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Multidisciplinary and Evidence-based Method for Prioritizing Diseases of Food-producing Animals and Zoonoses

[Q1. Title has been edited for brevity and EID style. Subtitles and sentences are not used. Titles must be as general (common language) as possible. OK?]

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[Author: see query 7 in Table 3].

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The present prioritization process is based on multicriteria decision-making that includes opinions of multidisciplinary experts and evidence-based data. One hundred diseases were included in the process and 5 categories of 57 criteria were considered. International experts performed intracategory (n = 40) and intercategory (n = 6) weighting of criteria. Information corresponding to each criterion/disease was collected by using an evidence-based method. An overall weighted score was calculated for each disease based on a deterministic (mean of each weight) and probabilistic (distribution functions of weights by using Monte Carlo simulation) approaches. Consecutive ranking was established. Classification and regression tree analysis enabled classification of diseases into 4 subgroups according to relative roles. Few differences were observed between deterministic and probabilistic approaches. This generic and predictive method is applicable in different contexts and to diseases affecting other species.

Agents that cause zoonotic diseases are infectious (transmissible) agents that are not only confined to 1 animal host, but which can cause an infection (infestation) with or without clinical disease in several hosts, including humans (*1*). Nevertheless, all diseases affecting animals and humans are not strictly zoonotic but are qualified as common. Animals and humans generally contract infections from the same sources (soil, water, invertebrate animals, and plants). However, animals do not play an essential role in the life cycle of the etiologic agent, but may contribute in various degrees to distribution and transmission of infections (*2*). According to the World Organisation for Animal Health (OIE), 75% of the emerging diseases originate in domestic or wild animals, which prompts close collaboration between animal and public health authorities (www.oie.int/eng/edito/en_avr09.htm).

To achieve such a goal, the one health strategy was recently developed to expand interdisciplinary collaborations and communications in all aspects of health care for humans, animals and the environment (www.onehealthinitiative.com/mission.php). Such collaborations are particularly evident when considering zoonoses. In the continuity of the

one health concept, a new strategy for animal health was recently adopted by the European Union (*3*). Categorization of animal-related threats is 1 of the pillars of this strategy. Such process aims to provide a tool for decisions in animal health issues for selecting disease-related threats that are worth being addressed by public policies, which is necessary if considering emerging infectious diseases. The process of disease prioritization has been defined as the "Organization of listed diseases into a hierarchy, considering their respective impacts" (*4*).

The main objectives of a prioritization process are to optimize financial and human resources for the surveillance, prevention, control, and eradication of infectious diseases and to target surveillance for early detection of any emerging disease. Our method is based on widely used multicriteria analysis, which consists of listing criteria to assess pathogens, evaluating pathogens on the basis of these criteria (scores), determining the relative role (weight) of each criterion, and aggregating scores and weights of criteria into 1 global score per pathogen (*5*). The originality of the prioritization procedure is a reasoning based on opinions of multidisciplinary experts (weighting process) and on evidence-based data of targeted diseases (animal diseases, zoonoses, and transmissible diseases common to animals and humans).

Methods

Diseases

One hundred diseases were included in the prioritization exercise. Species targeted were food-producing animals: cattle, small ruminants, swine, horses, poultry (included water birds such as ducks and geese), lagomorphs, and wildlife (species common in western Europe). The diseases were 86 diseases affecting the animal species under study and reportable to the OIE (www.oie.int/en/animal-health-in-the-world/oie-listed-diseases-2011/).

Highly pathogenic and low pathogenic avian influenza were considered separately. Twelve additional infectious diseases reported in Europe during September 2009 and September 2010 and reported to the International Society for Infectious Diseases (www.promedmail.org) (archives 20100215.0530, 20100803.2615, 20101227.4564, 20100729.2546, 20100330.0996, 20100111.0128, 20090912.3211, 20100620.2072, 20091217.4273, 20091004.3453, 20101106.4026, and 20100209.0442) were also included in the prioritization process: besnoitiosis, botulism, bluetongue (bluetongue virus serotype16),

hantavirosis (*Puumala virus*), hepatitis E, influenza (H1N1), norovirus disease, European tick-borne encephalitis, Usutu virus disease, porcine post-weaning multisystemic wasting disease (circovirus), equine atypical myopathy, and disease caused by *Escherichia coli* O157:H7. Parafilariasis (*Parafilaria bovicola*) was also included because it is considered as emerging in western Europe (*6*). Salmonellosis caused by *Salmonella enterica* serovar Enteritidis was considered because of its effect on public health and it is the most common serovar in the European Union (*7*). Foot-and-mouth disease (FMD) was included in the zoonotic/common category despite its low effect on public health and the limited number of human cases reported to date (*8*).

Prioritization Criteria

Five aspects of a pathogen were considered: epidemiology, prevention and control, effects on economy and trade, zoonotic characteristics, and effect on society. The prioritization criteria were established according to a review of previous priority settings (e.g., English Department for Environment, Food and Rural Affairs [DEFRA]) (archive.defra.gov.uk/foodfarm/farmanimal/diseases/vetsurveillance/strategy/programme/prioritisation.htm) (*9*–*13*) and principles of evidence-based medicine, which promotes collection, interpretation, and integration of valid, essential, and applicable scientific evidence (*14*). A total of 57 criteria were retained for the prioritization process and further submitted for opinions of experts. The distribution of criteria between 5 categories was 17 for epidemiology (EP), 8 for prevention/control (PC), 16 for economy/trade, 12 for public health (PH) and 4 for society (SO). The 57 criteria are summarized in Table 1. Strict definitions were given for each coefficient and criterion and are summarized in Table 2.

A particular classification of zoonoses based on interactions between host species is included as a criterion in the PH category. Type 1 diseases are those transmitted from wildlife to humans, type 1+ are transmitted from wildlife to humans with additional human-to-human transmission, type 2 are transmitted from wildlife to domestic animals and then to humans, and type 2+ are diseases transmitted from wildlife to domestic animals and then to humans, with further human-to-human transmission (*15*).

Coefficients of Criteria

For each criterion, a coefficient of 0–7 was assigned to every option (Table 2) according to its role, effect, or rate. Coefficients were correlated with severity: the more severe the effect, the higher the coefficient. For example, a case-fatality rate <1% has a

coefficient of 1 and case-fatality rate >90% has a coefficient of 7. For nonzoonotic agents, a coefficient of 0 was fixed for criteria included in the PH category.

For each disease, evidence-based information concerning the 57 criteria was obtained from different sources, including use of OIE and Iowa State University (Ames, IA, USA) fact sheets and consultation with Web sites of international organizations (OIE, World Health Organization, European Centre for Diseases Prevention and Control), and Centers for Disease Control and Prevention). Web site searches for peer-reviewed literature were conducted in PubMed and the Thomson Reuters (formerly ISI) web of knowledge. Useful information was also obtained from scientific reference books (*16*,*17*). Searches enabled collecting ≈100% of information needed for the 57 criteria of the 100 diseases.

