INTERAGENCY REPORT

Coordinated One Health investigation and management of outbreaks in humans and animals caused by zoonotic avian influenza viruses

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This report was produced by the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA).

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Abbreviations

ADIS	Animal Diseases Information System
AIV	avian influenza virus
Ct	cycle threshold
DG SANTE	Directorate-General for Health and Food Safety
EBS	event-based surveillance
EC	European Commission
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
EJP	European Joint Programme
EU	European Union
EEA	European Economic Area
EWRS	Early Warning and Response System
HPAI	high pathogenic avian influenza
LPAI	low pathogenic avian influenza
OHHLEP	One Health High Level Expert Panel
PH	public health
PPE	personal protective equipment
TESSy	The European Surveillance System
WOAH	World Organisation for Animal Health
zAI	zoonotic avian influenza

Executive summary

When investigating and controlling outbreaks caused by zoonotic avian influenza viruses (AIV), a One Health approach is key. However, knowledge-sharing on AIV-specific One Health strategies, tools and action plans remains limited across the EU/EEA. It is crucial to establish responsibilities, capacity requirements, and collaboration mechanisms during 'peace time' to enable timely and effective outbreak investigations and management.

This report focuses on five scenarios for outbreak investigation and management of zoonotic AIV at the human-animal-environment interface, emphasising key actions for the stakeholders involved. The document primarily highlights the collaborative framework necessary for interdisciplinary coordinated responses, referring to more detailed guidance and technical reports published elsewhere when applicable. Three scenarios are triggered by suspected outbreaks in animals, including kept animals of listed species, non-listed species, companion animals and wild birds/mammals. The other two scenarios are initiated by a probable human case or detection of the virus in wastewater or environmental samples (e.g. surface water or other sources).

All scenarios require cross-sectoral coordination and a One Health approach. While the specific sequence of actions and communication needs may differ across scenarios, the overarching response mechanisms for outbreak investigations and management remain consistent. By presenting each scenario alongside the integrated actions of stakeholders, the report identifies critical development needs, such as tools (e.g. communication and data sharing platforms); key points for information exchange across sectors, triggers for joint risk assessments, and gaps in existing knowledge.

The document should assist in developing guidance documents to facilitate coordinated One Health investigations and the management of outbreaks in humans and animals caused by zoonotic avian influenza viruses.

1. Scope of this document

This report has been compiled in response to a request from the European Commission (EC) to the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA) (Annex 1) and covers the investigation and the management of outbreaks in animals and humans caused by zoonotic avian influenza viruses using a One Health approach. The report considers five different scenarios at the human-animal-environment interface for outbreak investigations. It covers a One Health approach to investigating and controlling outbreaks caused by zoonotic avian influenza viruses, including an overall approach to joint outbreak investigations, joint risk assessments that should inform risk managers, and potential management measures that should be taken. Each of the five scenarios outlines the actions that should be undertaken by the different stakeholders to investigate the source of the infection and prevent further transmission using a One Health approach. This report does not cover the technical aspects of managing outbreaks in animals or humans in detail, as this is dealt with in EU legislation for animals and in various existing guidance and technical reports published by the European Centre for Disease Prevention and Control for humans. The guidance documents, legislation and technical reports are referred to in this document, where pertinent. Knowledge gaps for which guidelines or regulations still need to be developed are also highlighted.

2. Target audience

The target audience of this report is the European Commission (EC). The EC will use the scientific and technical assistance provided in this report to support Member States in developing their guidance documents to facilitate coordinated One Health investigations and the management of outbreaks in humans and animals caused by zoonotic avian influenza viruses.

3. Data and methodologies

This report was jointly developed by ECDC and EFSA experts. Input was also sought from other stakeholders, such as the European Environment Agency. Contributions by the European Agency for Safety and Health at Work (EU-OSHA) were collected in the development of recently published technical reports [1,2] and these reports are referenced, when applicable.

European legislation, guidance documents from ECDC and EFSA, and materials from other public health authorities were reviewed to develop this guidance. The selection process focused on their relevance to outbreak investigations and management, particularly in the context of zoonotic avian influenza and One Health approaches. Strategies and actions required for effective and timely One Health investigation and management of zoonotic avian influenza outbreaks identified in these documents are described and explained in this report. Knowledge gaps and recommendations for addressing these were developed using a consensus process involving the contributing experts, to ensure that they reflect both evidence and practical considerations.

The report focuses on five scenarios for outbreak investigation and management at the human-animal-environment interface. These scenarios have been jointly developed by the experts considering the different sets of circumstances that would trigger outbreak investigations requiring a One Health approach. Scenarios which only consider a single sector, such as animal-to-animal or human-to-human transmission, are not included.

4. The One Health approach

4.1 Principles of the One Health approach

According to the One Health High-Level Expert Panel (OHHLEP), the scientific and strategic advisory group to the Quadripartite organisations Food and Agriculture Organization of the United Nations (FAO), United Nations Environment Programme (UNEP), World Health Organization (WHO) and World Organisation for Animal Health (WOAH) [3], One Health is defined as 'an integrated, unifying approach that aims to sustainably balance and optimise the health of humans, animals, plants and ecosystems. It recognises the health of humans, domestic and wild animals, plants and the wider environment (including ecosystems) are closely linked and interdependent. The approach mobilises multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development.' [4]. The approach relies on collaboration, coordination and integration of disciplinary and sectoral knowledge into collective actions. Additional European regional guidance has recently been published on adopting an overall One Health approach [5,6]. A One Health approach assures timely, efficient, and more sustainable health outcomes for animal, human and environmental health.

4.2 Establishing One Health strategy and actions for outbreak response

For One Health outbreak investigations and management to be timely and effective, a One Health strategy should be established in 'peace time' which outlines responsibilities, capacity needs and collaboration mechanisms for responding to outbreaks. To allow efficient cross-sectoral collaboration, appropriate regulatory frameworks need to be put in place, removing any existing legislative barriers, and adequate financial resources need to be allocated, including horizontal funding for activities with shared objectives. In addition, key stakeholders need to be identified at national, regional and local level, including public health agencies, veterinary agencies, food safety agencies, medical professionals (veterinary and medical doctors), occupational health professionals, environmental agencies and wastewater surveillance stakeholders.

Developing an overall joint national One Health strategy assists in establishing effective collaboration between existing actors which can then be used effectively for different threats. It is important for the roles and responsibilities of the different stakeholders to be clearly outlined. An effective One Health strategy should also define the communication mechanisms between stakeholders and the data sharing mechanisms. Similarly, tools to be used during the investigation and management of outbreaks should be developed: standard One Health operating procedures, checklists, questionnaires, data models, joint databases and joint risk assessment models. These tools can then quickly be adapted to the situation at hand, as necessary. Joint training events, including simulation exercises, and information campaigns also need to be organised to disseminate knowledge and create awareness of the One Health strategy.

As outlined in their joint opinion on the preparedness, prevention and control of zoonotic avian influenza [2], ECDC and EFSA propose that the following points be included in a One Health strategy to respond to outbreaks:

- legal provision in place to implement measures using a One Health approach;
- collaboration and communication between relevant authorities, such as public health, occupational safety and health, animal health, and environmental authorities at national, regional and local level;
- clear role definition and lines of command;
- clear definition of actions and their timing;
- availability of human resources;
- laboratory capacity, including capacity to scale up diagnostic testing and provide timely whole genome sequencing;
- surveillance capacity;
- capacity for culling (if foreseen) and safe disposal of carcasses as Category 1 animal by-products [7];
- training of personnel to be involved in outbreak response;
- communication plan for specific target groups (e.g. farmers, citizens, hunters).

In addition, specific approaches and action-plans for known threats (e.g. zoonotic influenza) need to be drafted to allow for swift and coordinated responses. One example are threat-specific contingency plans (e.g. checklists, questionnaires, data models, joint databases and joint risk assessment models, see **Table 1**). Agreement of these approaches and action plans by the different stakeholders before an outbreak occurs will facilitate swift and coordinated responses. Tools that might help countries setting up their One Health strategy, actions and teams include the 'Guidelines for risk analysis of zoonoses' and the 'OH-EpiCap Tool' that have been developed under the One Health European Joint Programme (EJP) [8] projects 'Cohesive' [9] and 'Matrix' [10], respectively.

A recent fact-finding visit to Finland by Directorate F of the European Commission's Directorate-General for Health and Food Safety aimed to identify good practices and opportunities for improvement in implementing the One Health approach to reduce serious zoonotic risks from fur animal farming. The resulting report provides a detailed description and analysis of the relevant mechanisms in place following the One Health approach, that might be helpful for countries who intend to develop their own One Health strategy [11].

4.3 One Health approach to investigating and controlling outbreaks caused by zoonotic avian influenza viruses

When investigating and controlling outbreaks caused by zoonotic avian influenza viruses, a One Health approach is key. Table 1 outlines the main tools needed for outbreak investigation and management of zoonotic avian influenza and these should be developed with all those involved during 'peace time'. Adequate resources and political support are crucial for the development and implementation of these tools which ensure preparedness to respond rapidly and effectively to zoonotic avian influenza threats.

