An epidemiological database for aquatic animal infectious diseases

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Abstract

PANDA (Permanent Advisory Network for Diseases in Aquaculture, http://www.europanda.net/) was established in 2004 with funding from the EU Framework Programme 6 under the theme of scientific advice in support of policy. One of its objectives was to establish a readily available data source that could be used to support risk assessment, surveillance and contingency plans for exotic and emerging aquatic diseases in Europe. A small international task force was charged with developing a database to fulfil this need. The particular focus of the group was to develop an easily accessible structure that would include information on the epidemiology of each pathogen and the respective infections, in such detail that it could be used as the scientific basis for risk analysis. Even though the original PANDA task was to focus on exotic diseases, a decision was made to extend the database so that it could include information on many diseases that may be of interest in any area of the world. The process of development and pre-testing the database, the database structure and the resource implications of developing and sustaining such a database will be described and discussed. The database currently is available through the PANDA website in its complete form, tested during the past 3 years by the authors and a number of colleagues. To make the information accessible to as wide an audience as possible, we propose to publish the database on the World Wide Web as a free-access, peer-reviewed electronic journal (AQUATIC DISEASE RISK REVIEW). The presentation of the database as an on-line journal would ensure its continuous expansion to include new pathogens or information and the revision of existing information whenever that became necessary because of new scientific developments.

Introduction

PANDA (Permanent Advisory Network for Diseases in Aquaculture) was established in 2004 with funding from the European Union Framework Programme 6, under the theme of "scientific advice in support of policy". The purpose of the PANDA network has been to provide scientific support to the European Commission on policy making and legislation, in the areas of prevention and control of infectious diseases in aquaculture species in the EU. Even though PANDA was initially funded as a 3-year project, its continued

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existence was intended, through a network of experts (Hiney and Hill, 2004). Currently, the network has over 350 registered aquatic animal health experts.

One of the Work Packages (WP's) was given the task to identify the most significant exotic, emerging and re-emerging disease hazards in Europe and to assess their potential impact on aquaculture and wildlife in the EU. It was, however, evident that in order for any risk analysis effort to be successful a lot of specialized epidemiological information on specific pathogens should be readily available. A lot of this epidemiological information is often non-existent for aquatic animal pathogens and diseases. Even for pathogens for which such information exists, it may be dispersed among several studies, observations (published or unpublished) and media, so that it cannot be accessed easily in its entirety, especially at times of crisis, when a plan of action must be designed quickly.

To alleviate this problem, the "Epidemiology Work Package", WP 3, was given the task of designing a database of the current epidemiological knowledge on exotic, emerging and re-emerging infectious diseases that can impact (or can play a role in the future of) EU aquaculture and aquatic wildlife. The database would include information on the epidemiology of each pathogen and the respective infections, in such detail that it could be used as the scientific basis for risk analysis.

Even though, the original PANDA task was to focus on exotic diseases, a decision was made to extend the database so that it could include information on many diseases that may be of interest in any area of the world. Furthermore, it was decided that a broader range of tasks should be supported by the database, so additional fields were included to provide information that would be useful not only for risk analysis but also for other epidemiological activities, such as surveillance, surveys to assess freedom from disease, design and implementation of disease prevention and control schemes, as well as for supporting actions in emergency situations. The construction and basic structure of this database will be described in this paper.

Methods

The design of the database was guided by its purpose: to provide the basis for risk analysis, as well as for the design of surveillance systems and epidemiological surveys. It should, therefore, include all relevant and necessary fields and ensure the easy insertion of information. Additionally, it would be necessary to establish procedures and define the resources that would be required in order: a. to populate the database with required pathogen and disease information and b. to maintain the database in a manner that it could keep expanding and always contain current and up-to-date information.

The requirements that the database should fulfil were specified as:

a. It should focus on epidemiological information. This meant that the database would not have a "classical" appearance and organization of information that might be found in other disease/pathogen databases, targeted to clinicians, farm managers and laboratory workers. Instead

it would be created having in mind the epidemiologist and risk analyst and their information needs.

b. The information should be easily accessible, cross-linked and searchable.
c. The information should be of the highest quality and reliability. This meant that a quality control system should be designed and implemented for the insertion of information in the database.
d. Updating should be easy and implemented in regular intervals in order to keep the database current and up-to-date.

