengthening their preparedness for all emergencies, regardless of cause.

f) Emergency Management Exchange Programme

As part of the OIE-FAO-INTERPOL Project described above, the OIE – with the support of INTERPOL – is facilitating a pilot programme of emergency management exchanges using the 'twinning concept' to share expertise and knowledge in the management of animal health emergencies. An exchange will involve the temporary transfer of two emergency management experts (one from Veterinary Services and one from law enforcement) travelling from one country to another to participate in a schedule of activities jointly agreed by the partnered countries. This may include participation in a simulation exercise, updating a national contingency plan or participation in a training workshop. Six partnerships have been identified and include:

- a) the United Kingdom and Ghana
- b) France and Lebanon
- c) Italy and Tunisia
- d) the United States of America and Malaysia
- e) Australia and the Philippines
- f) New Zealand and Thailand.

Although COVID-19 has disrupted the physical implementation of the exchanges, the partnered countries are holding bilateral discussions to determine the exchange programme for the future and identify any virtual activities that could be conducted in the meantime. The exchanges will strengthen solidarity through collaboration between OIE Members and foster collaboration between law enforcement and Veterinary Services for emergency management (including emergencies that arise from agro-crime and/or agro-terrorism).

3. Sustainability of diagnostic services

The pandemic has highlighted the importance of diagnostics – often housed in or coordinated from laboratories – in identifying and characterising new and emerging pathogens and detecting outbreaks early to facilitate containment and avoid further spread.

The same systems support endemic disease surveillance and control and, in an animal health context, promote agricultural productivity, food security, food safety, animal and human health, and economic prosperity.

Well-designed systems which link surveillance, laboratory systems and effective disease intervention strategies can maintain or improve levels of performance of Veterinary Services over time. Such systems should be sustainable to ensure these benefits are maintained.

In addition to their role in disease surveillance, laboratories also store hazardous pathogens. Storing pathogens creates safety and security risks [30]. Laboratory accidents [31–34] (and deliberate releases of pathogens [35, 36] can have severe health [37] and economic impacts [38] and can quickly wipe out progress made through investments in capacity building and development, hampering efforts to achieve the UN Sustainable Development Goals.⁶

3.1. Evidence highlighting vulnerabilities

Expert opinion and anecdotal evidence have suggested that many laboratories around the world are faced with significant challenges to sustainability [39]. Such problems could undermine their performance, safety and security.

In March 2018, the OIE convened a Consultation on Sustainable Laboratories and invited more than 60 international experts and Members to share their experiences and discuss ways to improve the sustainability of laboratory systems ([Annex 4](#)). Challenges identified by the Consultation, many of which have also been observed in PVS Laboratory missions [40], include the following.

- Highly engineered laboratories are expensive to run – they often lack an adequate operating budget, and over-engineered laboratories may not meet local needs (may not be ‘fit for purpose’).
- Technical and engineering challenges in low-resource settings make it difficult to maintain continuous power, clean air in the laboratory, clean water, safe waste disposal, access controls, cool storage, and the physical integrity of the building.
- Barriers to the supply chain for equipment, spare parts, reagents and consumables prevent the continuous functioning of laboratories.
- Laboratories in remote areas are not easily accessible by transport networks (needed for sample submission/shipment, the supply chain, technicians, etc.).
- In some laboratories, there are wide fluctuations in the number of samples submitted to the laboratory (a low level of submission with periodic surges), leaving the lab inactive for extended periods and unable to cope during times of high demand [41].
- Often only limited local expertise is available for the risk assessment needed to support laboratory bio-risk management [42].
- Local expertise for certification, calibration and maintenance of equipment is often lacking.
- Laboratories often lack a structured, strategic, continuing education or training programme for their employees and have difficulty retaining some of their highly skilled and experienced staff.

These individual problems interact with each other and multiply to create significant challenges to running the overall system [43]. Such challenges to the sustainability of the laboratory system risk undermining investments in capacity building and costing everyone more in the long term [44].

⁶ <https://sdgs.un.org/goals>

Analysis of PVS Pathway data and Equipment Management Survey data confirms that laboratory sustainability is a problem and provides preliminary regional and global insights into the investment needs for laboratory systems.⁷ In line with the recommendations of the PVS External Evaluation, the OIE has been using data from the PVS Laboratory Tool to identify capacity gaps that undermine the sustainability of laboratory systems.

Equipment is a major resource for laboratories, and determines the kind of service a laboratory can provide to its clients. Quality and safety can be compromised for certain equipment if it is not properly maintained. Veterinary laboratory equipment maintenance was the subject of a survey of OIE National Focal Points for Veterinary Laboratories and veterinary laboratories themselves, undertaken by the OIE in August 2019. A total of 136 OIE Members (75%) responded, with 223 respondents from veterinary laboratories across all five OIE regions. The questionnaire was carried out to assess the status of laboratory equipment maintenance, repair, and calibration around the world and to develop insights into equipment-related challenges to laboratory sustainability. Laboratories were surveyed on 40 types of equipment, ranging from pipettes to thermal cyclers to biosafety cabinets.