Multidisciplinary Panel of Experts

The main characteristic of the panel of experts consulted within the framework of the project was its multidisciplinarity. A total of 74 international experts were elicited according to their field of expertise: veterinary and human epidemiologists, chief veterinary officers, economists, medical doctors, sociologists, and experts in public health and animal welfare.

Two tasks were assigned to the experts. First, they were asked to give their opinion on the pertinence of criteria proposed by indicating their degree of agreement. They were then asked to assign a score of 1 if they strongly disagreed with the criterion, 2 if they disagreed, 3 if they simply agreed, and 4 if they strongly agreed. In instances of strong disagreement, experts were asked to justify their decision and propose alternative options. Second, they were asked to weight criteria. Because all criteria do not have the same role in terms of risk and consequences within the same category, experts were thereafter asked to apply a Las Vegas method between for criteria according to their relative roles (or weights) (*18*). Because the number of criteria differs between categories, the number of points to distribute was proportional to the number of criteria per category: 90 for EP and PH, 60 for PC and EC, and 30 for SO. This approach was necessary to prevent criteria classified as major by experts (in terms of points distributed) from receiving less points because they belonged to a category that included more criteria. Finally, 6 international mulitcategory experts were asked to apply the Las Vegas method for intercategory weighting by distributing 100 points between the 5 categories of criteria.

Weighting of Scores and Ranking According to Experts

After experts weighted different criteria, an overall weighted score was calculated for each disease (*19*). To perform the ranking, an aggregation method combining 2 types of weighting was performed. First, intracategory weighting consisted in multiplying the coefficient (0–7) allocated to the criterion by the average of points (weight) distributed by the experts for that criterion. A global score for a category was obtained by summing the weighted scores obtained for each criterion. Second, multicategory experts performed intercategory weighting. The mean number of points allocated by these experts to each category of criteria (weight) was multiplied by the global score obtained for each category after the first weighting. The overall weighted score of each disease resulted from the summation of global scores obtained from the 5 categories, as shown in the equations $OWS = \Sigma_{cat} (GSC_j \times IrW_j)$ and $GSC_j = \Sigma_{crit} (C_i \times IaW_i)$, in which OWS = overall weighting score of a pathogen; GSC_j = global score of a category of criteria; IrW_j = intercategory weight for each category of criteria (average for deterministic approach); C_i = initial coefficient per criterion; IaW_i = intracategory weight for each criterion (average for deterministic approach); Cat = categories of criteria; and Crit = criteria.

Uncertainty Analysis

Uncertainty of the weighting process was estimated by using a probabilistic approach. All weights were converted into a function (Table 1) and computed by using @Risk software version 5.5 (Palisade Corporation, Ithaca, NY, USA). Functions were then combined through an aggregation process by using a Monte-Carlo simulation with 1,000 iterations to obtain a function of the overall weighted scores per disease with a 95% CI.

Classification of Diseases by Using Classification and Regression Tree Analysis

Different groups of roles were identified by using classification and regression tree (CART) (www.salford-systems.com) analysis with overall weighted scores per disease as input (probabilistic approach). This widely used method developed by Breiman et al. (*20*) can be applied to analyze either categorical (classification) or continuous data (regression) (*11*,*12*,*20*,*21*). In this report, regression tree models were used as the target variable and disease role was the continuous variable (*22*). The aim of these models was to obtain subgroups with minimal within-variance (grouping diseases with a similar role) by using cross-validation (*11*,*23*). Default settings of the software described by Steinberg and Golowya were used to develop the regression tree (*24*).

Results

Expert Opinions for Criteria

The response rate of the 74 experts on the procedure was 54% (i.e., 40 replies). Profiles of the experts are shown in Table 3. Experts were classified according to the different categories of criteria as follows: 18 for EP, 16 for PC, 14 for EC, 10 for PH, and 13 for SO. Opinions of 6 cross-categories experts who assessed all categories of criteria (multicategory experts) were also included individually in each category.

Opinions of experts on proposed criteria were taken into account to adapt the list of criteria. For example, in the EP category, 3 rates were primarily proposed to experts: morbidity (illness), mortality, and case-fatality. The experts suggested deleting mortality rate because case-fatality rate better reflects the gravity of the disease. Some modifications (clarifications) were made to definitions of each criterion and its coefficients. The final database of criteria, their coefficients, and definitions used for prioritization are shown in Table 1. The relative weight of category of criteria was 20 points for EP, mean = 19 and median = 18 points for PC, mean = 23 and median = 28 points for EC, mean and median = 25 points for PH, and mean = 14 and median = 15 points for SO. [Q. regarding mean and median values.]

Public health was considered as the major category of criteria in terms of prioritization. Weighting of criteria as proposed by experts is shown in Figure 1. Epizootic potential and case-fatality rate (%) were regarded as the 2 major epidemiologic indicators (Figure 1, panel A). Effectiveness of prevention and vaccination were weighted as the 2 major PC criteria (Figure 1, panel B). Loss of productivity and limitation of importation and exportation were the 2 major EC criteria (Figure 1, panel C). Case-fatality rate and epidemic potential were weighted as the 2 major PH criteria (Figure 1, panel D). Effect on animal welfare and biodiversity and lower consumption were the 2 major SO indicators (Figure 1, panel E). Nevertheless, within each category, differences between criteria were scarce. Conversely, the range in weights of each criterion was large, as shown by high SDs, which indicated variability between opinions of experts. To take variability into account, we used a probabilistic approach to estimate the overall weighted score per disease.

Ranking of Diseases

Final ranking of diseases according to their overall weighted scores and use of a probabilistic approach is shown in Figure 2. Few differences were observed between

deterministic (mean of each weight) and probabilistic approaches (function of weights) (Pearson correlation coefficient 0.999, $p < 0.0001$). This finding is likely associated with a few problems in subjective interpretation or dilution of individual discordances among the large number of experts.

FMD was considered as zoonotic. However, FMD could be included in the nonzoonotic category. In such an instance, it would be the highest ranked nonzoonotic disease. Newcastle disease was included in the zoonotic/common category, which could be questioned because of its limited effect on PH. The top 5 ranked diseases were all zoonotic/common: Nipah virus encephalitis, Venezuelan equine encephalitis, highly pathogenic avian influenza, West Nile fever, and botulism.

Classification of Diseases by Using CART Analysis

Regression trees enabled identification of 4 groups of diseases in function of importance, These diseases are shown in Figure 2.