Table 1. Development of specific tools for zoonotic avian influenza outbreak investigations and management (further details on each action can be found in Section 4.3)

	Action	Involved actors	Output
A	Identify stakeholders across sectors for coordinated planning, information sharing, assessments and outbreak management.	Public health, veterinary, environmental health and occupational health authorities as well as other stakeholders, e.g. from the farming sector.	List of specific stakeholders and their contact details.
B	Agree on objectives and procedures for data collection and sharing – this should include structure of the data to be collected (metadata).	Public health, veterinary, environmental, and occupational health authorities.	Agreed objectives and procedures outlining what data is collected (list of variables to be collected) and how and when it is shared.
C	Prepare a checklist for collecting the relevant information on the number of exposed individuals, their level of exposure and relevant contact details.	Public health, veterinary, environmental health, and occupational health authorities as well as other stakeholders.	Checklist with all relevant information needed.
D	Develop technical recommendations and organisational procedures for the protection of workers, including the use of personal protective equipment (PPE).	Public health and occupational health authorities, as well as other stakeholders involved in national preparedness planning, in consultation with veterinary authorities and representatives of relevant farming sectors.	Recommendations and procedures (technical and organisational) on protection of workers and personal protective equipment (PPE) use.
E	Design information to be given to exposed individuals in suspected animal outbreaks.	Public health, veterinary, and occupational health authorities.	Pamphlet with information on risk mitigation measures, contact points for questions and actions to be taken if symptoms develop.
F	Develop model for joint risk assessment.	Public health, veterinary, and environmental health authorities.	Model for joint zoonotic avian influenza risk assessment.
G	Establish plans for response (e.g. for vaccination of humans) and monitoring.	Public health, occupational health, and environmental health authorities.	Action plan that can be used in different outbreak scenarios, including monitoring of the response.

The key to any work on zoonotic avian influenza collaboration is to identify stakeholders across sectors for coordinated planning, information sharing, assessments and outbreak management (**Item A** in **Table 1**) at national and regional level. A list of up-to-date contact information on stakeholders should be available which can be used both in peace time, to establish Items B-G, and during an outbreak.

While it is important that the overall One Health strategy establishes overarching mechanisms, such as data sharing between agencies (e.g. a common data sharing platform), it is important that specific objectives and procedures for data collection and sharing are established for known disease threats. What, how, why and when data on humans, animals and the environment is to be collected and shared during a zoonotic avian influenza outbreak needs to be defined (**Item B** in **Table 1**). A structure for data collection (metadata) should be agreed

and established, taking legal and technical requirements into consideration [12,13]. Specific procedures on data sharing should ideally be tested in joint simulation exercises to ensure that data can be shared quickly and seamlessly in the event of an outbreak.

To obtain the relevant information during an outbreak, a checklist should be drawn up regarding exposed humans which would be completed by the first responding authority. The checklist should collect information on the exposed individuals, the time and level of exposure, and relevant contact details (**Item C** in **Table 1**), based on ECDC's guidance [12]. The information should be promptly shared with other stakeholders using established procedures that ensure the protection of personal data. (Item B). If the first responders are the veterinary authorities, they would collect the names and contact details of exposed individuals and provide the information to the public health authorities, who would then collect the remaining information on the level of exposure and any clinical symptoms. Training is needed to make sure the stakeholders know how to use the checklist in an outbreak scenario.

Recommendations on procedures outlining technical and organisational aspects for the protection of workers, including the use of personal protective equipment (PPE), will also need to be established in collaboration with the occupational health and safety authorities (**Item D** in **Table 1**) (for further information, see [2]). According to Article 3 of the EU Directive on the protection of workers from risks related to exposure to biological agents at work [14], employers are responsible for implementing appropriate preventive measures in accordance with a workplace risk assessment. This risk assessment needs to be updated regularly and include risk of exposure, and the nature, degree and duration of exposure. Recommendations should be developed by public health and occupational health authorities in consultation with veterinary authorities and representatives of the relevant farming sectors to ensure that they are tailored to relevant working environments and activities performed. Risk mitigation measures should also be included in the overall information pamphlet **(Item E** in **Table 1**).

In the case of an outbreak in animals, it is important that information on risk mitigation measures is shared with exposed individuals as soon as possible by the first responding authority. To facilitate this, a pamphlet should be prepared with information on the risk of zoonotic infection and risk mitigation measures that can be taken by individuals exposed to potentially infected animals. This pamphlet could include information on how to reduce exposure to infected animals and their environment; use of appropriate PPE; ventilation; avoiding or reducing procedures which generate dust and aerosols; disinfection; the need to monitor for symptoms of illness for 10–14 days after the last day of exposure; what to do if symptoms develop, and contact points for questions (**Item E** in **Table 1**). When designing this information, it is important to take into consideration the target population groups (e.g. language used, migration status sensitivity, etc.) and involve key national and regional stakeholders (e.g. public health, occupational health, and veterinary health authorities).

A joint zoonotic avian influenza risk assessment model should be developed specifically for several known scenarios involving zoonotic avian influenza virus transmission (**Item F** in **Table 1**). While risk assessment frameworks exist separately for animal [15] and human health [16], it is crucial to develop integrated joint risk assessment models that take into consideration the various approaches and priorities of different sectors. Key stakeholders should be involved in the exercise to establish risk pathways and data needs, and to identify possible actions (e.g. investigation and control). These risk assessment models can later be adapted to different situations as they arise. In addition, establishing these models in peace time will strengthen collaboration between key stakeholders and identify uncertainties and knowledge gaps.

It is important to also establish response plans for the different scenarios and plans for monitoring the response (**Item G** in **Table 1**), taking into consideration the feasibility of implementation. For example, to consider the use of antivirals for post-exposure prophylaxis and treatment, as well as scenarios in which vaccination in humans may be recommended. Vaccination against seasonal influenza in humans can be offered to individuals who are occupationally exposed to avian influenza viruses to reduce the risk of reassortment between avian and human influenza viruses. Furthermore, vaccination against A(H5) viruses can be considered for groups at higher risk of exposure to A(H5N1) infected animals or contaminated environments. Considerations that may inform the decision to offer vaccination include the epidemiological situation; the risk of zoonotic transmission and human infection, including severity; changes in genetic characteristics of circulating viruses which may affect the zoonotic risk, and the objective of vaccination. If zoonotic influenza vaccination is offered, it should be a component of a wider, comprehensive approach to outbreak management. It is important to monitor response actions in order to evaluate the effectiveness of interventions and their implementation. For example, monitoring of vaccine uptake and safety, as well as surveillance of viral characteristics should be incorporated into vaccination plans. Specific vaccination recommendations are under the remit of national authorities [2].

4.4 Scenarios at the human-animal-environmental interface of zoonotic avian influenza outbreaks

An investigation into a possible zoonotic avian influenza outbreak could be triggered by multiple scenarios. In this report, five scenarios are covered, with a focus on outbreaks of zoonotic avian influenza at the human-animal-environment interface: a suspected outbreak in kept animals of listed species[1] (Aves – Birds [17]) (Scenario 1a, Figure 1); a suspected outbreak in kept animals from non-listed species or cases in companion animals (Scenario 1b, Figure 2); suspected cases in wild birds or mammals (Scenario 2, Figure 3), a probable case in humans (Scenario 3, Figure 4), and detection in wastewater or environmental samples (surface water or other environmental samples, Scenario 4, Figure 5).

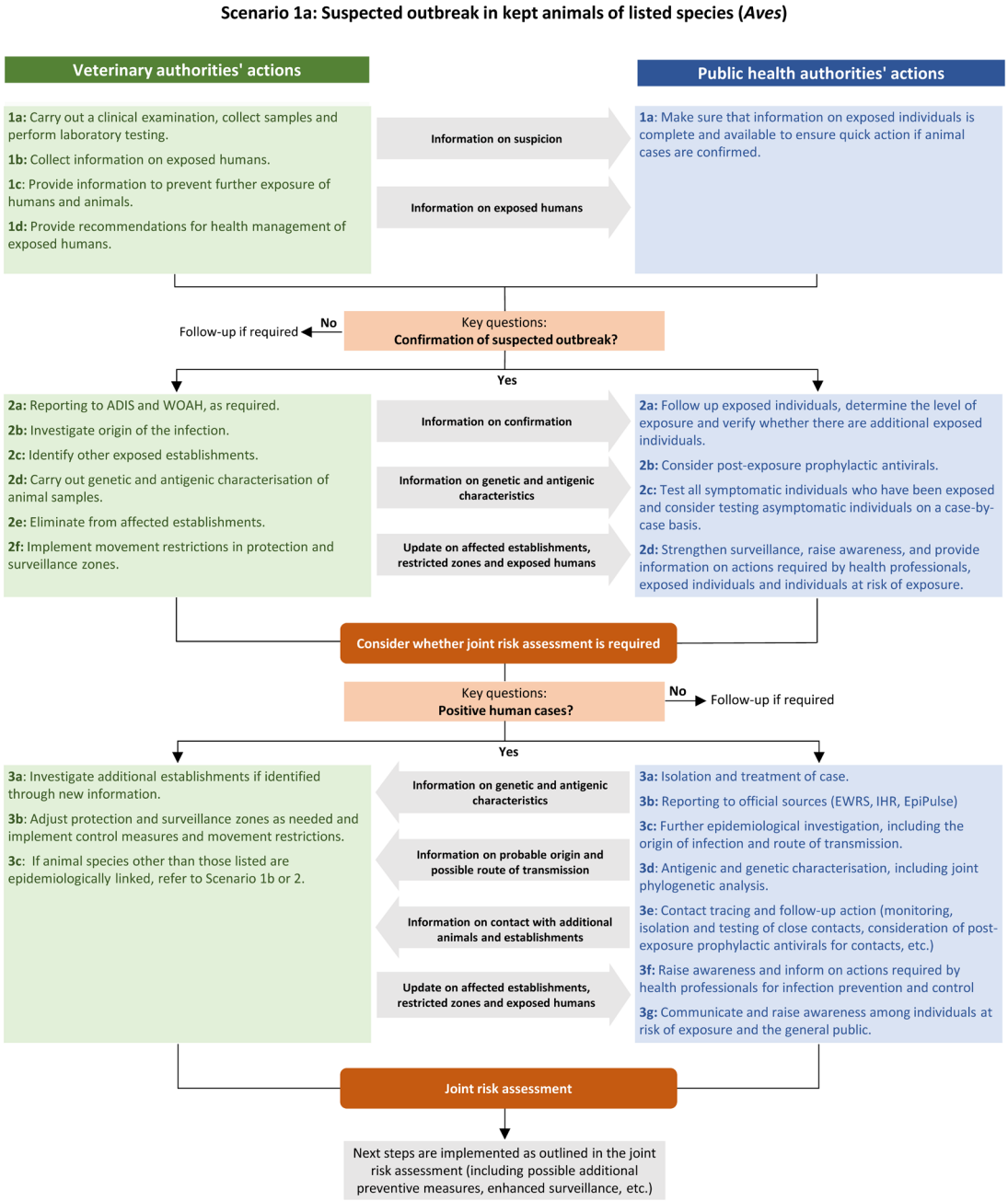
As soon as a zoonotic avian influenza virus is suspected or identified, the One Health response should be activated. While the environmental sector is only explicitly shown in Scenario 4, it is important for actors from this sector to be actively involved in all scenarios (e.g. sending alerts of the suspicion/confirmation of an outbreak which could lead to increased testing of environmental samples).