The results showed that, globally, veterinary laboratories possessed the equipment needed to detect and diagnose important animal and zoonotic diseases. However, of the more than 68,000 pieces of equipment reported globally, approximately 22% were not properly maintained and 46% were not properly calibrated, with variations between OIE regions (Fig. 11). Among the thermal cyclers and real-time PCR machines reported from across the globe, 19% and 24% were not properly maintained while 28% and 25% were not properly calibrated, respectively. Approximately 17% of Class I, 40% of Class IIA1, and 18% of Class IIA2 biosafety cabinets (BSCs) reported globally were not properly certified. These results call into question the safety, security and reliability of the results that veterinary laboratory equipment produces.

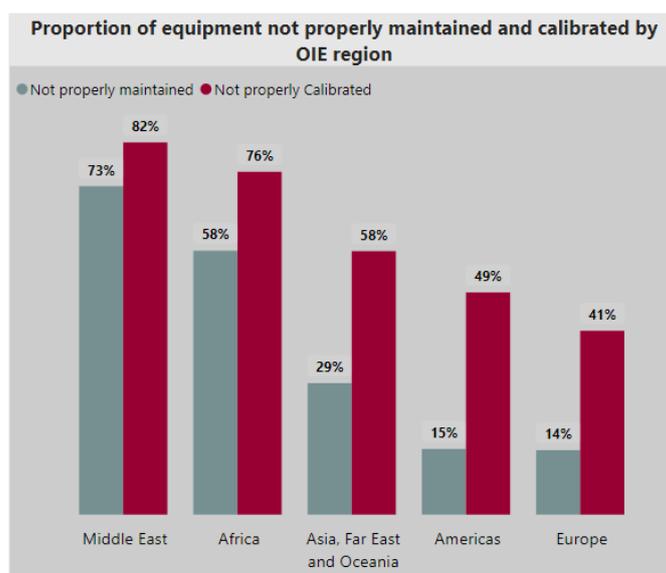


Fig.11

Proportion of all laboratory equipment that is not properly maintained and calibrated, respectively, by OIE region

Competencies to maintain, repair and calibrate highly specialised equipment are not easily accessible in all OIE regions. Globally, competencies to maintain and calibrate equipment exist in house for 18% of equipment, and within the country for 74% of equipment, with variation between OIE regions (Fig. 12).

⁷ As defined by the *Ad hoc* Group on Sustainable Laboratories, a sustainable laboratory system is a system of laboratories that can maintain appropriate safety, security, and quality on a path towards compliance with OIE International Standards, taking into account social, environmental, and economic factors in its day-to-day operations for the benefit of the health system.

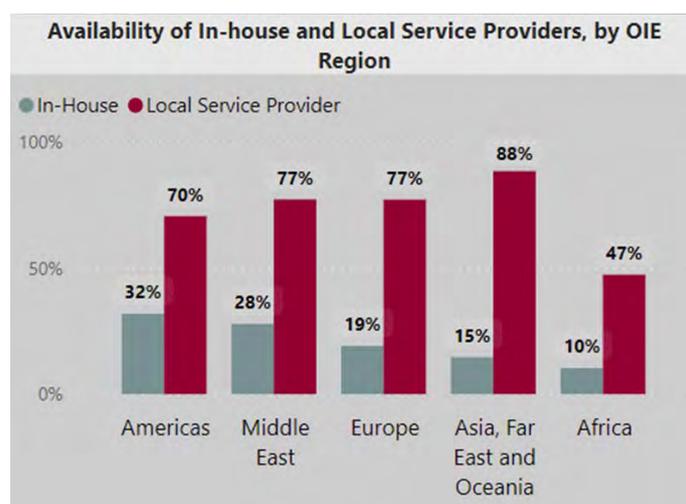


Fig. 12

Availability of in-house service providers and local service providers within the country, respectively, by OIE region

Inadequate investment in the maintenance and calibration of laboratory equipment by national authorities to leverage the significant capital investments made by external partners means that laboratory equipment purchased by those external partners has become ‘consumable’: purchased repeatedly after non-use, lack of preventative maintenance, and breakdowns with little access to repair services, shortening the time to obsolescence. The high cost of repair, maintenance and calibration, tough environmental conditions, and lack of national capacity compound these issues.

From an economic sustainability point of view, the amount and source of funding is critical, and heavy reliance on donor funding for running a laboratory system should be considered unsustainable. While the capital investment in start-up represents a significant one-off cost for which donor support may be necessary, a sustainable laboratory system requires the provision of relevant services that are paid for by clients in a manner that addresses at least the actual cost of the service and the maintenance costs of the laboratory, its equipment and competent staff. The investment from government should reflect its use of the network and the perceived value of the laboratory’s outputs and presence.

