

# THE ROLE OF VETERINARY SERVICES IN MANAGING EMERGING AQUATIC ANIMAL DISEASES: WHAT ARE THE FACTORS NEEDED FOR SUCCESS?

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Original: English

**Summary:** *The emergence of new aquatic animal diseases has been a regular feature of the world's rapidly growing aquaculture industry. This paper explores the role of Veterinary Authorities in managing emerging aquatic animal diseases and aims to identify the most important factors required for their successful management. The paper draws on the experiences of 28 Member Countries of the OIE Regional Commission for Asia, the Far East and Oceania comprising 90% of global aquaculture production volume.*

*Responsibilities for managing aquatic animal health are often shared between Veterinary Authorities and aquaculture or fisheries authorities, necessitating cooperation between the responsible authorities. More than two thirds of Member Countries believe that better cooperation between the responsible authorities is needed for improved aquatic animal health management.*

*Member Country approaches to notification of emerging diseases appears to be somewhat inconsistent. However, improving transparency regarding notification was nominated by countries as one of the most important actions Member Countries could take to support international efforts to manage emerging diseases of aquatic animals.*

*The most important factors for a successful response to an emerging disease include early response, industry cooperation, availability of diagnostic tests, and early detection of the event. Better understanding of emerging disease epidemiology is the single most significant factor to improve the success of a disease response.*

*Most Member Countries have prevention and preparedness arrangements for emerging diseases; however, there are some gaps that could usefully be the subject of capacity building efforts.*

*Important actions that Member Countries could take to support international efforts to manage emerging diseases include sharing epidemiological information on emerging diseases, improving transparency regarding disease notification and improving biosecurity and disease control within their aquaculture industry.*

*Important actions that the OIE could take to support international efforts to manage emerging diseases include coordinating regional action for serious emerging diseases, providing technical guidance on new emerging diseases, supporting OIE Member Countries to build their capabilities through the OIE PVS Pathway, and advocating improved transparency for notification of emerging diseases.*

**Keywords:** *aquatic animal disease – emerging disease – Veterinary Service.*

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## 1. Introduction

Recent growth in global aquaculture production has been extraordinary. In the 20 years to 2013 (the latest statistics currently available), global aquaculture production volume has increased from 27.8 million tonnes to 97.2 million tonnes [5]. Global per capita consumption of fish has almost doubled since the 1960s, and aquaculture now provides 50% of the aquatic animals consumed by humans compared to 5% in 1962 [4]. Aquaculture production is forecast to continue its strong growth, contributing to a rapid transition in global seafood supply from capture fisheries to production animals.

The characteristics of the world's rapidly growing aquaculture sector include rising production, intensification, production of new species, domestication and genetic selection of desirable characteristics, production of alien species in new environments, new production technologies and increased international trade. These characteristics of aquaculture are also consistent with many drivers of disease emergence [6].

The emergence of new diseases has been a feature of aquaculture in recent decades with some resulting in panzootics and significant economic impacts. Numerous examples are available that demonstrate the occurrence of diseases previously unknown to science, severe impacts on affected industries, transboundary spread of the diseases, and a need for significant investment to develop diagnostic tests and understand disease epidemiology. Two notable recent examples include acute hepatopancreatic necrosis syndrome (AHPND) of shrimp and ostreid herpes virus 1 microvariant (OshV-1 microvariant) of Pacific oysters.

Emerging diseases are particularly challenging because disease response decisions may need to be made in knowledge poor circumstances with few available tools such as diagnostic tests. In some countries, the shared responsibilities for managing aquatic animal health between the Veterinary Authority and other responsible authorities (such as the fisheries or aquaculture authorities) may create added complexity.

The regular emergence of aquatic animal diseases in aquaculture and their significant impacts warrants consideration of how these diseases can be best managed to mitigate their impacts and prevent transboundary spread. This paper explores the role of the Veterinary Authorities in managing emerging aquatic animal diseases and aims to identify factors needed for success.

The information presented draws on the experiences of Member Countries within the OIE Regional Commission for Asia, the Far East and Oceania (AFEO Regional Commission). Members were asked to respond to a questionnaire that included 21 questions relating to 5 aspects of aquatic animal disease management, including:

- 1) Responsibilities for managing aquatic animal health
- 2) Experiences with emerging diseases of aquatic animals
- 3) Responses to emerging diseases of aquatic animals
- 4) Prevention and preparedness
- 5) International cooperation.

## 2. Results

Completed questionnaires were received from 28 of the 36 (78%) Member Countries of the OIE Regional Commission for Asia, the Far East and Oceania. The 28 responding Member Countries comprise 99.5% of aquaculture production among the 36 Member Countries of the AFEO Regional Commission, 90% of global aquaculture production volume and 79% of global aquaculture production value [5].

Of the 28 completed questionnaires received, 21 were completed by the designated OIE National Focal Point for Aquatic Animals.

## 2.1. Responsibilities for managing aquatic animal health

The questionnaire included four questions relating to institutional responsibilities within Member Countries for managing aquatic animal health.

The Veterinary Authority has primary responsibility for management of aquatic animal health in 18 of the 28 responding Member Countries. In the remaining 10 Member Countries, primary responsibility for managing aquatic animal health rests with the government department or directorate with responsibility for fisheries or aquaculture. In all but two cases, the authority with primary responsibility for aquatic animal health was consulted in preparing the response to the questionnaire.