Discussion

Prioritization of diseases has acquired major interest within the past few years, especially from a preventive point of view and in the sector of public health. Such a process is needed within the context of emerging diseases because it is not known how severe socioeconomic consequences of outbreaks will be. Our study not only included zoonoses, such as those reported by Cardoen et al. (*11*) and Havelaar et al. (*12*), but also transmissible diseases common to humans and animals and reportable animal diseases. The prioritization process was developed by an independent group to avoid any bias that could result from the influence of stakeholders as reported (*25*,*26*).

Several groups have proposed a prioritization process that considers different categories of criteria. Previous studies focused on a specific aspect of infectious diseases, such as the multicriteria analysis designed by Mourits et al., to support discussions on control measures (*27*). Conversely, the method developed by the French Agency for Food, Environmental and Occupational Health and Safety included major aspects of a disease (*28*) and also considered 2 rankings, 1 for animal health and 1 for human health. Nevertheless, our study provides a unique ranking that included both types of diseases.

The current approach included more diseases compared with previous priority settings, such as those reported by DEFRA) (n = 25) or the European Commission (n = 46)

(*13*). Krause et al. applied a Delphi method for collecting opinions, but only prioritized 85 zoonotic or common diseases (*9,10*). In our study, a Delphi method was initially planned but for time, rational, and economic reasons, criteria were defined and established before being proposed to experts. Because our method includes qualitative and semiquantitative criteria, it is not completely numerically based, in contrast to the multicriteria analysis developed by Kurowicka et al. (*5*). Their method is applicable only for quantitative criteria and not always for all diseases in all contexts. Furthermore, they used a limited number of attributes for pathogens. Even if one relies on a quantitative approach, which is less arbitrary than a semiquantitative approach, the model developed by Havelaar et al. (*12*) is based on criteria reflecting the epidemiology and societal effect of zoonoses, but does not include risk perception by the general public or diseases targeting animal species.

The new method requires multidisciplinarity, which involves animal and human epidemiologists; chief veterinary officers; experts in agricultural economics, animal welfare, and biodiversity; and experts on societal aspects of diseases. Other prioritization processes often restricted their panel of experts to epidemiologists and infectious disease specialists (*9,10*).

The decision to start with the disease and not the animal species is in contrast to the method developed by Heffernan, who suggested that errors might be amplified throughout the weighting process (*29*). Nevertheless, by starting with the disease, the role of species is balanced by the EC category because the effect of different industries is taken into account. If an industry is not well developed in a specific area, the effect will be minimized. When the prioritization process is started with the species and its particular effect in the area/country, it makes the model only applicable in this specific area. However, if one starts with the disease and takes into account the economic role of this species industry in another category of criteria, the model can be applied anywhere.

Some methods applied a weighting system to criteria (DEFRA) (*9,10,30)* because it is not appropriate to consider all criteria on the same scale. For example, the human case-fatality rate should not be placed on the same scale as classification of zoonoses. Even if individual experts differed in their views on the relative role of various criteria and indicators, veterinary epidemiologists and experts in public health reached the conclusion that the epizootic/epidemic potential and case-fatality rate were the 2 major criteria in their respective category of expertise.

When one considers overall ranking of diseases, all diseases appearing in the top 20 are zoonotic/common, which is expected because their global score involves the whole public health aspect. CART analysis also illustrates the correlation between PH and SO, which is not surprising because consumer behavior might be influenced when a zoonotic/common agent is involved (*31*). Nevertheless, CARTs might lead to slightly biased results in relation to variable selection: identification of distinct subgroups does not enable estimation of net effects of independent variables because subdivision of data into 2 groups is based on only 1 value of only 1 explanatory variable (*32*). In addition, bootstrap or jackknifing analysis would have been also an alternative to estimate the uncertainty.

The analysis can be applied only to the 100 diseases included in the model. Nevertheless, its predictive value is useful. The model we developed could be presented as generic and should not be confined to the 100 diseases included in the current application or to exotic diseases as with the method developed by French Agency for Food, Environmental and Occupational Health and Safety (*28*). At the beginning of the 21st century, a scientific team in the United Kingdom established a list of 1,415 pathogens that possibly affected humans (*33).* If added to the pathogens involved in animal diseases, all of these pathogens could also be submitted to the prioritization process, with a preliminary categorization step. As specified in the work performed under the aegis of the European Council, the prioritization exercise should be performed regularly as the epidemiologic situation of diseases constantly evolves: biotechnological improvements are constantly achieved in terms of vaccination, treatment, and diagnostic tests (*30*). In addition, elaboration of each criterion relied on evidence-based medicine through consultation with >1,800 scientific references (*34*; S. Vandeputte et al., unpub. data). The critical point of the our method relies on the possible lack of independence between some criteria. Several of these criteria might be substantially dependent on each other. Although coefficients for ranges of illness and case-fatality rates were arbitrarily fixed, which may results in a loss of precision, they were accepted by experts. A Delphi method would have been more appropriate to reach a consensus on the criteria to be used.

In conclusion, the current method is a generic tool applicable on different geographic scales in a variety of contexts because it is not restricted to well-defined field of actions. The standardization of criteria ensures transparency and reproducibility of the model in other context and for other diseases. It enables adaptations (vaccination becoming available, increased knowledge on a pathogen, viral mutations or genetic reassortments increasing host-

specificity). In the same view, the model could be applied to diseases affecting domestic (dogs, cats) pets or exotic pets (reptiles). Conversely, it could also be used with enzootic conditions to better retarget the surveillance system and readapt control measures worldwide.

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Dr Humblet is _____ at _____. Her research interests are _____. **[Q4. Please provide the affiliation and position for Dr. Humblet and her research interests.]**

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22
23 Table 1. Fifty-seven criteria used for the prioritization process and corresponding weight attributed by experts

Category, criteria	Minimum	Average	Maximum	Fitting distribution
Epidemiology				
Illness rate (%)	2.05	7.59	18.00	RiskPert (2,05; 5; 18)
Case-fatality rate (%)	4.19	9.13	18.00	RiskPert (4,19; 5; 18)
Specificity of pathogen	0.00	4.55	10.23	RiskUniform (0; 10,23)
Mode of transmission	0.00	8.08	23.52	RiskPert (0; 10; 23,52)
Incubation period	0.00	3.43	6.00	RiskPert (0; 2; 6)
Clinical course	0.00	2.93	6.00	RiskPert (0; 2; 6)
Persistence in environment	0.00	6.37	12.56	RiskPert (0; 5; 12,56)
Epizootic potential	0.00	9.92	22.50	RiskPert (0; 10; 22,5)
Evolutive characteristics of pathogen	1.89	6.39	18.00	RiskPert (0; 5; 18)
Clinical disease in cattle	0.00	4.52	10.71	RiskTriang (0; 0; 10,71)
Clinical disease in small ruminants	0.00	2.37	4.74	RiskTriang (0; 0; 4,74)
Clinical disease in swine	0.00	3.60	9.00	RiskTriang (0; 0; 9)
Clinical disease in equines	0.00	2.99	10.00	RiskPert (0; 2; 10)
Clinical disease in poultry	0.00	3.42	9.00	RiskTriang (0; 0; 9)
Clinical disease in lagomorphs	0.00	3.42	9.00	RiskTriang (0; 0; 9)
Clinical disease in wildlife	0.00	4.39	11.25	RiskPert (0; 2; 11;25)
Presence/absence of vector(s)/reservoir(s) in European Union	3.07	6.90	11.25	RiskPert (3,07; 5; 11,25)
Intercategory weight	10.00	19.67	25.00	RiskPert (10; 20; 25)
Prevention–control				
Control of reservoir(s) or vector(s)	0.00	6.13	10.00	RiskUniform (0; 10)
Vaccination	5.00	8.63	15.00	RiskUniform (5; 15)