3.2. Mitigation steps

a) Capacity building

The OIE Laboratory Twinning Programme⁸ is the OIE’s flagship capacity-building initiative for laboratories. It has the mission of building sustainable capacity and fostering expertise in OIE Members to create a more even geographical distribution of scientific proficiency, increased resilience against animal diseases, stronger scientific networks, and improved compliance with OIE Standards worldwide.

The OIE Laboratory Twinning Programme has led to numerous partnerships, with more than 65 projects implemented to date, around 30 projects under way (Fig. 13), and 14 new OIE Reference Centres created as a direct result. The volume of projects in progress and the interests of participating laboratories and donors to the Programme have evolved over time. During the years 2008 to 2012, the diseases that gathered the most interest were avian influenza and brucellosis. In the past two years, these diseases have been replaced by rabies and viral haemorrhagic fevers.

⁸ OIE Laboratory Twinning webpage: <https://www.oie.int/solidarity/laboratory-twinning/>

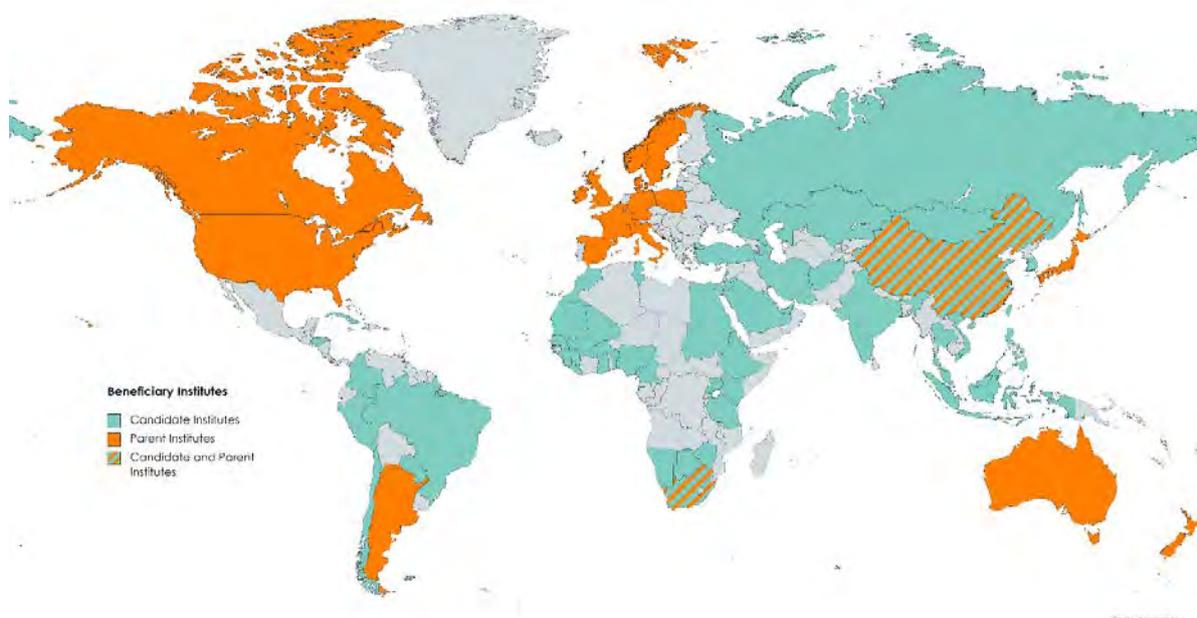


Fig. 13

Global distribution of countries engaged in laboratory twinning

b) Economic expertise

In collaboration with research partners, the OIE is undertaking studies to understand and communicate the economic aspects of laboratory sustainability. These studies include defining and describing benefit streams for clients of laboratory services (government, the private sector, donors, research partners) and providing analysis of the economic sustainability of laboratory systems. Economic experts are also providing advice to the OIE on the development of guidance on models for sustainable laboratories and tools, to highlight the value of investing in laboratory services; such arguments may be used to advocate for sustainable operating budgets.

In this way, the benefits of a secure, safe and sustainable laboratory system can be optimised and leveraged throughout the world's Veterinary Services.

c) Development and refinement of tools to support sustainable laboratory systems

With a focus on the sustainability of laboratories, the OIE initiated a process of review and refinement of its tools, aiming to enhance them, whilst taking the opportunity to make them more user friendly.

Good laboratory leadership (providing cohorts of laboratory leaders and 'champions') has been identified as important in ensuring that laboratories and systems function optimally and in a safe manner. To provide Members with access to training opportunities and materials, the OIE partnered with the Global Laboratory Leadership Programme (GLLP).