Members were asked to indicate which aquatic animal health management capabilities, if any, are under the responsibility of the Veterinary Authority. Options for 16 capabilities relevant to managing emerging diseases of aquatic animals were provided in the questionnaire. These 16 capabilities align with relevant Critical Competencies listed in the OIE Performance of Veterinary Services (PVS) Tool and the OIE PVS Tool: Aquatic.

For the 18 countries where the Veterinary Authority has primary responsibility for aquatic animal health, Veterinary Authority responsibility for each of the 16 capabilities ranged from 61% to 94% of Member Countries (Fig. 1). More than 80% of these 18 Member Countries reported that the Veterinary Authority had responsibility for veterinary products, implementation of legislation and regulations, preparation of legislation and regulations, international disease notification, border quarantine, import risk analysis, disease prevention and control, surveillance and laboratory diagnosis. Traceability was the aquatic animal health capability that was least reported to be under responsibility of the Veterinary Authority.

For the 10 countries where the Veterinary Authority does not have primary responsibility for aquatic animal health, Veterinary Authority responsibility for each of the 16 capabilities ranged from 10% to 70% of Member Countries (Fig. 1). The lower responsibility of Veterinary Authorities for aquatic animal health management capabilities in these 10 countries is to be expected, as responsibility would rest with other government authorities such as fisheries or aquaculture authorities. However, Member Country responses indicate that responsibilities are shared – for 9 of the 16 capabilities, the Veterinary Authority remains responsible in 40% or more of these countries. The capabilities that most commonly remain under the responsibility of the Veterinary Authority include veterinary products, international disease notification, border quarantine and animal production food safety.

## 2.2. Experiences with emerging aquatic animal diseases

Of the 28 Member Countries that responded to the questionnaire, 15 had experienced aquatic animal diseases in the past ten years that have had a significant impact on production, trade, or the environment.

Eleven of these 15 countries reported that some of these diseases had been emerging diseases (in accordance with the OIE *Aquatic Animal Health Code* – the *Aquatic Code* – definition of an *emerging disease*). Sixteen occurrences of 10 different emerging diseases were reported by Member Countries (Table I).

Members reported that 12 of the 16 occurrences of emerging diseases were reported to the OIE. Several reasons were provided to explain why the 4 occurrences were not reported to the OIE and multiple reasons were provided in some instances, including:

- not considered, at that time, to meet the OIE definition of an emerging disease;
- reporting to the Asia Pacific Quarterly Aquatic Animal Disease (QAAD) reporting programme was considered sufficient;
- the causative agent was not known;
- the evolving nature of the event meant that there was no clear trigger for notification; and
- not considered to meet reporting requirements in Chapter 1.1. of the *Aquatic Code*.

### 2.3. Responses to emerging aquatic animal diseases

Member Countries were asked 4 questions about their experiences responding to emerging aquatic animal diseases.

Member Countries were asked to identify which response measures were implemented for emerging diseases. Response measures were implemented in all 16 occurrences of emerging diseases. Movement controls, surveillance and tracing were implemented in most instances (Fig. 2). Treatment of affected aquatic animals (1 instance) and stamping out (2 instances) were rarely implemented.

Considering their experiences with the 16 occurrences of emerging diseases, Member Countries were asked to indicate the 3 most significant factors for success for each emerging disease. As might be expected, Member Country responses varied depending on the nature of the emerging disease event. Early response, industry cooperation, availability of diagnostic tests and early detection of the event were considered the most important success factors (Fig. 3).

Member Countries were asked to indicate the 3 most significant factors that would need to be addressed to improve success in responding to the 16 occurrences of emerging diseases. Poor understanding of emerging disease epidemiology was the most important factor. Other common factors included delay in detection, lack of industry cooperation and insufficient legislation (Fig. 4).

Member Countries were asked to indicate how successful their responses had been in mitigating the impacts of emerging diseases on production, trade or the environment. Members were asked to rate their success on a scale ranging from highly successful, successful, neutral (neither successful nor unsuccessful), unsuccessful and highly unsuccessful. Nine Member Countries indicated that their responses to emerging diseases had been successful and 2 reported that their responses had been neutral.

### 2.4. Prevention and preparedness

Member Countries were asked 6 questions about their prevention and preparedness for emerging aquatic animal diseases. Responses were invited from all Member Countries, not just those who had experienced emerging diseases.

Member Countries were asked, whether in the past 10 years, they had evaluated the import risk of emerging diseases that have occurred in other countries. Seventeen countries indicated that they had evaluated the risk presented by emerging diseases occurring in other countries. Of the 11 countries that had not evaluated risks, 2 are among the world's top 10 aquaculture producers.

Fourteen countries had implemented stronger border quarantine measures as a result of their evaluation of the risks presented by emerging diseases in other countries. Acute Hepatopancreatic Necrosis Disease (AHPND) was the disease risk most commonly evaluated (7 countries); however, other disease risks evaluated included ostreid herpes virus 1 microvariant, *Edwardsiella ictaluri*, and Laem Singh virus. Some countries advised that their risk assessment processes are commodity based and that risks of specific diseases, including emerging diseases, are assessed in the relevant commodity-based risk analyses.

Member Countries were asked to specify the measures implemented as a result of their assessment of emerging disease risks in other countries. Testing to determine batch freedom (either pre-export or post arrival) was the most common measure, followed by post-arrival quarantine (Table II). Only 1 of 14 countries reported that their stronger border quarantine measures were not based on risk assessment.