One of the main tasks was to identify all possible questions or pieces of information that would be needed by epidemiologists designing and conducting epidemiological surveys or risk analyses for aquatic pathogens. This was done through an iterative process of implementation of improvements and reassessment that was ongoing throughout the project.

Additionally, scientists were invited for comments by making the preliminary database available over the Internet. The functionality of the database was also tested during a workshop at the 2005 Annual Meeting of the National Reference Laboratories for Fish Diseases, organized in Århus, Denmark, by the European Community Reference Laboratory (CRL) for fish diseases. Moreover, an oral presentation concerning the database (structure, functionality, uses and examples) was given at an international epidemiological conference in 2006 (ISVEE XI – The Eleventh International Symposium on Veterinary Epidemiology and Economics).

The database was built using Microsoft® Access (Microsoft Corporation, Redmond, WA, USA), for ease and speed of implementation and in order to keep development cost to a minimum. After the database became operational, it was tested by entering information on specific pathogens. In this testing phase, the group evaluated the ease of use, the need for addition of new fields or changes in the description of existing ones or even the need for changes in the grouping of information presented.

Results

The database is currently available on-line at the PANDA website (http://www.europanda.net/epidb). The information is organized by pathological agent. The database currently holds preliminary information on 27 aquatic animal pathogens (11 viruses, 6 bacteria, 2 fungi, 5 protozoa and 3 other parasites) and related diseases (Table 1).

An important distinction made in the database is that between infection and disease. It is understood that disease causation is multifactorial and a pathogen is just one of the component causes implicated in the aetiology of each disease. Based on this principle, information is listed separately for each pathogen and for the clinical disease(s) in which it is implicated as a causal agent.

Presentation of the basic information is in tabular form. Several studies, which have produced information on the epidemiology of specific diseases, are observational. Therefore, it is not only important to list their findings but also to describe the conditions under which the studies were conducted, any alternative explanations of the findings or any reservations

Virus
Amphibian ranavirus: Ranavirus disease
Epizootic Haematopoietic Necrosis virus: Epizootic Haematopoietic Necrosis (EHN)
Infectious Hypodermal and Haematopoietic Necrosis virus: Infectious Hypodermal and Haematopoietic Necrosis
Infectious Pancreatic Necrosis virus: Infectious Pancreatic Necrosis (IPN)
Infectious Salmon Anaemia virus: Infectious Salmon Anaemia (ISA)
Koi Herpes Virus: KHV disease
Red sea bream iridovirus: Red sea bream iridoviral disease
Rhabdovirus carpio: Spring Viraemia of Carp (SVC)
Taura syndrome virus: Taura syndrome (TS)
White Spot virus: White spot disease (WSD)
Yellowhead virus (YHV): Yellowhead
Bacteria
Candidatus Xenohaliotis californiensis: Withering syndrome of abalone
Coxiella cheraxi: Crayfish systemic rickettsiosis
Lactococcus garvieae: Lactococcosis
Nocardia crassostreae: Pacific oyster nocardiosis
Streptococcus agalactiae: Streptococosis caused by St. agalactiae
Streptococcus iniae: Streptococosis caused by St. iniae
Fungus
Aphanomyces invadans: Epizootic ulcerative syndrome (EUS)
Batrachochytrium dendrobatidis: Amphibian chytridiomycosis
Protozoa
Ceratomyxa shasta: Ceratomyxosis
Marteilioides chungmuenis: Marteilioidosis
Neoparamoeba pemaquidensis: Amoebic gill disease
Perkinsus marinus: Perkinsosis
Perkinsus marinus: Perkinsosis caused by P. marinus
Trypanoplasma salmositica: Salmonid cryptobiosis
Other parasites
Parvicapsula pseudobranchicola: Parvicapsula pseudobranchicola infection
Perkinsus olseni/atlanticus: Perkinsosis caused by P. olseni/atlanticus
Gyrodactylus salaris: Gyrodactylosis

Table 1. Pathogens about which information currently exists in the database

about the applicability of the results that the authors of the studies might have presented in the original papers. It is difficult to include such information in formal database fields, however, it can be preserved in the database through the use of hyperlinks. For that reason, hyperlinks that lead to other pages are used in relation to several database fields.