The PVS Laboratory Tool was rebranded as the PVS Sustainable Laboratories Tool (2018). Informed by the PVS External Evaluation [45], the OIE is working to simplify the PVS tools, to develop virtual mission delivery methodology, to evolve key performance indicators to measure laboratory system performance, to add value to data through dynamic visualisations, and to develop open-source tools.

A Feedback Workshop for the OIE Laboratory Twinning Programme was held in Paris, in March 2011 [46]. Although the feedback from participating institutes was generally positive, there is no consistent and standardised framework to measure the impact of individual projects or the overall programme. After nearly 15 years of experience with laboratory twinning, the OIE plans to evaluate the programme and the 'twinning' approach to capacity building, with a view to highlighting strengths and success stories, sharing experiences, and developing a monitoring and evaluation framework. A thorough assessment framework for the OIE Laboratory Twinning Programme could inform improvements to the Programme and explore the value of applying the twinning approach to other capacity-building programmes, such as emergency management.

d) Innovation and research

The sustainability of laboratories is a ‘wicked’ problem, requiring complex solutions which the OIE on its own cannot solve. The OIE has engaged key partners and is currently exploring the possibility of launching a Grand Challenge to find solutions to improve the sustainability of laboratories. The OIE is also working to develop a Biosafety Research Roadmap, which will aim to provide an evidence base to support the application of biosafety in low-resource settings.

e) Advocacy

Given the cross-sectional nature of laboratory sustainability and the diverse stakeholders who invest in and depend on the outcomes of laboratory systems, the OIE has focused on building collaborations with partners across sectors who have an interest in finding solutions. Advocacy has been focused through participation in various groups, including the Global Partnership (GP) Biosecurity Working Group (BSWG), Nuclear Threat Initiative (NTI) Global Biosecurity Dialogue, International Experts Groups of Biosafety and Biosecurity Regulators (IEGBBR), and International Veterinary Biosafety Workgroup (IVBW). Targeted work on specific areas such as innovation, biosafety and quality management to build evidence-based advocacy has taken place with Chatham House, WHO, the World Association of Veterinary Laboratory Diagnosticians (WAVLD), and OIE Collaborating Centres, the United Kingdom Animal and Plant Health Agency (APHA) and the United States Institute of Infectious Animal Disease (IIAD). The OIE will continue to consult with and build coalitions among public health, agriculture, trade and development stakeholders.

Section 3. Conclusions

The COVID-19 pandemic required a whole-of-society response, international collaboration and coordination, rapid risk management, and adaptation to prolonged disruption. It provided an important opportunity for the OIE to gain insights into its value in the pandemic response and the resilience of its own systems, and to learn how to better prepare for future crises.

The OIE made an active and positive contribution to the global response. It supported the development of global research and development agendas; provided scientific evidence and animal disease event information to support risk assessment and risk communication; disseminated science-based guidance to inform policy; and contributed to international response mechanisms. The OIE’s response was of value to Members and the OIE’s partners, particularly WHO. The OIE supported Veterinary Services by advocating for their role in maintaining essential services and supporting the public health response; for instance, by testing human samples for SARS-CoV-2. Weaknesses were identified, including a lack of consistent interpretation of international standards and of the application of risk mitigation in accordance with the guidance provided. For the OIE, one such example relates to reporting obligations for an ‘emerging disease’, which have been inconsistently applied. However, the good will of all Members ensured that the OIE has been able to collate the information reported through various channels to provide an accumulating understanding of animal susceptibility and impact.

While WHO led the public health response, the strong partnership between the OIE, WHO and FAO facilitated a One Health approach to COVID-19. The ability of the OIE to develop and provide guidance in cooperation with WHO and FAO, as well as the OIE’s scientific networks, has been important for risk management. However, it was also recognised that the OIE should establish and leverage additional functional partnerships in the future; for example, in the areas of wildlife and ecosystem health.

COVID-19 was a stark reminder about the potential human and socio-economic costs of emerging diseases. As evidence pointed to a wildlife origin, attention focused on unregulated wildlife trade as a risk factor for disease emergence. The OIE did not promote outright bans on wildlife trade. It took the position that wildlife trade is highly complex and context specific, providing both benefits and risks, and that strategies to reduce disease risks around wildlife trade need to be carefully balanced to avoid detrimental unintended consequences. It was confirmed that there are gaps in the existing evidence base around disease emergence through wildlife trade, and risk mitigation strategies need to be accompanied by further research and a monitoring and evaluation framework to assess impact, whilst avoiding unintended consequences. A scientific review provided clear recommendations to the OIE, highlighting its potential value as a knowledge broker and the importance of taking a multisectoral approach. It also called for the OIE to broaden its thinking to consider a role in improving ‘health’, in the context of other global risks at the human–animal–environmental interface, such as climate change and biodiversity loss. The OIE has recently

convened an *ad hoc* group to develop guidance on reducing the risks of disease emergence and biodiversity loss through wildlife trade; insights provided by the review will support the work of this group.