Member Countries were asked to report which drivers of disease emergence, if any, are considered in their country's aquaculture planning and aquatic animal health management arrangements to mitigate disease emergence. Twenty four of 28 countries indicated that they consider at least 1 driver of disease emergence in aquaculture planning and aquatic animal health management arrangements. Production of alien species and aquatic animal

translocation are the drivers of disease emergence most considered by Member Countries to mitigate disease emergence (Fig. 5).

Member Countries were asked to indicate whether their country has a contingency plan for responding to aquatic animal disease emergencies. Seventeen countries indicated that they have a contingency plan (60% of respondents) and 15 indicated that it covers emerging aquatic animal diseases.

Member Countries were asked to indicate their level of agreement with the statement *'improved cooperation between the Veterinary Authority and Aquatic Animal Health Services is needed for better management of aquatic animal diseases, including emerging diseases'* as it applies to their country. Nineteen countries (68%) either agreed or strongly agreed with the statement, 1 country was neutral (neither agreed nor disagreed), 1 country disagreed and 7 believed the statement was not applicable to their circumstances.

## 2.5. International cooperation

Member Countries were asked 2 questions about international cooperation to manage emerging aquatic animal diseases. Responses were invited from all Member Countries, not just those who had experienced emerging diseases.

Member Countries were asked to identify the three most important actions that Member Countries could take to support international efforts to manage emerging diseases of aquatic animals. Sharing epidemiological information on emerging diseases (21 responses), improving transparency regarding disease notification (17 responses) and improving biosecurity and disease control within their aquaculture industry (17 responses) were considered the most important actions that Members could take (Fig. 6).

Member Countries were asked to identify the three most important actions that the OIE could take to support international efforts to manage emerging diseases of aquatic animals. Coordinating regional action for serious emerging diseases (17 responses), providing technical guidance on new emerging diseases (15 responses), supporting OIE Members to build their capabilities through the OIE PVS Pathway (12 responses), and advocating improved transparency for notification of emerging diseases (11 responses) were considered the most important actions that the OIE could take (Fig. 7).

Member Countries were asked whether they are involved in the OIE PVS pathway. Fifteen Member Countries responded that they are involved in the PVS Pathway but only 3 of the 15 had requested a PVS evaluation. However, 15 countries advised that they intend to make an application for a PVS Evaluation of their Aquatic Animal Health Services and 12 of those countries intend to make an application in the next two years. Ten countries advised that they do not currently intend to make an application for a PVS Evaluation - Aquatic. The reasons for not requesting such an evaluation included: a lack of human resources (3 responses), that there has been no decision or no political support (2 responses), that other initiatives to strengthen AAHS are underway (2 responses), that a self-evaluation is to be conducted (2 responses), and that there is no need due to existing strong systems (1 response).

## 3. Discussion

The emergence of new aquatic animal diseases has been a feature of aquaculture in recent decades. These diseases have resulted in serious impacts to aquaculture production and to the environment. The rate of disease emergence is indicated by the diseases listed in the 2015 *Aquatic Code*; only 9 of these 28 diseases were notifiable to the OIE in 1995. Some of these emerging diseases have been particularly significant; for example, the global shrimp industry has experienced several panzootics caused by diseases such as infectious haematopoietic and hepatopancreatic necrosis, infectious myonecrosis, Taura syndrome and white spot disease.

This technical item has explored several aspects of managing emerging aquatic animal diseases, including the role of the Veterinary Authority.

### 3.1. Responsibilities for managing aquatic animal health

Member Country responses demonstrate that responsibilities for managing aquatic animal health are often shared between the Veterinary Authority and other authorities such as the fisheries or aquaculture authority. For most countries (18 of 28), the Veterinary Authority is primarily responsible aquatic animal health. However, Veterinary Authorities rarely have responsibility for all aquatic animal health capabilities (Fig. 1) – presumably because some capabilities are the responsibility of another authority, although in some cases it may be that the capability does not exist. The Veterinary Authority remains responsible for many aquatic animal health management capabilities, even when primary responsibility for aquatic animal health management rests with the fisheries or aquaculture authority. Some examples include veterinary products, international disease notification and border quarantine.

It is clear that responsibilities are shared in many countries, and coordination and communication between the Veterinary Authority and other responsible authorities is necessary for effective prevention, preparedness and response to emerging aquatic animal diseases. This point was emphasised when Member Countries were asked if improved cooperation between the Veterinary Authority and Aquatic Animal Health Services is needed for better management of aquatic animal diseases, including emerging diseases. Sixty eight percent of respondents either agreed or strongly agreed with this statement.

### 3.2. Experiences with emerging aquatic animal diseases – reporting

Improving transparency regarding notification of emerging diseases was nominated by Member Countries as 1 of the 3 most important actions Member Countries could take to support international efforts to manage emerging diseases of aquatic animals.

Eleven Member Countries reported 16 occurrences of emerging diseases of aquatic animals over the past 10 years. AHPND was the emerging disease with the most occurrences (6 occurrences), followed by ostreid herpes virus 1 microvariant (2 occurrences).

Member Countries advised that 12 of the 16 occurrences of emerging diseases were reported to the OIE and several reasons were provided for the 4 occasions that emerging diseases were not reported to the OIE. However, for the 12 occurrences where Member Countries advised that they had reported to the OIE, only 3 relevant immediate notifications can be found in the World Animal Health Information Database (WAHID).