Scenarios 1– 4 provide an overview of the actions that human (Public Health, PH) and animal health (Veterinary Public Health, VPH) stakeholders should take following the trigger events. They also outline key communication topics, questions and consideration points for a joint risk assessment. They should be used in combination with the detailed description of the activities, the related legal documents, and existing resources provided in the text below the figures. The scenarios and suggested actions may need to be adapted in accordance with national or regional legislation and working practices. While the figures are presented in a linear manner, as an outbreak evolves, it may be important to circle back to earlier actions (e.g. if animals in a different establishment are affected) or jump to another scenario (e.g. if detections in wildlife are followed by detections in kept animal establishments). The scenarios and actions proposed do not cover all eventualities, and additional action, compatible with the respective legal frameworks, should be identified through joint risk assessments which are key tools for controlling an outbreak. This could also lead to the involvement of additional stakeholders.

[1] Animal species and groups of animal species posing a considerable risk for the spread of high pathogenic avian influenza, as per Commission Implementing Regulation (EU) 2018/1882.

5. Scenario 1a: suspected outbreak in kept animals of listed species

Figure 1. One Health actions triggered by a suspected outbreak in kept animals of listed species (Aves - Birds)



ADIS: Animal Diseases Information System, WOAH: World Organisation for Animal Health, EWRS: Early Warning and Response System, IHR: International Health Regulations

5.1 Veterinary public health action 1

When an outbreak of zoonotic avian influenza (zAI) in kept animals of listed species (Aves - Birds [17]) is suspected (Figure 1), the competent veterinary authorities should undertake an outbreak investigation in the suspected establishment and inform the public health authorities of the suspicion. The objective of this investigation is to confirm the suspicion and identify the causative agent, to understand the origin of the pathogen and the magnitude of spread within the holding as well as beyond it, and to identify risk factors associated with the outbreak. The investigations and disease control measures described in Commission Delegated Regulation (EU) 2020/687 [18] and those listed in Regulation (EU) 2016/429 [19] should be applied.

A clinical examination of poultry or other captive birds that appear sick should be carried out by the official veterinarian in each production unit. Samples must be collected from each production unit. The nature and number of samples to be collected is described in EFSA's Scientific Opinion on control measures for high pathogenic avian influenza (HPAI) [20]. The samples should be submitted to the relevant official laboratory, which should follow the detailed procedures for avian influenza diagnosis provided by the EU Reference Laboratory for Avian Influenza [21]. During the investigation, the official veterinarian should also remind the operator of the establishment to implement the disease control measures outlined in Article 5 of Commission Delegated Regulation (EU) 2020/687 [18] to prevent any spread of the disease.

According to Directive 2000/54/EC [14], employers are required to keep a record of workers that have been exposed to biological agents classified as Group 3 or 4. HPAI A(H5), HPAI A(H7) and low pathogenic avian influenza (LPAI) A(H7N9) viruses belong to zoonotic avian influenza subtypes, classified as Group 3 [22]. To limit the number of people visiting the establishment – which increases the spread risk – when inspecting the suspected establishment, the official veterinarian should also record which individuals have been exposed to the animals and how they can be contacted by the public health authorities. To this end, the checklist of relevant information to collect, that should have been developed as part of the country's One Health strategy (see Item C in Table 1), should be completed by the official veterinarian with the names and contact details of exposed individuals. This list should be shared with the relevant public health authorities using the data sharing procedure established in the country's One Health approach **(Item B** in **Table 1**). This will enable the public health authorities to collect the remaining information on the individual's level of exposure and any clinical symptoms, should the outbreak be confirmed. At the same time, the official veterinarian should give to the establishment operator and/or the personnel present the information on public health risk mitigation measures, contact points for health-related questions, and actions that people should take if they develop symptoms (see **Item E** in **Table 1**).

5.2 Public health action 1

After being informed of a suspected outbreak in kept animals of listed species (*Aves*) by the competent veterinary authorities, public health authorities should ensure that they have complete information on individuals exposed (as outlined in **Item C** of **Table 1**). Information on any exposed individuals should be forwarded to the relevant central, regional or local public health officials, as defined in **Item A** of **Table 1**. Early access to complete information on exposed individuals (**Item B** in **Table 1**) ensures timely follow-up and, if required, facilitates the testing of exposed individuals when an animal outbreak is confirmed.

5.3 Veterinary public health action 2

If the outbreak of zoonotic avian influenza in kept animals of listed species is confirmed, the competent veterinary authorities inform their public health colleagues and share the results of the laboratory tests with them. Furthermore, they need to report the findings to WOAH and to ADIS, as required by Commission Implementing Regulation (EU) 2020/2002 [23].

The AIV isolates from animals should be characterised genetically and antigenically, following guidance from the EU reference laboratory for Avian Influenza and Newcastle Disease [24]. Whole Genome Sequencing (WGS) should be carried out to identify linked animal outbreaks and human cases, and to assess the zoonotic risk of the virus, including mutations associated with mammalian adaptation, antiviral drug resistance, and antigenic changes compared to candidate vaccine viruses (EFSA Animal Health and Welfare (AHAW) Panel, ECDC et al., 2025). The results of the genetic and antigenic characterisation of the virus should be shared with the public health authorities, and sequences should be uploaded to an open repository, such as GISAID [25].

As outlined in Article 57, Section 2 of Regulation 2016/429 [19], the likely origin of the virus and the means of its spread should be established. The official veterinarian should determine how long the disease had been present in the establishment and how the AIV could have been introduced by talking to the operator and checking the establishment records. Movements of animals, fomites or people that could have spread the AIV to other establishments or the surrounding environment should also be identified. To this end, production and health records (e.g. daily mortality, egg production and feed and/or water intake) going back 21 days before the

commencement of clinical signs should be checked by the official veterinarian. This may lead to the identification of further flocks (or other epidemiological units) for clinical inspection and collection of samples. In addition, the results of the active or passive surveillance of avian influenza in kept and wild animals of non-listed species in the affected area that is carried out under Commission Delegated Regulation (EU) 2020/689 [26] should also be assessed to ascertain their role in the introduction of the AIV into the establishment. Sampling and testing of other kept and domestic animals in the affected poultry farm could also be considered. The public health authorities should be updated on any new affected establishments that are identified, the individuals exposed at these establishments, and the location and size of the restricted zones.

From the beginning of the outbreak investigation, the competent veterinary authorities should implement control measures to prevent the spread of the pathogen to other susceptible animals, humans and the environment. The control measures applicable to suspected and confirmed outbreaks of avian influenza in animals of listed species (*Aves*) are defined in Regulation (EU) 2016/429 [19] and in Commission Delegated Regulation (EU) 2020/687 [18]. These include immediate killing of poultry or captive birds in affected establishments, their disposal and the destruction of contaminated feed stuffs, equipment and manure, or their treatment leading to inactivation of the virus. To limit the spread of the virus, the competent authorities have to establish movement restrictions in the restricted zone, consisting of a protection zone and a surveillance zone around the affected establishment with a radius of at least three and 10 kilometres, respectively.

5.4 Public health action 2

Individuals exposed to zoonotic avian influenza should be assessed and followed up by public health professionals. People who have been exposed to animals infected with zoonotic avian influenza virus while not wearing appropriate personal protective equipment should be monitored for symptoms for 10–14 days after the last exposure. The decision to follow up actively, where the exposed individual is contacted regularly during the monitoring period by public health authorities, or passively, where exposed individuals contact public health authorities at specific intervals or if they develop symptoms, should be decided based on the exposure level. Exposed individuals should be tested if they develop symptoms compatible with zoonotic avian influenza infection, such as respiratory disease, conjunctivitis, or unexplained neurological symptoms [12,27], during the monitoring period. Following potential exposure to zoonotic avian influenza virus, individuals with symptoms should self-isolate until the zoonotic influenza infection has been excluded. Asymptomatic individuals, exposed to animals with suspected or confirmed zoonotic avian influenza virus infection where appropriate protective measures have not been taken, should be assessed on a case-by-case basis. A decision on whether to test such an individual will depend on the level of exposure, individual risk factors and the genetic and antigenic characteristics of the virus present in animals.

Antiviral post-exposure prophylaxis (e.g. oseltamivir, zanamivir, or baloxavir marboxil [28]) can be considered in individuals with unprotected exposure to zoonotic avian influenza viruses, in accordance with national recommendations. Further details on follow-up of humans exposed to animals infected with zoonotic avian influenza virus can be found in ECDC's investigation protocol for human exposure and cases of avian influenza [12]. Further information on diagnostic methods is available in ECDC's guidance on testing and detection of zoonotic avian influenza virus infection in humans [1].

Measures should be taken to reduce human risk of exposure to animals infected with zoonotic avian influenza. Occupational settings should have health and safety measures in place to reduce the risk of infection when in contact with potentially infected animals or highly contaminated environments. Preventive measures include reducing the number of individuals exposed to potentially infected animals, using appropriate personal protective equipment, avoiding aerosols and dust, and separating workwear and non-workwear. Information should be provided in relevant languages to raise awareness among people at potential risk of exposure and how the risk can be mitigated, with guidance tailored to specific occupational groups. Recommendations for PPE use should be developed in collaboration with veterinary authorities, occupational health authorities and other stakeholders, as part of the One Health preparedness tools outlined in Table 1, Item D. Workers should receive context-specific training on personal protective measures to reduce the risk of exposure to infection and on appropriate use of PPE, taking into consideration the working environment and the activities performed. Under Directive 2000/54/EC [14], employers are responsible for implementing preventive measures in accordance with a workplace risk assessment that is regularly updated [1].