It was confirmed that both the OIE and Veterinary Services are relevant actors in managing wildlife health, and that the OIE should better integrate wildlife health into its core business. However, Veterinary Services need support because they face a number of challenges in addressing wildlife health, including the lack of an enabling scientific, political, strategic and legal environment to properly address wildlife health issues. Moreover, it is evident that, although Veterinary Services have responsibilities for wildlife health, they are often not the lead agency, and multisectoral collaboration across key areas, including surveillance, is lacking. The absence of a clear leader in wildlife health at the national, regional and international level highlighted a critical need for multisectoral collaboration. The reporting of wildlife diseases to the OIE by its Members remains a weakness. Declining trends in reporting could be reversed by simplifying the reporting requirements (e.g. consolidating the list of diseases to be reported) and by demonstrating the value of wildlife health data collected by the OIE. Surveillance and reporting could also be greatly enhanced by improved multisectoral collaboration.

Through a coordinated set of activities, which build on the OIE's existing experience, mechanisms, tools, and partnerships, the OIE's Wildlife Health Framework aims *a)* to improve the ability of OIE Members to manage the risk of pathogen emergence in wildlife and transmission at the human–animal–ecosystem interface, while taking into account the protection of wildlife; and *b)* to support OIE Members to improve their surveillance systems, early detection, notification and management of wildlife diseases. The framework aims to integrate wildlife health across the OIE's core programmes and activities.

Inevitably, the pandemic has exposed gaps in the preparedness of public health systems, which will be better understood after a thorough review and analysis in the coming months. An ongoing review of Veterinary Services emergency management capacity, carried out by the OIE, has revealed several concerns. Although Veterinary Services consider emergency management to be important, emergency plans are often not matched with sufficient resources. The availability of resources may also be hampered because Veterinary Services are often not included in national emergency management plans. The exclusion of Veterinary Services from multisectoral frameworks is a missed opportunity and a significant weakness in One Health resilience. Emergency management is highly context specific; emergency plans and approaches to capacity building need to be adapted to the particular characteristics of a country, including the risk/hazard profile and level of advancement. Variations in country characteristics can challenge a highly prescriptive, top-down approach at the international level. Ways to improve sustainability in emergency management may include agreements between countries to cooperate and share resources; the use of novel resource mobilisation mechanisms; platforms to accelerate research and development; insurance schemes; and multidisciplinary networking.

Emergency management planning in Veterinary Services tends to have a narrow focus on a handful of diseases of terrestrial animals. Wildlife and aquatic animals are under-represented. Other hazards are often not included in Veterinary Services plans. The experience of working with Members and partners from other sectors underlines the vital importance of taking a multisectoral (indeed a whole-of-society) and all-hazards approach to emergency management.

The OIE is in the process of building an evidence base for its emergency management programme that can be drawn on, as can the experience of Members, to develop fit-for-purpose guidance, integrate emergency management into existing capacity-building tools more effectively, enhance solidarity, establish partnerships, and share models and best practices to support OIE Members in improving sustainability of their emergency management systems.

The importance of resilient diagnostic systems has been thrown into relief by the COVID-19 pandemic. However, the resources required to maintain the infrastructure for disease detection are significant, and an increasing volume of evidence suggests that laboratory sustainability is a significant challenge for health services. It is likely that the lack of attention to sustainability when laboratory infrastructure was established has contributed to a chronic and complex problem. Targeted action is needed to solve existing problems and to ensure that current and future investments do not further exacerbate this problem. In collaboration with key partners, the OIE is active in seeking targeted solutions and is also refining its own laboratory capacity-building tools to ensure that sustainability is integrated as a core component. Solutions to improve resilience were developed during the pandemic through innovation and multisectoral collaboration (e.g. veterinary laboratories supporting surge capacity). It will be important to review and capture these innovative solutions and put them to good use in the future.

The response to COVID-19 and subsequent reflection on the OIE's contribution in offering to build resilience of Members' Veterinary Services has demonstrated the OIE's potential role and impact across all five key dimensions defined by the *Lancet* One Health Commission in its forthcoming report: policy; health systems and governance;

investment and financing; digital health and big data; and education and leadership. It also underpins the realisation that the OIE must take urgent action to position itself and its Members to take a leadership role in advancing One Health in a post-COVID world. One Health resilience is undoubtedly dependent on breaking barriers and building bridges between sectors, which is made possible by strengthening and spotlighting the best practices already in place.

A renewed interest and momentum in the interconnectedness between humans, animals and the environment creates an unprecedented opportunity to direct attention towards managing a whole range of threats and a much-needed shift in thinking towards a more holistic systems-based approach.

The OIE and its Members have a golden opportunity to play a leading and impactful role in continuing to demonstrate the power of the One Health approach.