This discrepancy could be explained by a misunderstanding in reporting requirements. For the 6 occurrences of AHPND reported through this questionnaire, Members stated that 5 occurrences were reported to the OIE. No relevant immediate notifications for AHPND can be found in WAHID; however, relevant reports for AHPND can be found in the Asia-Pacific Quarterly Aquatic Animal Disease (QAAD) reporting scheme. Reporting through the QAAD scheme does not, however, satisfy the *Aquatic Code* requirements (Chapter 1.1) to provide reports to OIE Headquarters.

In 2014, the OIE World Assembly of Delegates adopted revised chapters on notification (Chapter 1.1) in both the OIE *Aquatic Animal Health Code* and *Terrestrial Animal Health Code*. These chapters included new articles (1.1.4) for reporting emerging diseases; however, the revised articles do not explicitly require immediate notification to the OIE (within 24 hours) when an emerging disease has been detected in a country, a zone or a compartment.

Responses indicate that Member Countries differ in their decisions to report emerging diseases. For example, diseases reported by some countries as emerging diseases, have also occurred in other countries but those countries have chosen not to report to the OIE (e.g. OsHV-1 microvariant and AHPND). These decisions may be justified, for example due to a lack of clinical disease or lack of 'significant impact' in accordance with the definition of an *emerging disease*<sup>2</sup>. However, the purpose of reporting diseases is to '*minimise the spread of important diseases of aquatic animals and their pathogenic agents and to assist in achieving*

2 Emerging disease means a disease, other than listed diseases, which has a significant impact on aquatic animal or public health resulting from: a) a change of known pathogenic agent or its spread to a new geographic area or species; or b) a newly recognised or suspected pathogenic agent.

*better world-wide control of these diseases' (Aquatic Code, 1.1.2).* In this context, reporting of a known *emerging disease* (or its pathogenic agent), even in the absence of clinical disease or significant impact, may be warranted to comply with the spirit of Chapter 1.1. For example, in the case of OSHV-1 microvariant, for which significant impact has been well established in some Member Countries, notification of occurrence in other countries (even in the absence of 'significant impact') would be warranted because the information may be important to minimise disease spread in accordance with *Aquatic Code* Article 1.1.2.

### 3.3. Responses to emerging aquatic animal diseases

Response actions were implemented by Member Countries for all 16 occurrences of emerging diseases. The most common controls implemented (movement controls, surveillance and tracing, quarantine of affected premises and zoning) are consistent with a response objective of containing the disease to affected areas or premises. The least most common response actions (stamping out and treatment of affected animals) would generally not be feasible or cost effective for many of the reported diseases (e.g. OSHV-1 microvariant and AHPND).

Members indicated that the most important factors for their successful response to emerging diseases were early response, industry cooperation, availability of diagnostic tests, and early detection of the event. The single most significant factor that would need to be addressed to improve success in disease response was better understanding of emerging disease epidemiology.

Several of these success factors (e.g. early response, industry cooperation, early detection of the event) are not disease-specific but are generic capabilities that can be incorporated into a country's broader preparedness arrangements.

Two of the success factors are disease-specific – better understanding of disease epidemiology and availability of diagnostic tests. For new diseases, these issues may present significant challenges and could require a significant investment in research and development. This has been the case for several of the emerging diseases reported by Members. For example, infection with abalone herpes virus is a disease only known to science for about a decade. It has required significant research investment to develop diagnostic methods and to understand disease epidemiology sufficiently to develop prevention and control measures [1, 2, 3]. Given the importance of these success factors for effective disease response, a coordinated approach within and among potentially affected countries is warranted.

Two thirds of Member Countries indicated that improved cooperation between the Veterinary Authority and Aquatic Animal Health Services is needed for better management of aquatic animal diseases, including emerging diseases. Such cooperation may be particularly important when responding to emerging diseases because coordination, decision-making, resources, and communication may be tested severely. The need for improved cooperation is reflected in the Regional Commission's draft Regional Work Plan Framework 2016-2020, which aims to address cooperation between veterinary and aquatic animal health services.

AHPND is an example where regional cooperation and coordination was necessary to prevent disease spread and mitigate impacts. The Network of Aquaculture Centres of Asia-Pacific (NACA) and the Australian Government convened one of the earliest regional activities in response to the AHPND – a regional workshop held in 2012. This meeting brought together all interested stakeholders within the region, provided a forum for sharing available knowledge, set objectives for further research, and produced a case definition and disease card for AHPND.

There may be a role for the OIE to facilitate similar early regional cooperation for emerging diseases, particularly where impacts are significant and transboundary spread is likely. A level of contingency planning may be warranted to determine when, how and what action should be taken to facilitate regional cooperation. Such an activity would align with objectives and activities proposed in the Regional Commission's draft Regional Work Plan Framework 2016-2020 which includes:

- strengthening Regional Commission activities on aquatic animal diseases in collaboration with relevant partners active in this field, namely Network of Aquaculture Centres in Asia-Pacific (NACA) and FAO;
- encouraging specific programmes for addressing aquatic animal diseases relevant to Asian aquaculture to mitigate the impacts.

### **3.4. Prevention and preparedness**

Most Member Countries evaluate the import risks presented by emerging diseases that occur in other countries. However, 11 countries do not evaluate the risks presented by emerging diseases occurring in other countries and two of these countries are among the world's top 10 aquaculture producers. This lack of risk assessment and management may place important aquatic animal production industries at risk to emerging diseases.