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Treatment	3.00	6.63	10.00	RiskUniform (3; 10)
Availability and quality of diagnostic tools	5.00	7.69	10.00	RiskUniform (5; 10)
Knowledge of pathogenic agent	0.00	7.38	15.00	RiskPert (0; 5; 15)
Effectiveness of control measures other than treatment, vaccination, and control of vectors	1.00	7.26	10.00	RiskUniform (1; 10)
Effectiveness of prevention other than vaccination	5.00	8.72	12.00	RiskPert (5; 10; 12)
Surveillance of pathogenic agent in European Union or worldwide	4.00	7.57	15.00	RiskTriang (4; 4; 15)
Intercategory weight	10.00	18.83	25.00	RiskPert (10; 20; 25)
Economy–trade				
Losses of productivity (milk, eggs, growth)	0.00	6.35	17.14	RiskPert (0; 9; 17,14)
Additional costs: mandatory slaughtering	0.00	5.11	12.95	RiskUniform (0; 12,95)
Additional costs: treatment, disinfection, labor	0.00	4.40	8.57	RiskPert (0; 5; 8,57)
Limited importation–exportation	0.00	4.40	8.57	RiskPert (0; 5; 8,57)
Disturbance of supply and demand (decrease in prices)	0.00	5.54	9.23	RiskUniform (0; 9,23)
Impact on adjacent sectors (tourism)	0.00	4.80	17.14	RiskTriang (0; 0; 17,14)
Impact on cattle industry		3.29	17.14	RiskTriang (0; 0; 17,14)
Impact on small ruminants industry	0.00	3.09	8.57	RiskUniform (0; 8,57)
Impact on swine industry	0.00	1.87	8.57	RiskTriang (0; 0; 8,57)
Impact on equine industry	0.00	2.81	8.57	RiskTriang (0; 0; 8,57)
Impact on poultry industry	0.00	1.77	8.57	RiskTriang (0; 0; 8,57)
Impact on rabbit industry	0.00	2.81	8.57	RiskTriang (0; 0; 8,57)
Impact on wildlife industry	0.00	2.81	8.57	RiskTriang (0; 0; 8,57)
Zoonotic impact (cost of illness)	0.00	2.17	8.96	RiskTriang (0; 0; 8,57)
Zoonotic impact (costs of prevention per person)	0.00	4.59	10.75	RiskTriang (0; 0; 10,75)
Intercategory weight	10.00	23.00	30.00	RiskUniform (10; 30)
Public health				
Zoonotic/common agent	0.00	7.81	20.00	RiskPert (0; 10; 20)
Classification of zoonoses	0.00	5.51	11.25	RiskPert (0; 6; 11,25)
Disease knowledge in humans	2.40	7.27	11.25	RiskPert (2,4; 5; 11,25)
Illness rate (%)	1.01	8.08	12.00	RiskUniform (1,01; 12)
Case-fatality rate (%)	1.01	9.46	18.00	RiskPert (1,01; 10; 18)
Mode of transmission	0.00	5.71	10.59	RiskPert (0; 5; 10,59)
After effects or negative impact on the patients' quality of life	5.29	8.88	12.00	RiskUniform (5,29; 12)
Presence of a fight plan	3.03	5.37	6.99	RiskPert (3,03; 5; 6,99)
Epidemic potential	5.29	8.98	12.13	RiskUniform (5,29; 12,13)
Vaccination	5.00	7.49	11.25	RiskUniform (5; 11,25)
Treatment	5.00	7.35	11.25	RiskUniform (5; 11,25)
Availability and quality of diagnostic tools	5.00	8.10	15.17	RiskTriang (5; 5; 15,17)
Intercategory weight	20.00	24.67	30.00	RiskUniform (20; 30)
Society				
Lowered consumption	0.00	7.19	15.00	RiskUniform (0; 15)
Perception of problem by consumer	0.00	6.92	12.00	RiskUniform (0; 12)
Potential impact on media	0.00	6.50	20.00	RiskUniform (0; 20)
Impact on animal welfare and biodiversity	1.00	9.38	20.00	RiskUniform (0; 20)
Intercategory weight	8.00	13.83	20.00	RiskUniform (8; 20)

[Q5. Table 1. What do the terms starting with Risk in the Fitting Distribution column mean? Please specify.]

Table 2. Fifty-seven criteria used for ranking diseases classified by category*

Epidemiology		Score							
Ranking	Criteria	0	1	2	3	4	5	6	7
1	Illness rate (%)		<1	1–10	11–30	31–50	51–70	71–90	>90
2	Case-fatality rate (%)		<1	1–10	11–30	31–50	51–70	71–90	>90
3	Agent specificity		1 host-species: only one species involved	2 hosts-species: 2 species involved	3 hosts-species: 3 species involved	4 hosts-species: 4 species involved	>4 hosts-species: >4 species involved		
4	Mode of transmission		No vector-borne transmission (not contagious)	Contamination by direct contact	Contamination by indirect contact	Vector-borne transmission	Airborne contamination		

5	Incubation period	Not applicable: clinical disease never reported in the species considered in the study	<1 d	1–7 d	8–14 d	15–30 d	1–6 mo	>6–12 mo	>12 mo
6	Clinical course	Not applicable: clinical disease never reported in the species considered in the study	<1 d	1–7 d	8–14 d	15–30 d	1–6 mo	>6–12month	>12 mo
7	Environmental Persistence	None: no persistence in the environment, no vector(s) nor wildlife reservoir(s) identified to date	Rare: anecdotal isolation in (a) potential vector(s) or in the environment	No data available on the presence/survival of the pathogen agent in the reservoir(s), vector(s) or in the environment	Wildlife reservoir(s)/vector(s): pathogen agent persistent in wildlife reservoir(s) and/or in vector(s)	Environment: agent naturally surviving in the environment (soil, water)			
8	Epizootic potential		Never: only sporadic cases, epizootics never reported	Rare: the majority of cases are sporadic but possibility of localized epizooty if ideal conditions (e.g., abnormal multiplication of reservoir(s) and/or vector(s))	Localized: pathogen characterized by a localized epizootic potential essentially related to the transmission mode (e.g.: food-borne diseases)	(Inter)national: epizootic character well known after introduction, possibility of a wide spatiotemporal expansion			