The outcomes of recent multiple consultations, surveys and studies, and the lessons identified from COVID-19, have reinforced the need to promote the role of Veterinary Services as an essential component of One Health resilience. It is essential that the OIE integrates emergency management, wildlife health management, sustainable laboratories, and systems for emerging diseases into its core work programme to support Veterinary Services in preparing for, adapting to, withstanding, and recovering and moving forwards from emergency events, such as the worldwide COVID-19 pandemic.

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Annexes

- Annex 1 Wildlife health questionnaire report:
www.oie.int/app/uploads/2021/03/wildlife-health-survey-report.pdf
- Annex 2 A rapid review of evidence on managing the risk of disease emergence in the wildlife trade:
web.oie.int/download/WG/Wildlife/OIE_review_wildlife_trade_March2021.pdf
- Annex 3 Wildlife Health Framework: [20]
www.oie.int/app/uploads/2021/03/a-wildlifehealth-conceptnote.pdf
- Annex 4 OIE Consultation on sustainable laboratories report: [40]
www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/OIE_sust_labs_report_final.pdf

References

1. National Research Council (United States of America) (2012). – *Disaster resilience: a national imperative*. National Academies Press, Washington, DC, United States of America, 260 pp. doi:10.17226/13457.
2. Brand T. (2021). – The interim after-action review on the OIE’s response to COVID-19. *Bull. OIE Official*, **2020-2**. oiebulletin.com/?official=08-1-0-2020-2_after-action-review (accessed on 22 April 2021).
3. World Organisation for Animal Health (OIE) (2019). – Technical Item 1 Report: How external factors (e.g. climate change, conflicts, socio-economics, trading patterns) will impact Veterinary Services, and the adaptations required. www.oie.int/fileadmin/Home/eng/Publications_%26_Documentation/docs/pdf/TT/2019_A_87SG_9.pdf (accessed on 22 April 2021).
4. World Health Organization (WHO) (2019). – Report of the WHO–China Joint Mission on Coronavirus Disease 2019 (COVID-19). 40 pp. <https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf> (accessed on 23 April 2021).
5. Xia W., Hughes J., Robertson D. & Jiang X. (2021). – How one pandemic led to another: ASFV, the disruption contributing to SARS-CoV-2 emergence in Wuhan [pre-print only]. www.preprints.org/manuscript/202102.0590/download/final_file (accessed on 22 April 2021).
6. Dauphin G., Hamilton K., Kim L.M., Choudhury B., Capua I. & Edwards S. (2010). – Main achievements of the World Organisation for Animal Health/United Nations Food and Agriculture Organization network on animal influenza. *Avian Dis.*, **54** (Suppl. 1), S380–S383. doi:10.1637/8761-033109-REV.1.
7. World Organisation for Animal Health (OIE) (2015). – Biological Threat Reduction Strategy: strengthening global biological security. 8 pp. www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/EN_FINAL_Biothreat_Reduction_Strategy_OCT2015.pdf.
8. World Health Organization (WHO) (2020). – A coordinated global research roadmap: 2019 novel coronavirus: March 2020. 68 pp. www.who.int/publications/m/item/a-coordinated-global-research-roadmap (accessed on 22 April 2021).
9. World Organisation for Animal Health (OIE) (2021). – OIE Portal on COVID-19. www.oie.int/en/scientific-expertise/specific-information-and-recommendations/questions-and-answers-on-2019-novel-coronavirus/oie-response/ (accessed on 22 April 2021).