Fourteen countries had implemented stronger border quarantine measures as a result of their evaluation of the risks presented by emerging diseases in other countries. This indicates that disease notification and sharing of epidemiological information on emerging diseases is important to ensure that any measures can be based on the best available information, and can mitigate the risk of disease spread with the least impact on trade possible.

Almost all Member Countries consider some drivers of disease emergence in their country's aquaculture planning and aquatic animal health management arrangements. However, almost half of the responding countries do not consider some of the most important drivers of disease emergence such as production of alien species and aquatic animal translocation. Three of these countries are among the world's top 10 aquaculture producers and this lack of risk management may also place important aquatic animal production industries at risk to emerging diseases.

Most Member Countries have contingency plans for responding to aquatic animal disease emergencies and all but two of these cover emerging diseases. However, many countries do not have contingency plans and two of these countries are among the world's top 10 aquaculture producers. Building disease preparedness arrangements in these countries could usefully be the focus of capacity building efforts.

This technical item sought information from Member Countries on the aquatic animal health management capabilities they have in place, but not on the adequacy or levels of advancement of those capabilities. Further evaluation and strengthening of existing aquatic animal health management capabilities is likely to be warranted in some cases.

### **3.5. International cooperation**

Member Countries identified important actions that Member Countries could take to support international efforts to manage emerging diseases. These include: sharing epidemiological information on emerging diseases, improving transparency regarding disease notification and improving biosecurity and disease control within their aquaculture industry.

Member Countries identified important actions that the OIE could take to support international efforts to manage emerging diseases. These include: coordinating regional action for serious emerging diseases, providing technical guidance on new emerging diseases, supporting OIE Members to build their capabilities through the OIE PVS Pathway, and advocating improved transparency for notification of emerging diseases.

These actions correspond with the factors necessary for successful responses to emerging diseases and some gaps in prevention and preparedness arrangements. Their importance as subjects for international cooperation, coordination and capacity building has been confirmed by this technical item. The strong interest expressed by Member Countries in undertaking an OIE PVS Aquatic evaluation (12 countries intend to make an application in the next two years) provides an opportunity to further address the factors needed for successful management of emerging diseases of aquatic animals.

#### 4. Conclusions

This technical item has explored the role of Veterinary Authorities in managing emerging aquatic animal diseases and has identified factors required for their successful management. The paper's findings have been drawn from the experiences of 28 Member Countries of the OIE Regional Commission for Asia, the Far East and Oceania comprising 90% of global aquaculture production volume.

Responsibilities for aquatic animal health management capabilities are often shared between the Veterinary Authority and other responsible authorities. For most Member Countries, improved coordination and communication between the Veterinary Authority and other responsible authorities is needed for better management of aquatic animal diseases, including emerging diseases.

Improved transparency regarding notification is one of the most important actions Member Countries can take to support international efforts to manage emerging diseases of aquatic animals. However, this technical item has found that Member Country approaches to notification of emerging diseases are somewhat inconsistent.

Most Member Countries have prevention and preparedness arrangements in place for emerging diseases of aquatic animals; however, there are some significant gaps, including among the world's top 10 aquaculture production countries. Building disease prevention and preparedness arrangements could usefully be the focus of regional capacity building efforts.

The most important factors for successful response to emerging diseases are early response, industry cooperation, availability of diagnostic tests, and early detection of the event. Member Countries should ensure that these factors are incorporated in their aquatic animal disease preparedness arrangements.

Better understanding of emerging disease epidemiology is the most significant factor that must be addressed to improve success. But this factor may require significant investment of resources and international cooperation may be warranted to share information and coordinate research efforts. There may be a role for the OIE to facilitate such regional cooperation for responses to emerging diseases, particularly where impacts are significant and transboundary spread is likely.

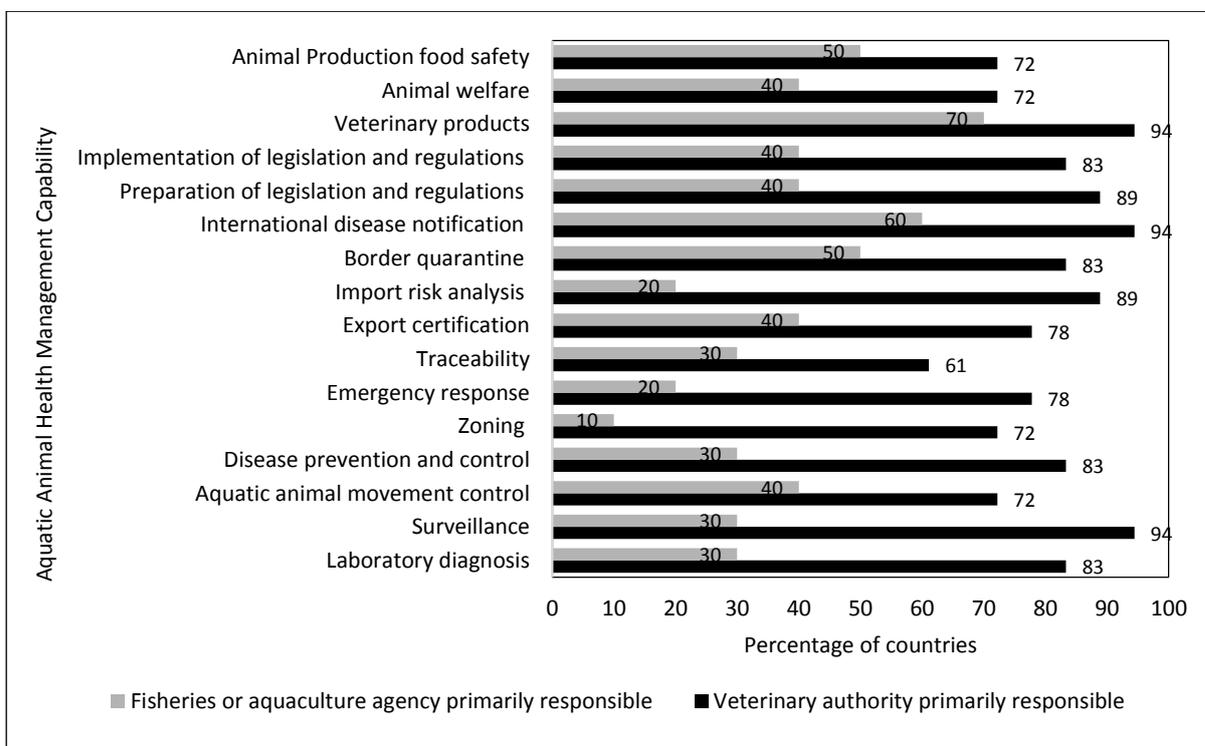
The OIE could support international efforts to manage emerging diseases by advocating improved transparency for notification of emerging diseases, providing technical guidance on new emerging diseases, and supporting OIE Member Countries to build their capabilities through the OIE PVS Pathway.