In its current form, the database consists of 7 sections: 1. Properties of aetiological agent, 2. Host susceptibility and pathogenicity, 3 Transmission, 4. Diagnostic tests, 5. Sanitary policies, 6. Related diseases, and 7. Bibliography.

1. Properties of pathological agent

Information listed in this section includes: scientific name and synonyms for the agent, taxonomic information, whether it is listed by OIE and EU, geographical distribution, existence of strains and their implication in the epidemiology of the resulting infection, methods to differentiate strains and sensitivity of agent to physico-chemical products.

2. Host susceptibility

This section lists all hosts that can be susceptible to the specific pathogen. For each pathogen there are fields that list: the susceptible hosts and any host characteristics that can affect susceptibility to infection and susceptibility to disease given that the host becomes infected, whether host strains with genetic resistance exist, and what is the expected morbidity, mortality, infective period and incubation period of the specific pathogen in the given host. Also, in this section there exist fields to insert information on known risk factors for infection.

3. Transmission

This section focuses on known methods of transmission and presents epidemiological information on available descriptions of field observations of occurrences of transmission. Database fields include: infective period, minimum infectious dose, methods of direct transmission (vertical, horizontal, survival off-host and relevant environmental conditions), routes of indirect transmission (biological, mechanical, aquatic animal products), intermediate hosts and their geographical distributions, existence of reservoirs and risk factors associated with transmission. Finally, there are two fields in which information about any historical evidence of transmission or of establishment of infection can be listed.

4. Diagnostic tests

This section details information on diagnostic methods that are used to detect infection or exposure in live aquatic animals or to detect infection in aquatic animal products. For each diagnostic test a hyper-linked page details the following information: what is the test designed to detect, description of the testing methodology, whether the test is a gold standard and whether it is included in the OIE manual. Also, what is the sensitivity and specificity of the test and how, under what conditions and in what populations was the test evaluation conducted? This information is very important in judging the applicability of the published sensitivity and specificity values in specific field situations, as diagnostic sensitivity and specificity of a test may differ in different testing situations and populations (Greiner and Gardner, 2000).

5. Sanitary policies
This section is concerned with the existence of regulatory policies for prevention, monitoring and detection of infection in EU member-countries.

6. Information about diseases
This section lists all diseases in the aetiology of which the specific agent is implicated. More specifically, special fields exist for name and synonyms of the disease, case definition, clinical signs and pathological features, pathognomonic signs or lesions that may exist, expected morbidity, mortality and incubation period, existence of subclinical infections and carrier states, treatment, availability of vaccines, biological control or other prevention methods. This section also lists names of experts and researchers on the specific diseases.

7. Bibliography
This section includes a list of all relevant bibliographic sources and a field that specifies when this list was last updated.

Discussion

A database of epidemiological information on aquatic animal pathogens and the resulting infections is presented. Several other databases of aquatic animal pathogens are available, however, none of them has a focus on epidemiological information. Examples are the OIE Manual of Diagnostic Tests for Aquatic Animals (OIE, 2006), the Aquatic Animal Pathogen and Quarantine Information System database (AAPQIS) (FAO, 2008), the International Database on Aquatic Animal Diseases (Aquatic DB, 2008), and the Registry of Aquatic Pathology (RAP 2008). Our purpose was to provide an easily accessible source of information on aquatic animal epidemiology that would cover comprehensively the information needs of formal risk analysis and other epidemiological activities. We are not aware of the existence of similar non-commercial databases for terrestrial livestock pathogens and diseases, except for the respective OIE publications for terrestrial animals.