10. World Organisation for Animal Health (OIE) & World Veterinary Association (WVA) (2021). – Press release: COVID-19 and veterinary activities designated as essential. OIE/WVA joint statement. www.oie.int/en/for-the-media/press-releases/detail/article/covid-19-and-veterinary-activities-designated-as-essential/ (accessed on 22 April 2021).
11. World Organisation for Animal Health (OIE) (2021). – OIE considerations on the application of sanitary measures for international trade related to COVID-19. 1 p. www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/COV-19/A_COVID-19_Considerations_OIE_Sanitary_Measures.pdf (accessed on 22 April 2021).
12. World Organisation for Animal Health (OIE) (2021). – Statement of the OIE Wildlife Working Group: Wildlife Trade and Emerging Zoonotic Diseases. 1 p. www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/COV-19/A_OIEWildlifeTradeStatement_April2020.pdf (accessed on 22 April 2021).
13. World Organisation for Animal Health (OIE) (2020). – Veterinary Laboratory Support to the Public Health Response for COVID-19. Testing of human diagnostic specimens in veterinary laboratories. 4 pp. www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/COV-19/A_Guidance_for_animal_health_laboratories_1April2020.pdf (accessed on 22 April 2021).
14. World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO) & World Organisation for Animal Health (OIE) (2021). – SARS-CoV-2 in animals used for fur farming: GLEWS+ risk assessment. 26 pp. www.oie.int/fileadmin/Home/MM/GLEWS_risk_assessment_fur_animals_SARS_CoV_2.pdf (accessed on 22 April 2021).
15. World Organisation for Animal Health (OIE) (2019). – Terrestrial Animal Health Code, 28th Ed. www.oie.int/standard-setting/terrestrial-code/access-online (accessed on 22 April 2021).
16. World Organisation for Animal Health (OIE) (2019). – Aquatic Animal Health Code, 22nd Ed. www.oie.int/standard-setting/aquatic-code/ (accessed on 22 April 2021).
17. World Organisation for Animal Health (OIE) (2020). – Wildlife Health Survey Report. OIE, Paris, France, 25 pp. www.oie.int/fileadmin/Home/eng/Internationa_Standard_Setting/docs/pdf/WGWildlife/Wildlife_Health_Survey_Report.pdf (accessed on 22 April 2021).
18. Ben Jebara K., Ripani A., Popovic M. & Forcella S. (2016). – WAHIS-Wild and its interface: the OIE worldwide monitoring system for wild animal diseases. *Vet. Ital.*, **52** (2), 91–100. doi:10.12834/VetIt.235.779.3.
19. World Organisation for Animal Health (OIE) (2018). – Report of the Meeting of the OIE Working Group on Wildlife, Paris, France, 12–15 December 2017. 30 pp. www.oie.int/fileadmin/Home/eng/Internationa_Standard_Setting/docs/pdf/WGWildlife/A_86SG_13_GT.pdf (accessed on 22 April 2021).
20. World Organisation for Animal Health (OIE) (2021). – OIE Wildlife Health Framework: ‘Protecting wildlife health to achieve One Health’. OIE, Paris, France, 17 pp. www.oie.int/fileadmin/Home/eng/Internationa_Standard_Setting/docs/pdf/WGWildlife/A_Wildlifehealth_conceptnote.pdf (accessed on 22 April 2021).
21. Bonbon E. & Myers L. (2020). – Good emergency management practices: a review of the core principles, with a focus on preparedness. *In* Disaster prevention and preparedness (G.A. Vroegindewey, ed.). *Rev. Sci. Tech. Off. Int. Epiz.*, **39** (2), 533–541. doi:10.20506/rst.39.2.3104.
22. Adamson D., Gilbert W., Hamilton K., Donachie D. & Rushton J. (2020). – Preparing for animal health emergencies: considerations for economic evaluation *In* Disaster prevention and preparedness (G.A. Vroegindewey, ed.). *Rev. Sci. Tech. Off. Int. Epiz.*, **39** (2), 625–635. doi: 10.20506/rst.39.2.3112.
23. McDougale J., Sabirovic M., Pietropaoli S. & Hamilton K. (2020). – The gulf between emergency plans and the resources needed: a global review. *In* Disaster prevention and preparedness (G.A. Vroegindewey, ed.). *Rev. Sci. Tech. Off. Int. Epiz.*, **39** (2), 373–384. doi:10.20506/rst.39.2.3088.
24. World Organisation for Animal Health (OIE) (2019). – OIE tool for the evaluation of performance of Veterinary Services (PVS tool), 7th Ed. 68 pp. www.oie.int/fileadmin/Home/eng/Support_to_OIE_Members/docs/pdf/2019_PVS_Tool_FINAL.pdf (accessed on 15 February 2021).
25. Nasim A., Attal-Juncqua A., Eia C., Phelan A. & Katz R. (2020). – Inclusion of Veterinary Services in national emergency management plans. *In* Disaster prevention and preparedness (G.A. Vroegindewey, ed.). *Rev. Sci. Tech. Off. Int. Epiz.*, **39** (2), 359–371. doi:10.20506/rst.39.2.3087.
26. World Organisation for Animal Health (OIE) (2021). – National contingency plan platform. www.oie.int/en/solidarity/emergency-management/planning-for-emergencies/ (accessed on 15 February 2021).
27. World Organisation for Animal Health (OIE) (2020). – OIE Guidelines for Simulation Exercises. www.oie.int/fileadmin/Home/MM/DD_OIE_Guidelines_for_Simulation_Exercises.pdf (accessed on 15 February 2021).