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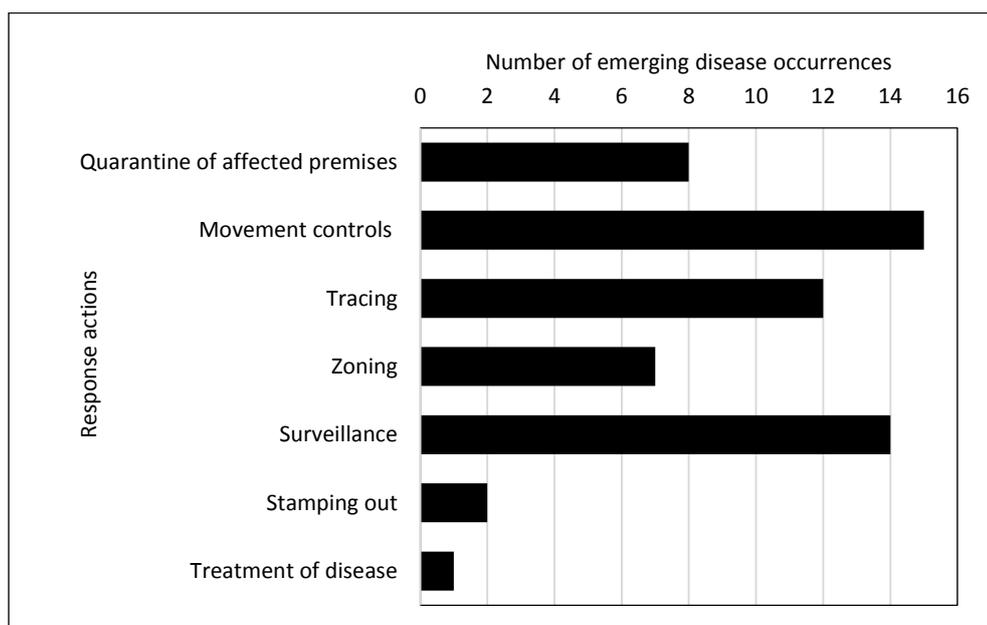


**Figures**

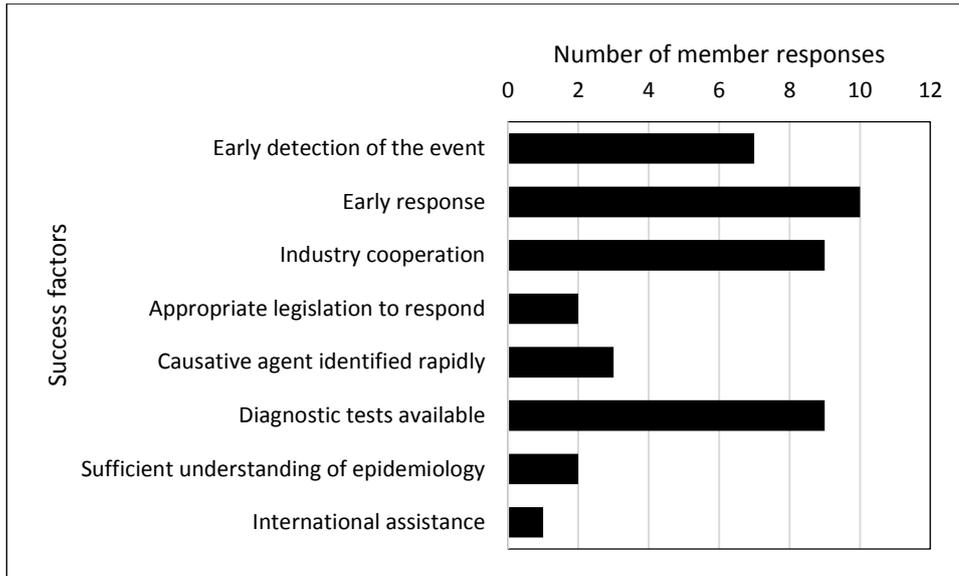


**Fig. 1**  
**Percentage of Member Country Veterinary Authorities that are responsible for each of 16 aquatic animal health management capabilities**