The key to continuous operation of the database is to expand the number of people who contribute to the database. This can be done by inviting or encouraging peer-review submissions of database entries from experts in the form of pathogen reviews. Furthermore, to make the information accessible to as wide an audience as possible, we propose to publish it on the World Wide Web as a free-access, peer-reviewed electronic journal (AQUATIC DISEASE RISK REVIEW). The journal would have an editorial board appointed by a standing committee and would be published twice per year. ISI® (now Thomson Scientific) listing would be sought for the new journal. The intended audience would be epidemiologists, risk analysts, aquatic animal disease specialists, diagnosticians, mathematical and statistical modellers and policy makers. The aim will be to provide a comprehensive compilation of epidemiological information about all the major aquatic diseases that can affect finfish, molluscs and crustaceans worldwide.

Standardization of the inserted information would be assured by providing authors and reviewers with detailed instructions about what information needs to be included, how to identify and indicate knowledge gaps, how

to distinguish between information on disease vs. infection, etc. Furthermore, information on technical and practical issues would be provided to the authors, for example, information on filling in the database, on updating information, whenever necessary, on providing references and bibliography, etc. Contributing authors would be encouraged to review all available information (including unpublished observations and "grey" literature) and offer personal opinion and critical evaluation of published epidemiological information. Currently, it is not possible to include a reference for each individual piece of data that is entered in the database, since this would increase the size of the database considerably and it could complicate the process of entering information, in cases, for example, in which some information is mentioned in more than one publication or is compiled from multiple sources. All the relevant bibliography, however, is listed in the respective field of the database, while the peer-review process will guarantee the accuracy and quality of all the information in the database.

Quality control and updating of the information would be under the supervision of the journal editorial board. In general, reviews would only be updated every 2 years, in the first instance, unless a submitting author could make a good case for new information, which would necessitate a more rapid update. Minor supplementary information might be added to each review during this 2-year period if it was correctly cited and approved by the editor. The scientific personnel of European Community reference labs and National reference labs could also play an important role in providing up-to-date information and informing the editorial board about any needs for updating.

The presentation of the database as an on-line journal will ensure its continuous expansion to include new pathogens or information and the revision of existing information whenever that becomes necessary because of new scientific developments. As such a database evolves, it will compile available epidemiological information for aquatic animal diseases from different areas of the world and become a valuable tool for people working in risk analysis, prevention and control of aquatic animal diseases and training in aquatic animal epidemiology. The need for such a database seems highly relevant as current disease control efforts (in an age of considerable worldwide trade of fish, molluscs, crustaceans and related products), should consider the disease situation globally and cannot just focus on specific geographical areas.

PANDA provided funding and the technical infrastructure for the database during the project period. Even though a lot of effort and resources have been expended in building, testing and populating the database with information, it is not yet considered a finished product. New fields and capabilities (for example a search function) need to be added, while for the pathogens that already exist in the database, there exist information gaps. For finalizing the database and maintaining a system for the continuous up-dating and quality control of information, basic financial support is needed as well as a dedicated editorial board. With the support and contribution of aquatic animal epidemiology

experts, it can become a very useful tool for everybody working with aquatic animal disease, while at the same time it can also help identify knowledge gaps and future research needs.

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References

Aquatic DB, (2008). International Database on Aquatic Animal Diseases. OIE Collaborating Centre for Aquatic Animal Diseases. http://www.collabcen.net/toWeb/aq2.asp.

FAO, (2008). Aquatic Animal Pathogen and Quarantine Information System (AAPQIS) http://www.aapqis.org/v2/Default.aspx.

Greiner M & Gardner IA, (2000). Epidemiologic issues in the validation of veterinary diagnostic tests. *Preventive Veterinary Medicine* **45**, 3-22.

Hiney M & Hill BJ, (2004). Development of a permanent network of experts on infectious diseases of aquaculture species for providing scientific advice on EU policy (PANDA). *Bulletin of the European Association of Fish Pathologists* **24**, 38-44

OIE, World Organization for Animal Health, (2006). Manual of Diagnostic Tests for Aquatic Animals, 5th Ed. http://www.oie.int/eng/normes/fmanual/A_summry.htm.

RAP, (2008). Registry of Aquatic Pathology. Centre for Environment, Fisheries and Aquaculture Science (Cefas). http://www.aquaticpathology.co.uk/index.aspx.