All healthcare workers, including primary care workers, should be made aware of the epidemiological situation and range of possible symptoms associated with zoonotic avian influenza infection in humans. Surveillance efforts for zoonotic influenza A in humans should be enhanced in areas where this is indicated by the epidemiological situation. Healthcare professionals should be vigilant for potential human cases of zoonotic avian influenza, especially in geographical areas where the virus is known to occur in animals [27,29].

5.5 Potential joint risk assessment

At this stage, a joint risk assessment should be considered. Criteria for deciding if this is necessary include human exposure risk and whether there are any new groups (e.g. occupational groups or other sub-populations) at risk of exposure; virus characteristics, such as genetic changes associated with an increased zoonotic risk, or availability of treatment options – e.g. antivirals. The risk assessment should identify the next steps that the respective stakeholders need to take to reduce the infection risk.

5.6 Public health action 3

If the public health investigations confirm human cases of zoonotic avian influenza infection, confirmed human cases should isolate for 14 days and be managed clinically in accordance with national protocols. If hospitalisation is required, cases should ideally be placed in an isolation room with an anteroom and negative pressure. Isolation of confirmed cases can be discontinued before the recommended 14 days has elapsed if symptoms resolve and two consecutive RT-PCR tests, with a one-day interval in-between, are negative. Antiviral treatment should be initiated as soon as possible in confirmed cases [12].

Information on human infections with zoonotic or novel influenza A viruses and response measures should be reported within 24 hours of laboratory diagnosis to the Early Warning and Response System of the European Union (EWRS) and World Health Organization in accordance with EU regulations and International Health regulations [30,31]. Epidemiological data should also be shared via EpiPulse (Event-based surveillance (EBS) [32] and TESSy [33]).

In order to determine the population at risk of exposure, prevent further transmission events and identify any additional measures required, epidemiological investigations of human cases should be performed. The clinical presentation and severity of infection, likely source of infection and route of transmission should be established. Suggested case-based data to be collected for human cases of zoonotic avian influenza are described in ECDC's zoonotic influenza virus reporting protocol [13]. The outcome of the epidemiological assessment should be communicated to the animal health authorities, including information on whether there has been any contact with additional animals or animal establishments that needs to be followed up. It is important to note that migrant and seasonal workers may be linked to an animal outbreak. They may have travelled to a different region or country where contact with additional animals or animal establishments may have occurred. Therefore, cross regional/national collaboration and communication may be required in the epidemiological investigations.

To assess changes in the zoonotic risk posed by circulating viruses and available countermeasures, samples from cases should be characterised genetically and antigenically. Zoonotic avian influenza viruses from humans should be sequenced and shared in public databases in a timely manner, as outlined in Section 5.3. Genetic changes, including reassortment events and mutations that may alter the zoonotic potential, indicate mammalian adaptation or reduce susceptibility to available antiviral drugs, should be monitored. Antigenic similarity to authorised vaccines and candidate vaccine viruses, and any changes that may affect cross-reactivity of viruses should also be assessed. Veterinary authorities should be informed of the genetic and antigenic characteristics of the virus and a joint phylogenetic analysis of available human and animal sequences should be performed.

Public health authorities should coordinate contact tracing and management for confirmed human cases of zoonotic avian influenza. The case investigation should record the number of contacts identified and traced for each confirmed human case. Contacts of confirmed cases should be tested as soon as possible and advised to self-isolate and monitor for symptoms for 14 days from the last day of exposure, even if the test result is negative. Public health authorities should actively monitor contacts for the development of symptoms consistent with zoonotic AIV infection through daily follow-up. If symptoms develop, the contacts should be re-tested as soon as possible. Antiviral post-exposure prophylaxis can be considered for close contacts, depending on the level and duration of exposure, the risk of complications from infection, and antiviral susceptibility of circulating avian influenza virus strains.

If potential or probable cases are identified later in the investigation process or after recovery from symptoms, serological testing can be considered to assess for the presence of antibodies against avian influenza virus, as an indication of previous exposure to infection. Furthermore, where specimens are suspected to be positive as a result of environmental contamination, serological testing can be used as a tool in combination with other evaluations to help distinguish between true infections and environmental contamination of the mucosa. However, the limitations of serological tests need to be considered, such as the possibility of cross-reactions between subtypes or lineages of subtypes.

Further information on epidemiological investigation, follow-up and management of individuals with confirmed infection can be found in ECDC's guidance on testing and detection of zoonotic influenza virus infections in humans [1] and ECDC's investigation protocol for human exposures and cases of avian influenza [12].

As mentioned under Public health action 2 (section 5.4), all healthcare workers, including primary care workers, should be made aware of the epidemiological situation (e.g. confirmation of human cases) and range of symptoms associated with zoonotic avian influenza infection in humans. Human cases of AIV infection should be managed as potentially highly infectious and staff involved in the care of cases should be trained in infection prevention and control and appropriate use and disposal of PPE. Healthcare staff involved in the care of human cases should be monitored for symptoms in accordance with the previously described guidance on contact tracing. Further information on clinical aspects, infection prevention and control in healthcare settings can be found in the previously described ECDC publication [12].

Clear communications should be provided to the general public and individuals at risk of exposure, using multiple communication channels. Measures should be taken to reduce human risk of exposure to zoonotic avian influenza virus, including awareness-raising among the general public on the risk of infection with zoonotic avian influenza virus and how it is transmitted. The general public should be informed of the need to avoid contact with sick or dead animals and potentially contaminated environments in areas with known outbreaks on farms.

The need for additional response actions, such as vaccination, should be considered depending on the epidemiological situation and risk of zoonotic infection (Table 1, Item G).

5.7 Veterinary public health action 3

Throughout the duration of the outbreak, the competent veterinary authorities should investigate additional establishments, as indicated by new information emerging from the veterinary or public health investigations. Protection and surveillance zones may therefore need to be adjusted and control measures and movement restrictions implemented, as required. If the investigations indicate that animal species other than those listed are epidemiologically linked to the outbreak (e.g. companion animals, animals kept for fur production or wild mammals), the actions identified in a joint risk assessment should be carried out (see Scenario 1b or 2). Information on any additional affected establishments identified, the individuals exposed and their contact details, and the location and size of the restricted zones should be provided to the public health authorities.

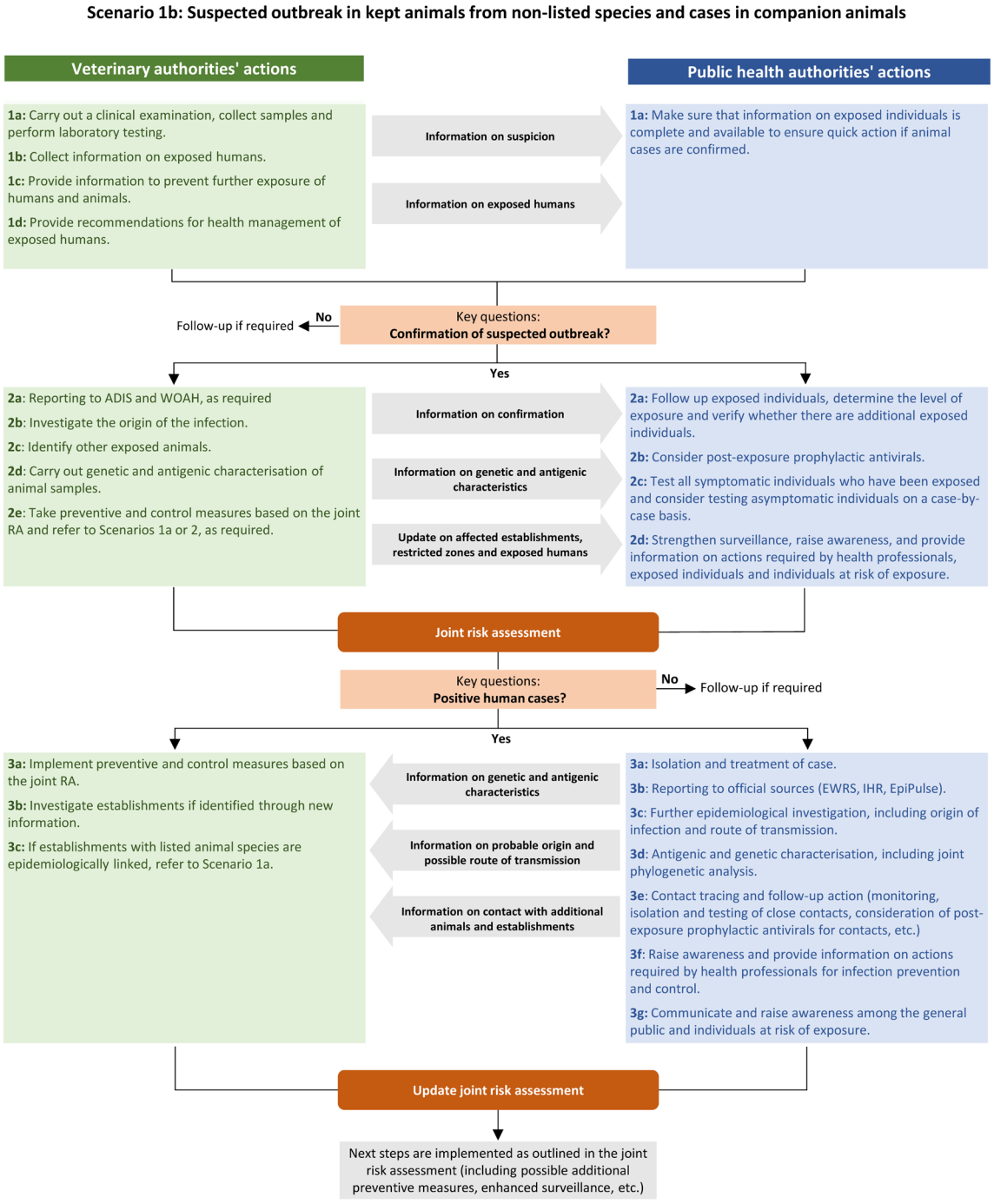
If appropriate or necessary, the competent veterinary authorities may apply vaccination against HPAIV in high-risk transmission areas or zones of affected Member States, to support the measures outlined above. As stipulated in Commission Delegated Regulation (EU) No 2023/361, these emergency protective vaccinations of poultry or captive birds can be implemented by the competent authorities in establishments where the disease has not (yet) been confirmed or suspected. Emergency protective vaccinations can also be carried out in non-affected Member States or zones of non-affected Member States in response to a change in the risk of introduction. In addition, preventive vaccinations can be implemented by the competent veterinary authorities in non-affected geographic areas. The objective of these vaccinations is to prevent HPAI virus introduction and transmission and reduce the number of affected farms, as well as the duration of the epidemic. For emergency protective vaccinations, a 3-km radius has been recommended by EFSA. For preventive vaccination, EFSA has recommended targeting the most susceptible and/or most infectious poultry species (ducks, geese, turkeys and layer chickens) depending on the region. For vaccination to be effective, certain factors need to be considered. A good antigenic match between the circulating field virus and the vaccine virus is important, and the vaccine must be adequate for the poultry species in the affected area. As the vaccines are injectable, no mass administration is possible, and their successful application requires large vaccination teams. Another point to consider is the fact that the vaccination teams entering the farms increases the risk of potential virus spread among different poultry farms [34]. It is necessary to carry out surveillance during and/or after emergency protective vaccinations and preventive vaccinations, and specific rules for this surveillance are stipulated in Commission Delegated Regulation (EU) No 2023/361. EFSA has recommended the diagnostic methods and the surveillance strategies that should be applied in vaccinated populations in order to achieve different objectives, such as early detection of outbreaks, estimation of the vaccination effectiveness/induced level of immunity and demonstration of freedom from disease [35].