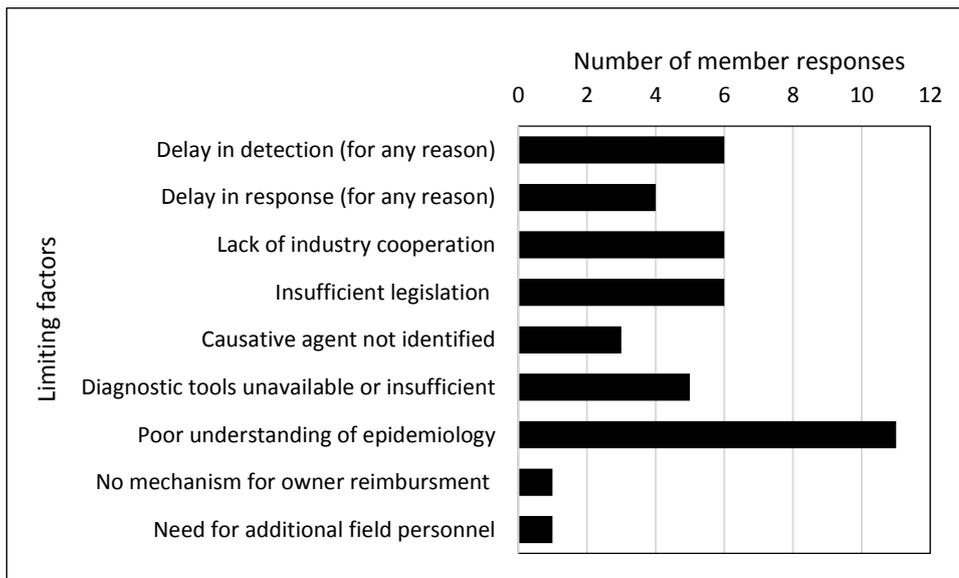
Black bars, countries where primary responsibility for aquatic animal health management rests with the Veterinary Authority (n=18); grey bars, countries where primary responsibility for aquatic animal health management rests with the government's fisheries or aquaculture authority (n=10).



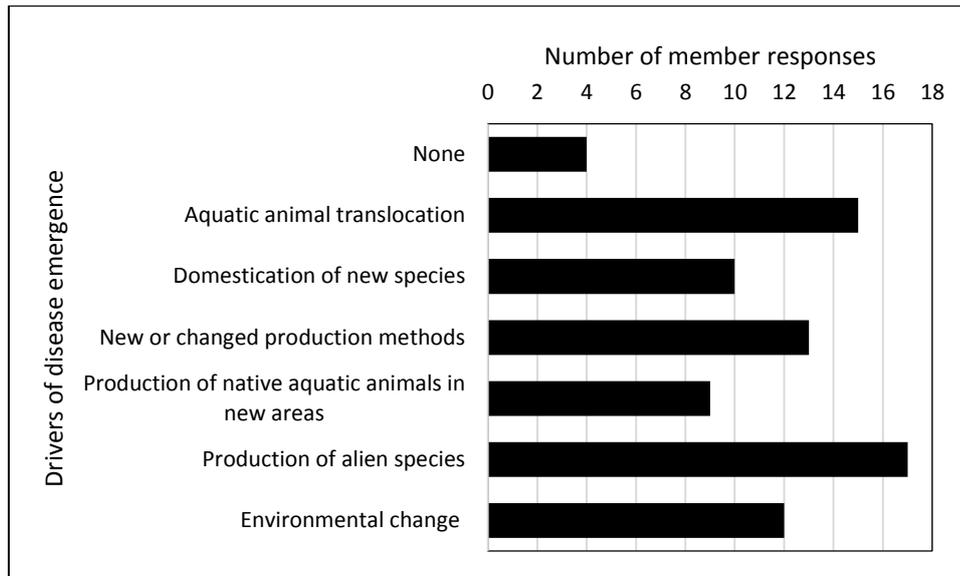
**Fig. 2**  
**Actions implemented by 11 Member Countries in response to 16 separate occurrences of emerging diseases**  
 Member Countries were asked to nominate all response actions employed for each occurrences of an emerging disease



**Fig. 3**  
**The most significant factors for success in Member Country responses to 16 separate occurrences of emerging diseases**  
 Member Countries were asked to nominate only the 3 most important success factors for each occurrence of an emerging disease