9	Evolutive characteristics of the pathogen agent		Null: stability of the pathogen agent, stable pathogen agent-vector(s)/pathogen agent-reservoir(s) relationships (no impact on pathogenicity)	Rare: some mutations/re-assortments observed but without any impact on the agent pathogenicity, stable pathogen agent-vector(s)/pathogen agent-reservoir(s) relationships	Moderate/not determined: pathogen agent not characterized for its evolutive character yet (recently discovered, limited means of study), mutations with limited consequences on its virulence; stable pathogen-vector(s)/pathogen - reservoir(s) relationships	Frequent: genetic variability under the form of replication cycles more or less defined; variability of pathogenicity, species affected, reservoir(s) and vector(s)	High: pathogen agent known for having a high mutation rate/frequent genetic re-assortments with creation of new pathogenic variants at each cycle (variable pathogenicity, host(s), reservoir(s) and vector(s))	
10	Cattle	Pathogen never reported as etiologic agent of clinical disease in that species	Accidental: few clinical cases reported, only if favorable conditions (wound, traumatism, favorable environmental conditions)	Rare: clinical disease reported in a minority of cases, with no need for favorable conditions	Occasional: clinical disease occasionally reported, with no need for favorable conditions	Frequent: clinical disease frequently reported in that species, but not specifically (multi-species pathogen)	Specific: clinical disease only reported in that species	Reservoir species
11	Small ruminants	Pathogen never reported as etiologic agent of clinical disease in that species	Accidental: few clinical cases reported, only if favorable conditions (wound, traumatism, favorable environmental conditions))	Rare: clinical disease reported in a minority of cases, with no need for favorable conditions	Occasional: clinical disease occasionally reported, with no need for favorable conditions	Frequent: clinical disease frequently reported in that species, but not specifically (multi-species pathogen)	Specific: clinical disease only reported in that species	Reservoir species
12	Swine	Pathogen never reported as etiologic agent of clinical disease in that species	Accidental: few clinical cases reported, only if favorable conditions (wound, favorable environmental conditions)	Rare: clinical disease reported in a minority of cases, with no need for favorable conditions	Occasional: clinical disease occasionally reported, with no need for favorable conditions	Frequent: clinical disease frequently reported in that species, but not specifically (multi-species pathogen)	Specific: clinical disease only reported in that species	Reservoir species

13	Equine	Pathogen never reported as etiologic agent of clinical disease in that species	Accidental: few clinical cases reported, only if favorable conditions (wound, traumatism, favorable environmental conditions)	Rare: clinical disease reported in a minority of cases, with no need for favorable conditions	Occasional: clinical disease occasionally reported, with no need for favorable conditions	Frequent: clinical disease frequently reported in that species, but not specifically (multi-species pathogen)	Specific: clinical disease only reported in that species	Reservoir species
14	Poultry	Pathogen never reported as etiologic agent of clinical disease in that species	Accidental: few clinical cases reported, only if favorable conditions (wound, traumatism, favorable environmental conditions)	Rare: clinical disease reported in a minority of cases, with no need for favorable conditions	Occasional: clinical disease occasionally reported, with no need for favorable conditions	Frequent: clinical disease frequently reported in that species, but not specifically (multi-species pathogen)	Specific: clinical disease only reported in that species	Reservoir species
15	Lagomorphs	Pathogen never reported as etiologic agent of clinical disease in that species	Accidental: few clinical cases reported, only if favorable conditions (wound, traumatism, favorable environmental conditions)	Rare: clinical disease reported in a minority of cases, with no need for favorable conditions	Occasional: clinical disease occasionally reported, with no need for favorable conditions	Frequent: clinical disease frequently reported in that species, but not specifically (multi-species pathogen)	Specific: clinical disease only reported in that species	Reservoir species
16	Wildlife	Pathogen never reported as etiologic agent of clinical disease in that species	Accidental: few clinical cases reported, only if favorable conditions (wound, traumatism, favorable environmental conditions)	Rare: clinical disease reported in a minority of cases, with no need for favorable conditions	Occasional: clinical disease occasionally reported, with no need for favorable conditions	Frequent: clinical disease frequently reported in that species, but not specifically (multi-species pathogen)	Specific: clinical disease only reported in that species	Reservoir species
17	Presence/absence of vector(s) and/or reservoir(s) in EU	Not vector-borne disease and/or no reservoir known	Absence of the vector(s)/reservoir(s) in EU	Localized presence: reservoir(s) and/or vector(s) in a limited geographic area of one or more member states	Mediterranean region/northern Europe/central Europe: vector(s) and/or reservoir(s) in 1 of these 3 regions, each one covering several member states, presence linked to bioclimatic preferences	Mediterranean region + northern Europe/northern Europe + central Europe: vector(s) and/or reservoir(s) in 1 of both regions according to bioclimatic preferences	Generalized repartition: repartition of vector(s) and/or reservoir(s) in the whole EU (few bioclimatic specificities)	

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Prevention–control Ranking	Criteria	Score 0	1	2	3	4
1	Control of reservoir(s) and/or vector(s)	Not applicable: no vector-borne transmission and/or no reservoir(s) known to date	Effective: limited reservoir(s), easy-to-identify; effective fighting measures and trapping; reservoir(s)/vector(s) with a limited demographic and geographic repartition; high scientific knowledge on vector(s)/reservoir(s); possibility of integrated fighting approach	Limited: limited reservoir(s), easy-to-identify; effective fighting measures and trapping but not applicable at a large scale; reservoir(s)/vector(s) with a limited demographic and geographic repartition; high scientific knowledge on vector(s)/reservoir(s); absence of integrated fighting approach	Possible but poorly/not effective: reservoirs easy to identify but numerous; fighting measures and trapping poorly effective (poorly active molecule(s); resistances and/or negative impact on environment); reservoir(s)/vector(s) with a limited demographic and geographic repartition; lack of scientific knowledge on vector(s)/reservoir(s); absence of integrated fighting approach	Absent/impossible: vector(s)/reservoir(s) not identified; no effective fighting measure against vector(s) (no active molecule, ineffective trapping); strong demography and/or wide repartition of vector(s) and/or reservoir(s); absence of scientific knowledge on vector(s)/reservoir(s); absence of integrated fighting approach
2	Vaccination	Not applicable: clinical disease never reported in the species considered in the study	Commercialized: commercial vaccine available on a global scale (worldwide)	Local/mono-species: vaccine available at a regional/national scale and/or for a targeted species (not systematically available for a global fight plan)	Experimental: experimental vaccine, not commercialized to date; severe adverse reaction when applied; limited protector effect	Absence: no vaccine available on the market for a use in the species considered in the study, no experimental vaccine either
3	Treatment	Not applicable: clinical disease never reported in the species considered in the study	Available/effective: effective treatment available on the market; recommended in case of infection; economically and rational from a zootechnical point of view	Available but not recommended: masks the clinical course of the disease; contrary to the fight plan; not justified economically nor from a zootechnical point of view	Available but poorly/not effective: treatment with a limited effectiveness; severe adverse reactions; experimental or empirical treatment	Absence: no effective treatment available on the market nor experimentally
4	Availability and quality of diagnostic tools		High: field test(s) available and easy to use, with highly discriminating sensitivity and specificity	Moderate: tests only used in local/regional laboratories	Low: tests only used in specialized laboratories/national reference laboratory	Absence: no diagnostic tools available to date