5.8 Joint risk assessment

A joint risk assessment should be performed by veterinary and public health authorities, informed by the outcome of the epidemiological and genomic investigation in animals and humans, including the identification and assessment of exposures. Any additional investigations and options for response (including prevention and control measures required at the human-animal interface) should be outlined in the joint risk assessment. Options include enhanced surveillance and additional preventive measures, such as vaccination, or the culling of kept animals of non-listed species [18]. Sampling criteria and guidance for surveillance in non-human mammals to address zoonotic risk of avian influenza are provided in the scientific opinion on the risk and prevention of zoonotic avian influenza (EFSA AHAW Panel and ECDC, 2025).

6. Scenario 1b: suspected outbreak in kept animals of non-listed species or cases in companion animals

Figure 2. One Health actions triggered by a suspected outbreak in kept animals from non-listed species or cases in companion animals



6.1 Veterinary public health action 1

In the event of a suspicion of zoonotic AI outbreaks in **kept animals of non-listed species** (Figure 2), the actions to be taken by the competent veterinary authority to investigate the outbreak/infections are the same as those that should be taken for a suspected zoonotic AI outbreak in kept animals of listed species (see Section 5).

Cases of zoonotic avian influenza in **companion animals** would be detected when a sick companion animal is presented to a veterinary practitioner by its owner and the practitioner then notifies the competent veterinary authorities of a positive laboratory result. The veterinary authorities should immediately inform the public health authorities and report the case to ADIS and WOAH, as required. Furthermore, the veterinary authorities should investigate the origin of the infection by talking to the owners of the affected companion animals and, if necessary, collecting samples for testing. They should also alert veterinary practitioners in the affected area and ask them to sample animals presenting with acute respiratory disease or other clinical signs compatible with zoonotic avian influenza for laboratory analysis. As outlined in Section 5, genetic and antigenic characterisation of the animal samples should be carried out.

The results of the investigations should be shared with the public health authorities in a timely manner.

6.2 Public health action 1

Similar to a suspected outbreak in kept animals of listed species (Section 5), following a suspected outbreak in kept animals of non-listed species or suspected cases in companion animals, public health authorities should review the details of the suspected outbreak and exposed humans, and assure they have complete information on the individuals exposed to potentially infected animals or their environment, as described in Section 5.2. Information on any exposed individuals should be forwarded to the relevant central, regional or local public health officials, as defined in Item A of **Table 1**.

6.3 Joint risk assessment

When the causative agent for the outbreak in kept animals of non-listed species, or cases in companion animals, has been confirmed to be caused by zoonotic AIV, a joint risk assessment should be carried out to identify the best course of action. This should be done, irrespective of whether human cases have occurred. Options include enhanced surveillance and additional preventive measures, such as vaccination and biosecurity measures, or the culling of kept animals of non-listed species. Preventive measures (e.g. information campaigns for keepers of non-listed species or owners of companion animals on preventing contact between their animals and wild birds) could also be proposed, as relevant, to limit further spread. Recommendations for such preventive measures are described in EFSA et al. [36]. Human groups at risk of exposure should be identified in the risk assessment to establish any additional measures required to protect human health.

6.4 Veterinary public health action 2 and 3

In the event of an outbreak in kept animals of non-listed species, investigations into the origin of infection and other exposed animals need to be carried out, as described in Section 5. If the investigations indicate the involvement of animals of listed species, wild birds or mammals, the actions outlined in Scenario 1a or 2 should be taken, as required.

6.5 Public health action 2 and 3

Individuals exposed to kept animals of non-listed species, or companion animals infected with zoonotic avian influenza virus should be followed up, as outlined in Section 5.4. If new potential transmission routes or groups at risk of exposure to infected animals are identified in the joint risk assessment, recommendations for preventive measures and personal protective equipment should be revised accordingly, to reduce the risk of exposure. Guidance on preventive measures should be tailored to the groups at risk of exposure, taking into consideration potential transmission routes, feasibility of application in the local environment and the different activities or tasks being performed. As described in Section 5.4, information should be provided to raise awareness among individuals at risk of exposure, and healthcare workers. This information should include details of any new potential transmission routes and at-risk groups identified in the joint risk assessment, and proposals for reducing the associated risk.

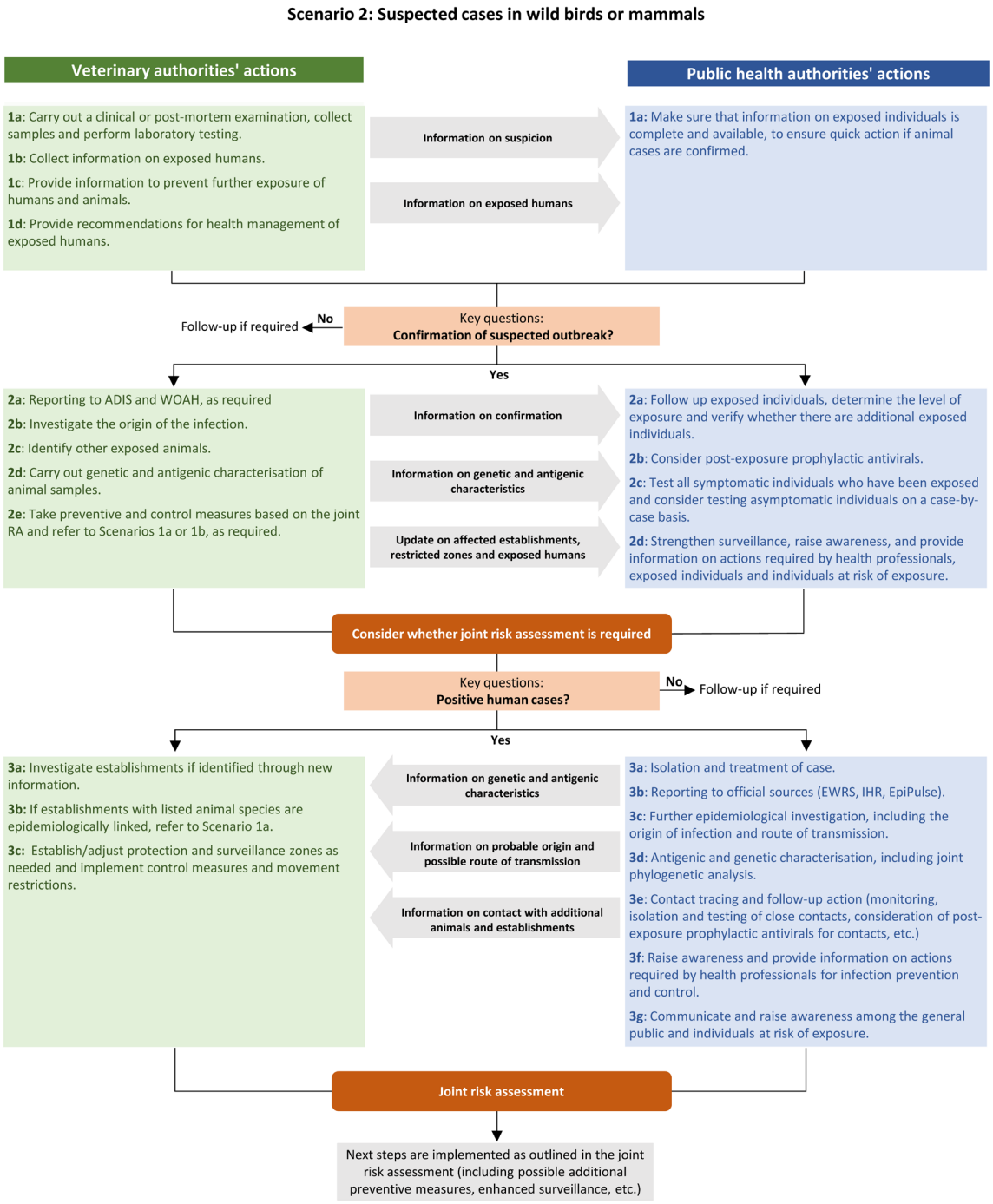
If positive human cases of zoonotic avian influenza are identified, actions to be taken and information to be shared with veterinary authorities are described in Section 5.6.