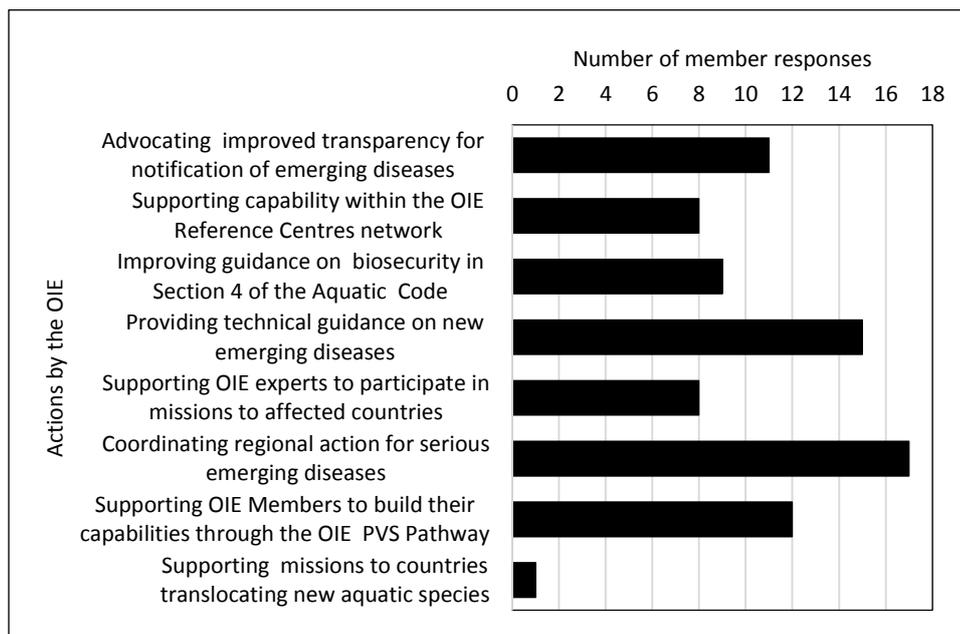


**Fig. 4**  
**The most significant factors that would need to be addressed to improve Member Country success in responding to 16 separate occurrences of emerging diseases**  
 Member Countries were asked to nominate only the three most important factors for each occurrence of an emerging disease

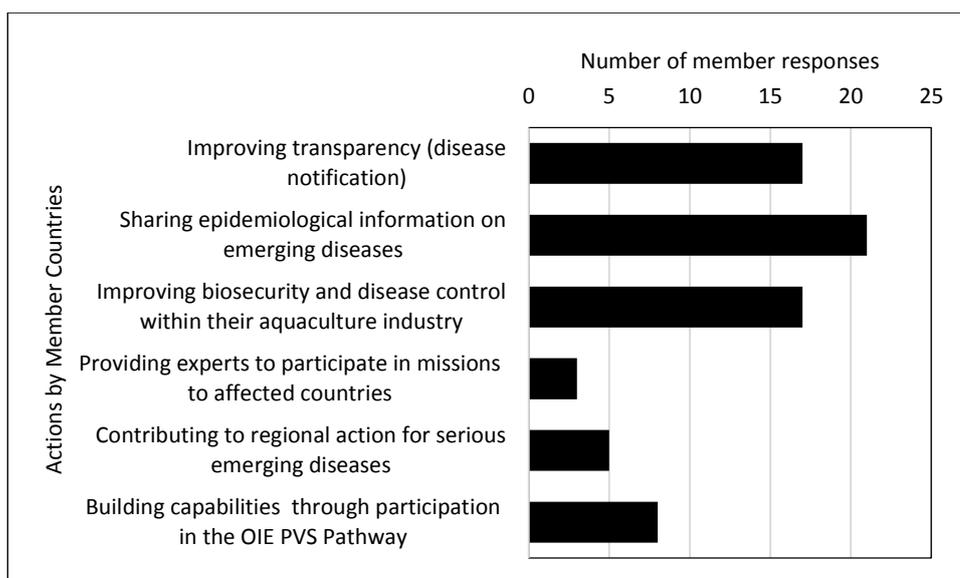


**Fig. 5**  
**Drivers of disease emergence considered by Member Countries in their aquaculture planning and aquatic animal health management arrangements to mitigate disease emergence**

Aggregate response for 24 Member Countries that indicated they consider at least 1 driver of disease emergence



**Fig. 6**  
**The most important actions, as nominated by Member Countries, which the OIE could take to support Members to manage emerging diseases of aquatic animals**



**Fig. 7**  
The most important actions, as nominated by Member Countries, that Member Countries could take to support international efforts to manage emerging diseases of aquatic animals

## Tables

**Table I**

**Emerging diseases of aquatic animals reported by Member Countries to have occurred in the 10 years prior to 2015**

Eleven countries reported 16 occurrences of 10 different emerging diseases

Disease	Countries reporting	Comments
Acute hepatopancreatic necrosis disease	6	First listed in the 2015 <i>Aquatic Code</i>
Ostreid herpes virus 1 microvariant	2	Not listed by the OIE. Previously listed in the <i>Aquatic Code</i> as an emerging disease.
Infection with abalone herpes virus	1	First listed in the 2009 <i>Aquatic Code</i>
Soft tunic syndrome	1	Not listed by the OIE
Oyster oedema disease	1	Not listed by the OIE
<i>Streptococcus agalactiae</i>	1	Not listed by the OIE
Viral haemorrhagic septicaemia (IVb)	1	Listed in the first edition of the <i>Aquatic Code</i> (1995)
Infectious myonecrosis	1	First listed in the 2007 <i>Aquatic Code</i>
Koi herpes virus disease	1	First listed in the 2007 <i>Aquatic Code</i>
White spot disease	1	First listed in the 2000 <i>Aquatic Code</i>

**Table II**

**Border quarantine measures implemented by Member Countries following their assessment of emerging disease risks in other countries**

Specific measures reported by Member Countries have been categorised for ease of reporting

Measure	Instances
Source freedom (country, zone or compartment)	1
Temporary restriction on import from outbreak countries	3
Pre-export quarantine	1
Batch freedom (pre-export testing or post-arrival testing)	6
Enhanced border surveillance and inspection	2
Post-arrival quarantine	4
Increased inspection vigilance at border posts	2
Other biosecurity measures – not specified	3