5	Knowledge of pathogen	Very high: deep scientific knowledge on the pathogen, extensive scientific literature available on its biology (transmission mode, knowledge on vector(s), infectivity)	High: detailed scientific knowledge on the pathogen but conflicting scientific results; some elements of the pathogen agent biology are still not elucidated	Moderate: limited scientific knowledge on the pathogen agent because it is still under characterization; pathogen recently discovered/isolated but belonging to a well known and studied family of pathogen agents; pathogen agent characterized by multiple variants not characterized yet	Low: lack of scientific knowledge on the pathogen (multiplication, infectivity, incubation period, transmission mode); pathogen agent recently discovered or emerging
6	Effectiveness of control measures (other than treatment, vaccination, and vector(s)/reservoir(s) control)	High: effectiveness of implemented control measures (quarantine, slaughter and restriction area); effective epidemiologic investigation (origin of the infection rapidly identified and quick implementation of control measures)	Moderate: effectiveness of implemented control measures (quarantine, slaughter and restriction area); epidemiologic investigation poorly conclusive (incomplete traceability of animals and by-products)	Low: limitation of control measures implemented (quarantine, slaughter and restriction area), limiting the dissemination of the pathogen agent; epidemiologic investigation totally inconclusive	Null: ineffectiveness of implemented control measures (quarantine, slaughter and restriction area) and/or control measures not indicated because of the characteristics of the pathogen agent; epidemiologic investigation totally inconclusive
7	Effectiveness of prevention (other than vaccination and control of vector(s)/reservoir(s))	High: sanitary certificate; effective traceability of animals and by-products; effective disinfection measures; no contact between domestic and wild animals; effective biosecurity measures	Moderate: no sanitary certificate; effective traceability of animals and by-products; effective disinfection measures; limited or incomplete possibilities to restrict contacts between domestic and wild animals; effective biosecurity measures	Low: no sanitary certificate; incomplete traceability of animals and by-products; ineffective disinfection measures; incomplete restriction of contacts between domestic and wild animals; ineffective biosecurity measures	Null: no sanitary certificate; no traceability of animals and by-products; ineffective disinfection measures; impossibility to restrict contact between domestic and wild animals; biosecurity measures totally ineffective
8	Surveillance of the pathogen agent	Generalized: surveillance implemented by all EU Member States (even worldwide surveillance)	Member States at risk: surveillance of the pathogen in one or more neighboring member states and in those where epizootics were recently reported	Outside EU: pathogen surveyed in non-EU regions	Absent: no surveillance of the pathogen
Economy–trade				Score	

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Ranking	Criteria	0	1	2	3
Individual data (herd/farmer)					
1	Losses of productivity (milk, eggs, growth)	Null: no impact on animal productivity	Low: losses of productivity <20%	Moderate: losses of productivity between 20 and 50%	Severe: losses of productivity >50%
2	Additional costs: mandatory slaughtering	Not required	Outbreaks only	Outbreaks and restriction areas	
	Additional costs: treatment, disinfection		Low: treatment not required (e.g., slaughtering or not justified from an economic point of view) or absent (virus), application of basic sanitary measures (disinfection, footbath)	Moderate: spontaneous resolution of cases, only the animals with serious clinical signs require a treatment, application of basic sanitary measures (disinfection, footbath)	High: systematic treatment of animals with clinical signs; application of stricter sanitary measures
3	Additional costs: vaccination		Low: no vaccination advocated or no vaccination available	Moderate: vaccination not mandatory but possible in particular cases, e.g., avian sector	High: mandatory vaccination
Global (sector/market)					
4	Limitation of importation-exportation	Absent: no impact on the importation/exportation of animal and/or by-products	Local: restrictions of animal and/or by-products movements limited to surveillance areas implemented when an outbreak is confirmed	Regional: animal and/or by-products movements limited in a geographic area greater than the surveillance zone but only in one Member State	International: perturbation/limitation of importations/exportations of animal and by-products between several member states and/or between member states and countries outside the EU
5	Disturbance of supply and demand (decrease in prices)	Absent: no impact on supply and demand	Low: temporary disturbance of supply and demand in a limited geographic area, with low impact on prices	Moderate: temporary disturbance of supply and demand with decrease in prices <30% in one or several member states	High: major disturbance of supply and demand with decrease in prices >30% affecting several member states
6	Impact on related sectors (tourism, animal feeds)	Absent: no impact on related sectors	Low: turnover reduction of <20% in one or several related sector	Moderate: turnover reduction of 20%–50% in one or several related sector	High: turnover reduction >50% in one or several related sector
7	Impact on cattle industry	Absent: no impact on cattle industry	Low: increased spends and/or decreased benefits <20% compared with anterior situation	Moderate: increased spends and/or decreased benefits between 20% and 50% compared with anterior situation	High: increased spends and/or decreased benefits >50% compared with anterior situation
7	Impact on small ruminants industry	Absent: no impact on small ruminants industry	Low: increased spends and/or decreased benefits <20% compared with anterior situation	Moderate: increased spends and/or decreased benefits between 20% and 50% compared with anterior situation	High: increased spends and/or decreased benefits >50% compared with anterior situation