6.6 Update of joint risk assessment

The joint risk assessment should be updated, as required, based on the results of the investigations and the control measures implemented. In the event of transmission to humans from a new source, systematic and rapid operational research should be carried out to provide important epidemiological parameters for characterising the outbreak (e.g. possible transmission routes, transmissibility, incubation period, case fatality rate, risk factors, and other virus characteristics). A joint regional study approach, based on a unified study protocol and pooled data, can be a valuable tool as special studies can be technically demanding, resource-intensive or unfeasible, due to low case counts [37]. Special studies should involve all relevant stakeholders at the human-animal-environmental interface. As additional information becomes available, the risk assessment should be updated accordingly.

7. Scenario 2: suspected cases in wild birds or mammals

Figure 3. One Health actions triggered by suspected cases in wild birds or mammals



7.1 Veterinary public health action 1

In the event of a suspected zoonotic AI outbreak in wild animals (Figure 3) indicated by increased mortality observed in wildlife, the competent veterinary authorities should carry out clinical or post-mortem examinations, and collect samples for laboratory testing to ascertain the cause of the illness or mortality observed [18]. The official veterinarian should also record the contact details of individuals who have been exposed to the animals (e.g. ornithologists, wildlife wardens, hunters, citizens notifying the authorities of the sick/dead wild animals) and forward the information to the public health authorities. The official veterinarian should also hand out information on public health risk mitigation measures.

7.2 Public health action 1

Following a suspected case of zoonotic avian influenza in wild animals, public health authorities should ensure they have complete information on the known individuals exposed to potentially infected animals or their environment, identified by the competent veterinary authorities as described in Section 5.2. They should also forward this information to the relevant central, regional or local public health officials, as defined in Item A of **Table 1**. However, it may be difficult to identify all the individuals exposed to infected wild animals and therefore local health professionals should be made aware of the situation.

7.3 Potential joint risk assessment

If the suspicion of zoonotic AIV in wild birds or mammals is confirmed, a joint risk assessment should be considered. Criteria to help decide whether this is necessary include human exposure risk and whether there are any new groups (e.g. occupational groups or other sub-populations) at risk of exposure; virus characteristics, such as genetic changes associated with an increased zoonotic risk, or availability of treatment options (e.g. antivirals). The risk assessment should identify the next steps to be taken by the respective stakeholders to reduce the infection risk (e.g. enhanced surveillance) and additional preventive measures (e.g. vaccination of kept animals).

7.4 Veterinary public health action 2 and 3

Investigations need to be carried out into the origin of infection and other exposed animals. If these investigations indicate the involvement of kept animals or companion animals, the actions outlined in Scenario 1a or 1b should be taken, as required.

7.5 Public health action 2 and 3

Individuals exposed to cases of avian influenza in wild animals should be followed up, as outlined in Section 5.4. If new potential transmission routes or groups at risk of exposure are identified in the joint risk assessment, the recommended preventive measures may need to be revised, as described in Section 5.5. In the case of mass mortality events in wild animal populations, the joint risk assessment could be used to inform any decisions on temporarily restricting public access to the affected areas.

Information should be provided to raise awareness among people at potential risk of exposure to wild animals infected with zoonotic avian influenza (e.g. hunters, ornithologists, the general public) and explain how the risk can be mitigated. The general public should be informed of the need to avoid contact with sick or dead birds and other animals potentially infected with zoonotic avian influenza. Information should also be provided on what to do if they find dead animals and how to inform the relevant authorities to ensure safe removal and further investigation, if required.

Healthcare workers should be made aware of geographical areas where zoonotic avian influenza has been identified in wild animals and the possibility of human exposure to infected animals or contaminated environments among the general public.

If positive human cases of zoonotic avian influenza are identified, the actions to be taken and the information to be shared with veterinary authorities are described in Section 5.6.

7.6 Joint risk assessment

A joint risk assessment should be performed by veterinary and public health authorities, informed by the outcome of the epidemiological and genomic investigations in animals and humans, including the identification and assessment of exposure. If a joint risk assessment was carried out following suspicion of zoonotic AIV in wild animals (as described in Section 7.3), this should be updated as required, based on the results of the investigations and the control measures taken. In the event of transmission to humans from a new source, systematic and rapid operational research should be carried out to provide knowledge on the epidemiological parameters in order to characterise the outbreak (described in Section 6.6). As additional information becomes available, the risk assessment should be updated accordingly.

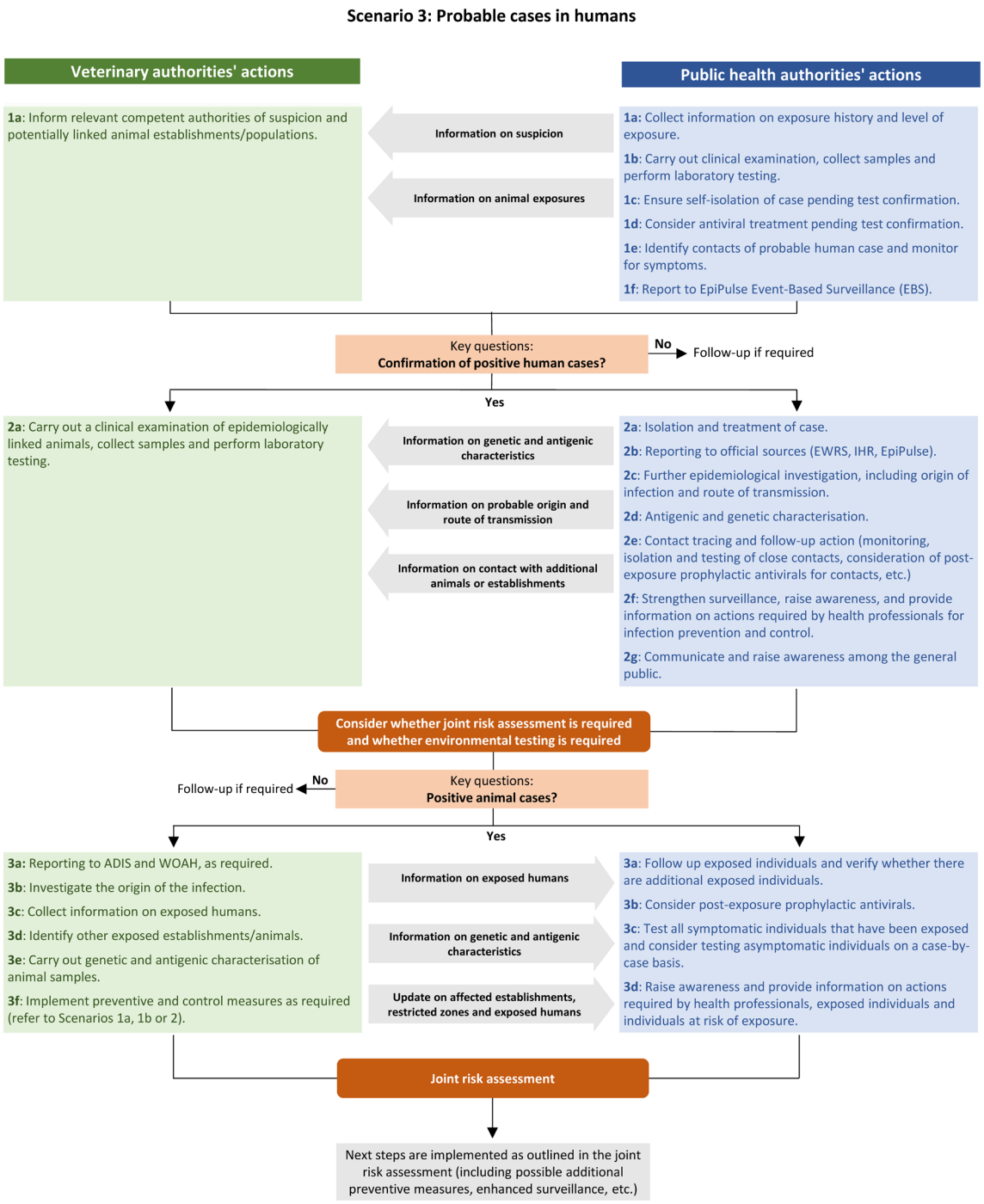
8. Scenario 3: Probable cases in humans

A probable case of zoonotic avian influenza infection in humans may include individuals with exposure to infected animals and a positive test result, but no clinical symptoms. It may include a symptomatic person with exposure history to infected animals pending laboratory confirmation. It may also include an individual with no symptoms, or mild symptoms, who has a positive AIV laboratory test but a high cycle threshold (Ct) value on diagnostic testing (e.g. Ct>32) and no virus isolation, serological evidence of infection, or sequencing output [12].

A confirmed case of zoonotic avian influenza infection in a human may be defined as an individual, with or without exposure history to infected animals, who reports symptoms and is positive for AIV on diagnostic testing with a low Ct value (e.g. Ct<32), which is confirmed positive through retesting. Asymptomatic individuals with diagnostic testing results suggesting a true infection (e.g. through a low Ct value on RT-PCR which has been confirmed, whole genome sequencing, virus isolation or serological evidence of acute infection) can also be considered confirmed cases. The case definitions for probable and confirmed cases of zoonotic avian influenza in humans may need to be adapted, depending on the outbreak setting, exposure history, clinical presentation and diagnostic testing results.

The following scenario considers One Health actions triggered by a probable case of human infection with zoonotic avian influenza virus, which would often have been identified though the monitoring of individuals with a known exposure to potentially infected animals or their environment. If a human case of infection with zoonotic avian influenza virus is identified and confirmed through routine surveillance, investigation would start with the actions following confirmation of a positive human case (Sections 5.6 and 8.4).