28. World Organisation for Animal Health (OIE) (2020). – Exploring innovative approaches to improving sustainable management of animal health emergencies. www.oie.int/fileadmin/Home/MM/DD_Exploring_Innovative_Approaches_to_Improving_Sustainable_Management_of_Animal_Health_Emergencies.pdf (accessed on 15 February 2021).
29. World Organisation for Animal Health (OIE) (2020). – Towards a stronger partnership between Veterinary Services and law enforcement: tackling agro-crime affecting animal health and welfare. 26 pp. www.oie.int/fileadmin/Home/MM/OIE_Agro-Crime_Workshop_Report.pdf (accessed on 15 February 2021).
30. Dickmann P., Sheeley H. & Lightfoot N. (2015). – Biosafety and biosecurity: a relative risk-based framework for safer, more secure, and sustainable laboratory capacity building. *Front. Public Hlth*, **3**, 241. doi:10.3389/fpubh.2015.00241.
31. Siengsanon-Lamont J. & Blacksell S.D. (2018). – A review of laboratory-acquired infections in the Asia-Pacific: understanding risk and the need for improved biosafety for veterinary and zoonotic diseases. *Trop. Med. Infect. Dis.*, **3** (2), 36. doi:10.3390/tropicalmed3020036.
32. Collins C. & Kennedy D.A. (1999). – Laboratory acquired infections: history, incidence, causes and preventions. Butterworth Heinemann, Oxford, United Kingdom, 324 pp.
33. Pike R.M. (1976). – Laboratory-associated infections: summary and analysis of 3921 cases. *Health Lab. Sci.*, **13** (2), 105–114.
34. Sewell D.L. (1995). – Laboratory-associated infections and biosafety. *Clin. Microbiol. Rev.*, **8** (3), 389–405. doi:10.1128/CMR.8.3.389-405.1995.
35. Frischknecht F. (2003). – The history of biological warfare. Human experimentation, modern nightmares and lone madmen in the twentieth century. *EMBO Rep.*, **4** (Suppl. 1), S47–S52. doi:10.1038/sj.embor.embor849.
36. Riedel S. (2004). – Biological warfare and bioterrorism: a historical review. *Proc. (Bayl. Univ. Med. Cent.)*, **17** (4), 400–406. doi:10.1080/08998280.2004.11928002.
37. Harling R., Twisselmann B., Asgari N., Morgan D., Lightfoot N., Reacher M. & Nicoll A., for the Deliberate Release Teams (2001). – Deliberate releases of biological agents: initial lessons for Europe from events in the United States. *Euro. Surveill.*, **6** (11), 384. doi:10.2807/esm.06.11.00384-en.
38. Harling R., Morgan D., Edmunds W.J. & Campbell H. (2002). – Interim smallpox guidelines for the United Kingdom. Developing new policies from old evidence. *Br. Med. J.*, **325** (7377), 1371–1372. doi:10.1136/bmj.325.7377.1371.
39. Davies J., Abimiku A., Alobom, Mullan Z., Nugent R., Schneidman M. & Sikhondze W. (2017). – Sustainable clinical laboratory capacity for health in Africa. *Lancet Glob. Hlth*, **5** (3), e248–e249. doi:10.1016/S2214-109X(17)30024-4.
40. World Organisation for Animal Health & Canada (2018). – OIE consultation on sustainable laboratories. 18 pp. www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/OIE_sust_labs_report_final.pdf (accessed on 22 April 2021).
41. Sayed S., Cherniak W., Lawler M., Tan S.Y., El Sadr W., Wolf N., Silkensen S., Brand N., Looi L.M., Pai S.A., Wilson M.L., Milner D., Flanigan J. & Fleming K.A. (2018). – Improving pathology and laboratory medicine in low-income and middle-income countries: roadmap to solutions. *Lancet*, **391** (10133), 1939–1952. doi:10.1016/S0140-6736(18)30459-8.
42. World Organisation for Animal Health (OIE) (2018). – Chapter 1.1.4. Biosafety and biosecurity: standard for managing biological risk in the veterinary laboratory and animal facilities. In *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals*, 8th Ed. www.oie.int/fileadmin/Home/eng/Health_standards/tahm/1.01.04_BIOSAFETY_BIOSECURITY.pdf (accessed on 22 April 2021).
43. Wilson M.L., Fleming K.A., Kuti M.A., Looi L.M., Lago N. & Ru K. (2018). – Access to pathology and laboratory medicine services: a crucial gap. *Lancet*, **391** (10133), 1927–1938. doi:10.1016/S0140-6736(18)30458-6.
44. Horton S., Sullivan R., Flanigan J., Fleming K.A., Kuti M.A., Looi L.M., Pai S.A. & Mark Lawler M. (2018). – Delivering modern, high-quality, affordable pathology and laboratory medicine to low-income and middle-income countries: a call to action. *Lancet*, **391** (10133), 1953–1964. doi:10.1016/S0140-6736(18)30460-4.
45. World Organisation for Animal Health (OIE) (2021). – PVS Pathway external evaluation: towards greater impact. *Bull. OIE Official*, **2020-2**. <https://oiebulletin.com/?official=08-1-4-2020-2-pvs> (accessed on 22 April 2021).
46. World Organisation for Animal Health (OIE) (2011). – OIE Laboratory Twinning Feedback Workshop, Paris, France, 30–31 March 2011. 5 pp. www.oie.int/fileadmin/Home/eng/Support_to_OIE_Members/pdf/twinningfeedback.pdf (accessed on 22 April 2021).

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