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7	Impact on swine industry	Absent: no impact on swine industry		Low: increased spends and/or decreased benefits <20% compared with anterior situation	Moderate: increased spends and/or decreased benefits between 20% and 50% compared with anterior situation		High: increased spends and/or decreased benefits >50% compared with anterior situation	
7	Impact horse industry	Absent: no impact on horse industry		Low: increased spends and/or decreased benefits <20% compared with anterior situation	Moderate: increased spends and/or decreased benefits between 20% and 50% compared with anterior situation		High: increased spends and/or decreased benefits >50% compared with anterior situation	
7	Impact on poultry industry	Absent: no impact on poultry industry		Low: increased spends and/or decreased benefits <20% compared with anterior situation	Moderate: increased spends and/or decreased benefits between 20% and 50% compared with anterior situation		High: increased spends and/or decreased benefits >50% compared with anterior situation	
	Impact on lagomorph industry	Absent: no impact on poultry industry		Low: increased spends and/or decreased benefits <20% compared with anterior situation	Moderate: increased spends and/or decreased benefits between 20% and 50% compared with anterior situation		High: increased spends and/or decreased benefits >50% compared with anterior situation	
7	Impact on wildlife industry	Absent: no impact on wildlife industry		Low: increased spends and/or decreased benefits <20% compared with anterior situation	Moderate: increased spends and/or decreased benefits between 20% and 50% compared with anterior situation		High: increased spends and/or decreased benefits >50% compared with anterior situation	
Cost of disease in humans								
8	Zoonotic impact (cost of illness)	Absent: non zoonotic nor common** disease		Low: medical consultation facultative, hospitalization not required, treatment for most severe clinical cases with conventional drugs, incapacity of maximum 7 d	Moderate: medical consultation necessary, hospitalization of most severe clinical cases, systematic and adapted treatment with conventional drugs, incapacity of 8 to 14 d		High: medical consultation necessary, systematic hospitalization but of variable duration, required and adapted treatment with second line drugs, incapacity >14 d, quarantine may be required	
9	Zoonotic impact (costs of prevention per person)	Absent: non zoonotic nor common** disease		Low: vaccination not advocated, simple and low-cost preventive measures (handwashing, mask carrying, insect repellents)	Moderate: vaccination of populations at risk (YOPI), simple and low-cost preventive measures (handwashing, mask carrying, insect repellents)		High: generalized vaccination recommended, restricting and expensive preventive measures (thermograph, quarantine, home containment)	
Public health Ranking	Criteria	0	1	2	Score 3	4	5	6 7

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1	Zoonotic/ common agent†	Not zoonotic or common	Accidental: human clinical disease only when favorable conditions are set (YOPI, high infection pressure, practices at risk, unusual transmission route)	Rare: human clinical disease reported in a minority of cases, without necessity of favorable conditions	Frequent: clinical disease often reported in man (multi-species pathogen) without need for favorable conditions	Systematic: clinical disease systematically reported in man			
2	Classification of zoonoses	Not zoonotic or common	1: transmission from wild animals to humans	1+: transmission from wild animals to humans with further human-to-human transmission(s)	2: transmission from wild animals to domestic animals to humans	2+: transmission from wild animals to domestic animals to humans, with further human-to-human transmission(s)			
3	Disease knowledge in humans	Not zoonotic or common	Very high: deep scientific knowledge on the pathogen agent, extensive scientific literature available on its biology (transmission mode, knowledge on vector(s), infectivity)	High: detailed scientific knowledge on the pathogen agent but conflicting scientific results; some elements of the pathogen agent biology are still not elucidated	Moderate: limited scientific knowledge on the pathogen agent because it is still under characterization; pathogen agent recently discovered/isolated but belonging to a well known and studied family of pathogen agents; pathogen agent characterized by multiple variants not characterized yet	Low: lack of scientific knowledge on the pathogen agent (multiplication, infectivity, incubation period, transmission mode); pathogen agent recently discovered or emerging			
4	Illness rate (%)	Not zoonotic or common	<1	1–10	11–30	31–50	51–70	71–90	>90
5	Case-fatality rate (%)	Not zoonotic or common	<1	1–10	11–30	31–50	51–70	71–90	>90
6	Mode of contamination	Not zoonotic or common	No vector-borne transmission (not contagious)	Contamination by direct contact	Contamination by indirect contact	Vector-borne transmission	Airborne contamination		

7	After effects or negative impact on the patients' quality of life	Not zoonotic or common	Null: no after-effects	Moderate: percentage of disability <30% but no loss of autonomy	Severe: after effects not enabling a professional activity anymore, but no loss of autonomy	Very severe: complete incapacity to carry on a professional activity and loss of autonomy and personal assistance necessary	
8	Presence of a fight plan (vaccination, determination of populations at risk, surveillance of the disease, definition of areas at risk)	Not zoonotic or common	Worldwide (EU and other countries): international and coordinated fight plan (Member States and third countries)	Generalized (EU): coordinated fight plan implemented in all Member States	Targeted: coordinated fight plan implemented in one or more Member State(s) at risk	Extracommunautary: absence of a fight plan in the EU but implemented in third countries	Absent: no fight plan elaborated and implemented to date
9	Epidemic potential	Not zoonotic or common	Never: only sporadic cases, epidemics never reported	Rare: the majority of cases are sporadic but when favorable conditions are set, possibility of localized epidemics (e.g., abnormal multiplication of reservoir(s) and/or vector(s))	Localized: pathogen agent characterized by a localized epidemic potential essentially related to the transmission mode (e.g.: food-borne diseases)	(Inter)national: epidemic character well known after introduction, possibility of a wide spatiotemporal expansion	
10	Vaccination	Not zoonotic or common	Commercialized: commercial vaccine available on a global scale (worldwide)	Local/mono-species: vaccine available at a regional/ national scale (not systematically available for a global fight plan)	Experimental: experimental vaccine, not commercialized to date; severe adverse reaction when applied; limited protector effect	Absence: no vaccine available on the market, nor experimental	
11	Treatment	Not zoonotic or common	Existing/effective: effective treatment available on the market	Available but not recommended: major side effects	Existing but not or poorly effective: treatment with limited effectiveness, partial resistance of the pathogen or experimental treatment	Absent: no effective treatment available on the market nor experimentally	

12	Availability and quality of diagnostic tools	Not zoonotic or common	High: field test(s) available and easy to use with highly discriminating sensitivity and specificity	Moderate: tests only used in local/regional laboratory	Low: tests only used in specialized laboratories/ national reference laboratory	Absence: no diagnostic tools available to date	
Society Ranking	Criteria	0	1	Score 2	3	4	
1	Lowered consumption	No: no impact on consumption	Low: impact on consumption with a decrease <20% compared with previous consumption	Moderate: impact on consumption with a decrease of 20%–50% compared with previous consumption	High: impact on consumption with a decrease >50% compared with previous consumption		
2	Perception of the problem by the consumer (problem poorly known or not known at all, poorly or not controllable at all, affects a sensitive public)	Not zoonotic nor common	Null: clear perception by the consumer; problem well known, controllable, and no impact on the family; short-term effect; does not affect a sensitive public (children, pregnant women)	Low: clear perception by the consumer; problem well known, controllable, and no impact on the family; long-term effect; does not affect a sensitive public (children, pregnant women)	Moderate: clear perception by the consumer; problem poorly known, controllable, with an impact on the family; long-term effect; affects a sensitive public (children, pregnant women)	High: bad perception by the consumer; problem poorly known, difficult to control, with an impact on the family; long-term effect; affects a sensitive public (children, pregnant women)	
3	Potential impact of media	Null: no impact of media on consuming habits	Low: short-term and minor impact on consuming habits	Moderate: long-term but minor impact on consuming habits	High: major and long-lasting impact on consuming habits (reject of a particular by-product)		
4	Impact on animal welfare and biodiversity	Null: no impact on animal welfare and biodiversity: no slaughtering, no specific control measures applied to wildlife, no quarantine nor containment of animals	Low: no slaughtering but limited control measures and limited containment of species at risk (domestic and wild animals)	Moderate: selective slaughtering of animals showing clinical signs in outbreaks, control and containment of species at risk (domestic and wild animals)	High: systematic slaughtering of domestic and wild animals (outbreaks and surveillance zones), mandatory quarantine, containment of domestic animals at risk		