Figure 4. One Health actions triggered by probable cases in humans



8.1 Public health action 1

If there is a probable case of zoonotic avian influenza (Figure 4), public health authorities should carry out a case investigation, including diagnostic testing, undertake an epidemiological investigation to identify potential sources of infection and human contacts, and take action to limit possible onward transmission and protect public health.

A probable case of human infection with AIV should undergo clinical examination and immediate diagnostic testing to confirm or exclude AIV infection. If a test generates a borderline positive result (e.g. Ct >32), the sample should be retested or, if required, a new sample should be collected for testing. All human specimens positive for AIV using RT-PCR should be retested to confirm AIV detection. Further information on diagnostic methods is available in ECDC's guidance on testing and detection of zoonotic avian influenza virus infection in humans [1].

Probable cases should be informed of the risk of onward transmission to others and asked to self-isolate pending the results of diagnostic testing. If hospitalisation is required, probable cases should ideally be placed in an isolation room. Antiviral treatment can be considered pending test results and should be initiated as soon as possible for all symptomatic patients. Furthermore, public health authorities should collect information on the exposure history of the probable case within two weeks of symptom onset or, if unavailable, before hospital admission to identify possible sources of infection and level of exposure, in accordance with the ECDC investigation protocol [12].

Contacts of probable cases should be identified and actively monitored for symptoms for 10–14 days even before the probable case is confirmed. If a contact develops symptoms, they should self-isolate and get tested immediately. If AIV infection in the probable case is excluded, monitoring of contacts can be discontinued.

Probable cases of zoonotic avian influenza in humans, that are presumably positive (pending confirmation by the National Reference Laboratory), should be reported to EpiPulse Event-Based surveillance, where updates on the epidemiological situation and assessments of zoonotic AIV infections in humans can be shared with appointed experts in public health [32]. Public health authorities should also inform veterinary authorities of the probable case, using the established mechanism for One Health data sharing described in Table 1, Item B.

8.2 Veterinary public health action 1

If probable cases have been identified in humans, the information provided by the public health authorities on the suspicion and the animals that the probable cases were exposed to prior to onset of illness should be disseminated to the relevant regional and local official veterinarians.

8.3 Potential joint risk assessment

If the human cases have been confirmed, a joint risk assessment should be considered, in addition to a human health risk assessment. Criteria to help decide whether this is necessary include known exposure and suspected source of infection; virus characteristics, such as genetic changes associated with an increased zoonotic risk, or available treatment options, such as antivirals. The risk assessment should identify the next steps to be taken by the respective stakeholders. Depending on the possible source of the virus, this could include recommendations to investigate epidemiologically linked animals or animal establishments, and environmental testing.

8.4 Public health action 2

If there is a confirmed human case of AIV infection, public health authorities should coordinate outbreak investigation and management of exposed individuals and their contacts, as described in Section 5.6, in order to rapidly detect any onward transmission and implement targeted control measures.

8.5 Veterinary public health action 2 and 3

Using the information provided by the public health authorities, the official veterinarians should carry out investigations in implied animal establishments or wildlife populations. Relevant results from the active or passive surveillance of avian influenza in kept and wild animals of non-listed species in the affected area, carried out under Commission Delegated Regulation (EU) 2020/689, should also be assessed.

If the investigations identify outbreaks in kept animals or cases in wild or companion animals, the veterinary authorities should report these to the European Commission, the other Member States and WOAH, in accordance with the relevant rules. Further investigations and preventive and control measures should be taken, as outlined in Scenarios 1a, 1b and 2. The information on the outbreaks, or cases of zoonotic AIV identified in animals should be shared with the public health authorities in a timely manner through the established One Health communication and data sharing channels (Table 1, Item B). This includes information on any exposed humans (Table 1, Item C).

8.6 Public health action 3

After receiving information on any outbreaks or cases of AIV identified in animals, public health authorities should follow up on any individuals exposed to infected animals or their environment and raise awareness among relevant groups, in accordance with the public health actions outlined in Scenarios 1a, 1b and 2.

8.7 Joint risk assessment

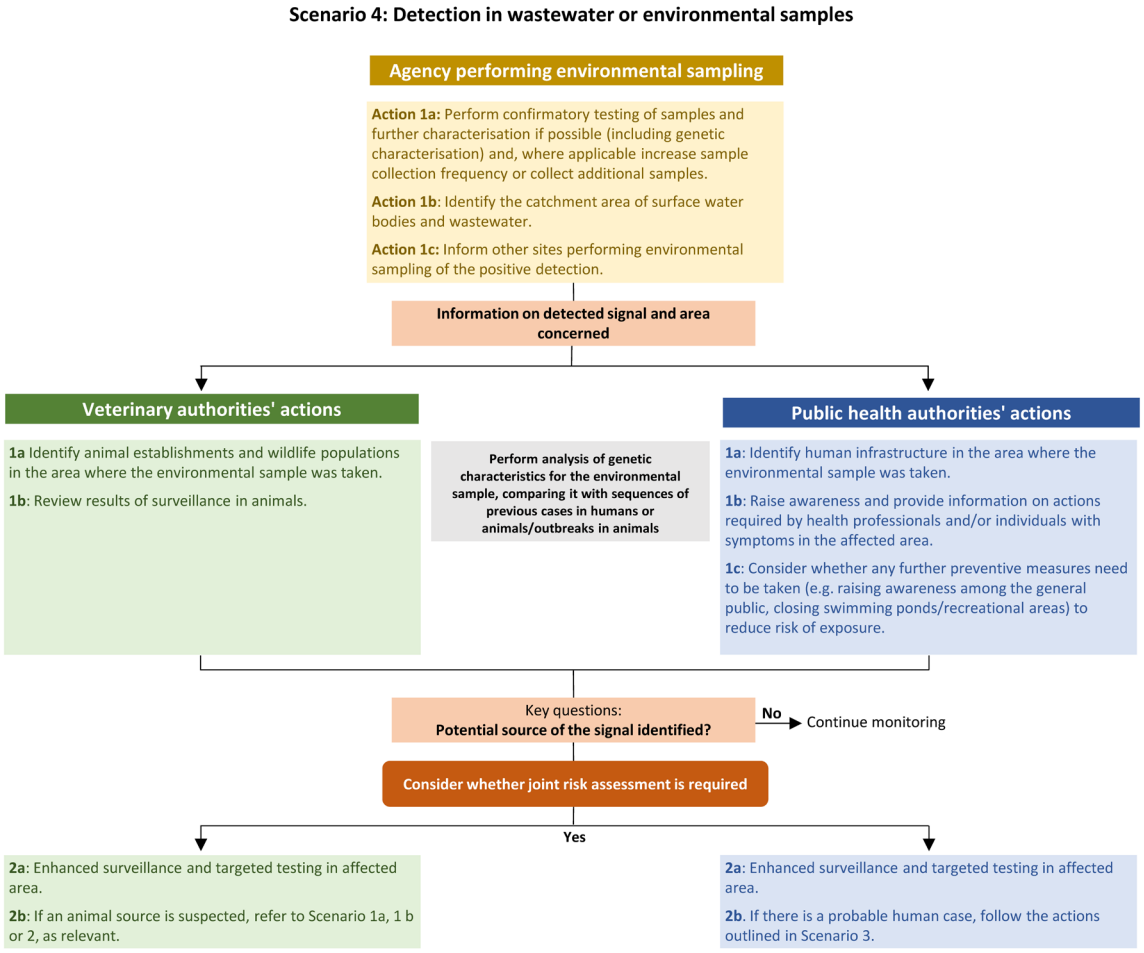
If outbreaks in kept animals or cases in wild or companion animal have been identified, a joint risk assessment is required. This should identify any additional investigations and prevention and control measures required at the human-animal interface. In the event of transmission to humans from a new source, systematic and rapid operational research should be carried out to provide knowledge on epidemiological parameters in order to characterise the outbreak (described in Section 6.6). As additional information becomes available, the risk assessment should be updated accordingly.

9. Scenario 4: Detections in wastewater or environmental samples

Early detection of zoonotic avian influenza virus in environmental samples, such as wastewater and surface water samples, offers an opportunity for early warning and timely interventions, given that the source of the virus can be identified at an early stage. Sources could be infections in the wildlife population, kept animals and waste associated with animal production or animal-related products, or human infection with zoonotic avian influenza viruses. However, the value of wastewater-based surveillance as an early warning tool likely only applies to populations and production facilities directly linked to sewage systems (e.g. dairy farms or abattoirs), as well as potentially contaminated areas within the catchment zone of the sampling points.

Wastewater samples represent pooled data, which makes it challenging to trace specific sources (such as birds, mammals or humans) or locations of infection without supplemental data from targeted field investigations or other surveillance approaches. Elevated avian influenza virus levels in US wastewater, as reported recently in several studies [38,39], may be influenced by effluent from dairy processing plants, which are typically connected to wastewater systems. Similarly, rainwater run-offs from areas with ongoing avian influenza virus outbreaks in wild birds entering wastewater treatment plants may influence avian influenza virus levels in wastewater. Nevertheless, wastewater data can complement traditional surveillance methods, providing a timely method for assessing virus presence without the need for individual testing of animals (kept and wild) or humans. It also allows for the monitoring of larger geographical areas and populations usually not under surveillance (e.g. asymptomatic humans). Similarly, the surveillance of contamination in surface water bodies, such as wetlands, can help identify the virus in natural areas as a complementary approach to surveillance in wild birds. This could support the identification of hotspots for potential zoonotic spillover events, support targeted interventions, and mitigate the risk of zoonotic avian influenza transmission to humans. However, a recent study found no evidence of direct transmission of zoonotic avian influenza virus to humans through contact with aquatic environments or the ingestion of contaminated water [40]. Further considerations regarding the potential benefits and limitations of wastewater-based surveillance are provided in the scientific opinion recently published by ECDC and EFSA [2].

Figure 5. One Health actions triggered by AIV detection in an environmental sample (e.g. wastewater, surface water or other environmental samples)



While the entry point to Scenarios 1–3 is very specific (known or suspected host), a signal in an environmental sample as outlined in Scenario 4 is a non-specific signal, requiring further investigation. If zoonotic avian influenza virus is detected in wastewater or environmental samples (wastewater, surface water or other environmental samples) (Figure 5), a rapid assessment of the signal is required. The detection of zoonotic avian influenza virus in wastewater does not necessarily give reason for concern, and there are several factors that should be considered when determining the potential risks to human and animal health. The animal, human and environmental stakeholders should collaborate to identify the source of the virus.

9.1 Agency performing environmental sampling action 1

It is important that samples are subjected to confirmatory testing in order to exclude a testing error. If possible, further characterisation should be carried out, such as identification of the zoonotic avian influenza virus strain. In addition, the agency performing the environmental sampling should rapidly share information on the catchment area where the sample was collected with the competent veterinary authorities, public health authorities and other agencies performing environmental sampling. Raising awareness of the positive detection with other agencies performing environmental sampling (especially in nearby sites) would facilitate increased testing and potential identification of further environmental detections.

9.2 Veterinary public health action 1

When the competent veterinary authorities receive information about a detection of a zoonotic avian influenza virus in wastewater or other environmental samples from the environmental authorities, they should review the results of the active or passive avian influenza surveillance of kept and wild animals of non-listed species in the area of concern and check which animal establishments or wildlife populations are located there.

9.3 Public health action 1

When the public health authorities receive information about a detection of a zoonotic avian influenza virus in wastewater or other environmental samples from the environmental authorities, they should investigate the human infrastructure in the area (e.g. large hospital, airport, urban setting). Based on the epidemiological situation, the public health authorities should raise awareness and issue clear guidance for healthcare professionals on the monitoring and testing of potentially exposed people (e.g. individuals working with wastewater or those in contact with contaminated aquatic environments) [27,29]. Depending on the situation, further preventive measures may need to be considered, such as raising awareness and providing guidance to the general public or restricting public access to swimming ponds/recreational areas, to reduce risk of exposure.

9.4 Veterinary public health action 2

If a potential animal source has been identified for the environmental signal, enhanced surveillance and targeted testing should be carried out in the affected area. If this leads to the suspicion that kept, wild or companion animals are the source, the actions under Scenarios 1a, 1b or 2 should be carried out, as required. If the potential source of the virus detection in the environmental sample remains unidentified, it is essential to continue monitoring the situation closely.

9.5 Public health action 2

If the potential source is identified, enhanced surveillance and targeted testing should be implemented in the affected area. For any probable human cases, the actions outlined in Scenario 3 should be followed. If the potential source of the virus detection in the environmental sample remains unidentified, it is essential to continue monitoring the situation closely.

9.6 Potential joint risk assessment

If a potential source is identified, a joint risk assessment should be considered. Criteria that help decide whether if this is necessary include the suspected source of infection; virus characteristics, such as genetic changes associated with an increased zoonotic risk, and availability of treatment options (e.g. antivirals). The risk assessment should also assess whether the wastewater or the contaminated environment could be a source of spread to humans (e.g. sewage workers or urban populations near affected areas, or as a result of agricultural activities, such as irrigation with contaminated water), or to kept animals or wildlife. The risk assessment should identify the next steps that the respective stakeholders should take, including prevention and control measures.

10. Knowledge gaps and recommendations

Establishing and implementing a zoonotic AIV-specific One Health strategy

At present, there is limited knowledge and sharing of zoonotic AIV-specific One Health strategies, tools, and action plans available in Member States. More widespread sharing of these resources and experiences would enable countries to learn from one another, fostering greater preparedness and collaboration across the region. An example of successful information sharing is the report from a recent fact-finding visit to Finland, which aimed to identify good practices and opportunities for improvement in implementing the One Health approach to reduce serious zoonotic risks from fur animal farming [11]. In the event of an AIV outbreak in one country, transparent and timely reporting of information across borders is key and existing regional reporting platforms (e.g. EpiPulse, EWRS, ADIS, WOAH) play an important role in communication. As the AIV outbreak evolves, the One Health strategies implemented in one country would enable neighbouring countries to adapt their approaches, based on shared evidence and best practices.

Many countries may lack established One Health strategies or zoonotic AIV-specific tools. Externally facilitated exercises, such as the recent fact-finding visit to Finland by Directorate F of the Directorate-General for Health and Food Safety in the context of its pandemic pathway series [11], can play a key role in bringing together the necessary stakeholder to develop effective, tailored One Health strategies to address zoonotic AIV risks.

Overall, if Member States have limited experience in implementing One Health strategies and using the zoonotic AIV-specific tools that have been developed, simulation exercises are valuable for trialling these tools during peace time, ensuring that all stakeholders are trained, and facilitating any necessary adjustments.

A unified, One Health risk assessment model for the EU/EEA would facilitate standardised assessment of the risk associated with zoonotic avian influenza viruses and highlight necessary actions at local and regional level. In the event of transmission to humans from a new source, a joint regional study approach, based on a unified study protocol and timely sharing of results, would facilitate systematic and rapid operational research. Through a standardised investigation protocol for the first few X cases (FFX) [41], pooled data from several countries can provide insights into epidemiological, clinical and virological characteristics of the outbreak to update risk assessments and inform control measures.

In countries experiencing an AIV outbreak, it is crucial to evaluate the current outbreak investigation and management. An after-action review facilitates the identification of good practices and areas that require improvement [42]. The outcomes and conclusions of the review should be shared with all stakeholders involved at the human-animal-environment interface. Furthermore, lessons learned from such evaluations should ideally be shared with other Member States to improve the effectiveness of their strategies.

Laboratory testing

Due to the rapid evolution of influenza viruses, there is a constant need to develop or adapt, standardise and validate diagnostic methods, including tests for detection, new types of sample matrices (e.g. bulk milk) and new species (e.g. mink, cattle), standardised protocols for serological testing of humans and validation of rapid tests used in the investigation of human cases. There is also a need for national laboratories to have access to reference material and to share knowledge on needs for adaptation of existing tests.

Further research is necessary to understand how specific genetic mutations in AIV strains that cause outbreaks in animals and/or cases in humans affect zoonotic potential (i.e. how specific mutations affect mammalian adaptation and transmissibility to and among mammals, including humans). The link between genotype and phenotype is not always well-defined or straightforward, limiting our ability to predict zoonotic risk, especially when a new strain with new virological characteristics emerges (either through evolution or reassortment). Targeted in vitro studies, such as testing receptor-binding affinity, viral replication efficiency in human cells, and immune response evasion, are crucial for assessing potential zoonotic transmission. In addition, in vivo studies in appropriate animal models are needed to evaluate the AIV pathogenicity, transmission routes, and overall fitness in mammals. These studies would provide critical information on the zoonotic potential of AIV and inform risk assessments and actions, both on the animal and human health side.

Risk of human infection and effectiveness of interventions

Although human infections with zoonotic AIV appear to be rare, there is currently limited evidence on the risk of infection in humans through different exposure routes and the effectiveness of interventions on the absolute risk of infection in different settings. Further evidence is required on the risk of human infection through different exposure routes and the impact of interventions in different scenarios to inform risk management actions (e.g. through serological studies). Examples of interventions for which additional research on effectiveness is required include medical countermeasures, such as combined antiviral treatments and vaccination against zoonotic avian influenza; use of different PPE; and the impact of restricting access to natural areas or decontamination of public spaces on the risk of infection from environmental contamination. As recommended in the ECDC and EFSA joint opinion [2], any deployment of vaccination for zoonotic avian influenza in humans should be accompanied by close monitoring of vaccine safety and effectiveness, as well as adequate surveillance.

Wastewater/environmental surveillance

The use of environmental samples, particularly wastewater sampling, to detect zoonotic AIV is a relatively new approach, with significant knowledge gaps and uncertainty as to its effectiveness and reliability. Further work is needed to better understand the positive and negative predictive value of wastewater test results in different scenarios, considering that viruses may not be shed consistently or in high enough quantities to be easily detected in wastewater. In addition, there might be several other pathways by which the virus enters sewage systems, making it challenging to determine the source (e.g. effluent from abattoirs, potential human infections, rainwater runoffs from areas with virus circulation in wild birds, etc.). Environmental factors such as water temperature, flow rate, and viral degradation can also affect the accuracy and sensitivity of results.

There are also technical aspects to consider, such as limited standardisation and validation of sampling and detection methods, making it challenging to compare wastewater surveillance results. At present, protocols for collecting, processing, and analysing wastewater samples for avian influenza are not fully established, leading to variability in results across studies and locations. Factors such as sample concentration techniques, RNA extraction methods, and detection assays can significantly affect sensitivity and accuracy, making it difficult to compare data between regions or across time. Potential different characteristics of avian influenza viruses, such as differing stability in wastewater, are not fully understood, adding complexity to the method validation.

Further validation and targeted studies are needed to assess the effectiveness of wastewater surveillance for early detection of AIV outbreaks in animal and human populations and define the resulting need for prevention and control measures. Similarly, standard surveillance practices for the sampling and analysis of AIV presence have not yet been established for other environmental surveillance methods, such as the monitoring of surface water bodies. Further research and exploration are needed to understand how this approach could effectively complement existing wildlife testing strategies and enhance overall surveillance efforts.

At present, there is limited understanding of the risk of infection for humans or animals through AIV contaminated wastewater, natural environments, or ecosystems. Developing a more comprehensive, holistic understanding of these risks is crucial for effective prevention and control, and the preservation of natural ecosystems.

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Annex

Terms of reference as received from the European Commission

To provide jointly (ECDC and EFSA, in collaboration with the European Environment Agency and other relevant actors, for example those dealing with water and environmental water surveillance) technical and scientific assistance to the Commission for the development of guidelines to support coordinated 'One Health' (animal, human and environmental) outbreaks investigations and management when human and animal populations are involved in the outbreaks.

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