*Eu, European Union; YOPI, young, old, pregnant, immunosuppressed.
†Common, pathogen able to cause a clinical disease in humans and animals but without a zoonotic characteristic (common source of contamination).

Table 3. Characteristics of 40 experts who analyzed diseases*

Expert	Location	Sex	Background	Country	Field of expertise	Keywords	Categories of criteria
H. Amory	Univ	F	DVM, PhD, University Professor (Faculty of Veterinary Medicine)	Belgium	Horse internal medicine	Internal Medicine, Cardiology, echocardiography, infectious diseases	EP

J.-M. Bouquiau	Min	M	Agronomy Engineer, University Professor (Faculty of Agronomy)	Belgium	Agriculture economy	Agricultural economist, evaluation of losses, farmer, industry, prevision of indigenous brut production	EC
S. Brunet	Univ	M	Lic Political Science and Public Administration, PhD, instructor in Political Science	Belgium	Sociology	Risk sociology, participative methods, interactions science/society	SO
Y. Coppieters	Univ	M	DM, PhD, University Professor (School of Public Health)	Belgium	Public health	Epidemiology, health promotion, adult formations, cardio-vascular diseases	PH
G. Czaplicki	Lab	M	DMV, Head of a Veterinary Diagnostic Laboratory	Belgium	Laboratory of diagnosis	Animal serology, bovine pathology, swine pathology, epidemiology, animal infectiology	EP
X. Demarche	EuroC	M	DMV, Administrator European Institution	International	Agriculture economy	Agriculture, animal health, food hygiene, community expenditures, international trade	EC
M. Dominguez	FAO	F	DMV, FAO Global Early Warning System, Associate Professional Officer	Italy	Animal epidemiology	Epidemiology, veterinary public health, surveillance, arboviruses, international	EP, EC, PC, PH, SO
P.-V. Drion	Univ	M	DMV, PhD, University Professor (Experimental methods of laboratory animals and ethics in animal experiments, University of Liege)	Belgium	Animal welfare	Animal ethics, laboratory animals, animal experimentation	SO
B. Duquesne	Univ	F	Lic Agronomy, PhD, University Professor (Faculty of Agronomy)	Belgium	Agriculture economy	Veterinarian, consumption, food safety, economy, agro-alimentary industry	EC
F. Fecher	Univ	F	Lic Economics, PhD, University Professor (Faculty of Economics)	Belgium	Economy	Health economy, social economy, health systems, hospital financing	EC
S. Geerts	Univ	M	DVM, PhD, Dipl. EVPC, University Professor (Institute of Tropical Medicine, Animal Health Department, head of the unit of veterinary protozoology)	Belgium	Parasitology	Tropics, parasitology, zoonosis, trypanosomiasis, cysticercosis	EP, EC, PC, PH, SO
J. Godfroid	Univ	M	DVM, PhD, University Professor (Professor at the Norwegian School of Veterinary Science, Section of Arctic Veterinary Medicine; Extraordinary Professor at the University of Pretoria, Faculty of Veterinary Science, Department of Veterinary Tropical Diseases)	Norway, South Africa	Bacteriology	Brucellosis, tuberculosis, cattle, diagnosis	EP, EC, PC, PH, SO
C. Gosset	Univ	F	DVM, PhD, University Professor (School of Public Health, Faculty of Medicine)	Belgium	Public health	Public health, epidemiology, health observatory, health care, economy of health	EP, PC, EC, PH
L. Hallet	CVO	M	DVM, former Chief Veterinary Officer	Belgium	Control	Reportable diseases, veterinarian, rabies vaccination	EP

A. Huberty	CVO	M	DVM, Chief Veterinary Officer	Luxemburg	Control	Biosecurity, epidemiosurveillance, vigilance, risk assessment, identification	EP, EC, PC, PH, SO
N. Kirschvink	Univ	F	DVM, PhD, University Professor (Department of Veterinary medicine; Unit of integrated research in Veterinary medicine, Namur Research Institute for Life Sciences)	Belgium	Small ruminants	Animal production, sheep reproduction, ovine medicine, pathophysiology, respiratory diseases	EP
A. Leblond	Univ	F	DVM, PhD, Dipl European College Equine Internal Medicine, University Professor (Department of horse internal medicine); RESPE scientific committee; ANSES	France	Horse internal medicine	Internal medicine, equids, epidemiology, infectious diseases, neurology	EP, PC
M. Lefèvre	Univ	F	Lic. Economics, PhD (Department of Economics)	Belgium	Agriculture economy	Development economy, micro-economy, agricultural economy, dairy cattle, Western Africa	EC
L. Lengelé	CVO	M	DVM, former Chief Veterinary Officer and head of veterinary Services; Delegated with OIE	International	Animal epidemiology	Veterinary Public Health, welfare of production animals, prevention and control of diseases, epidemiology	EP, EC, PC, PH, SO
P. Léonard	Univ	M	MD, Master in Acute Medicine, Master in Internal Medicine, Master in tropical medicine, University Professor (Department of Infectious Diseases and Tropical Diseases, Liege University Hospital)	Belgium	Internal Medicine - tropical	Infectious diseases, immunodeficiency, tropical diseases, emerging diseases, internal medicine	PH
A. Linden	Univ	F	DVM, PhD, University Professor (Department of Infectious and Parasitic diseases, Unit Wildlife health and pathologies); Walloon Wildlife health monitoring surveillance network	Belgium	Wildlife	Wildlife, Mycobacteria, Bluetongue, Bacteriology, Pathology	EP
M. Lomba	ARSIA	M	DMV, Veterinary Diagnostic Laboratory	Belgium	Animal epidemiology	Diagnosis, epidemiology, cattle, communication	EC, SO
B. Losson	Univ	M	DVM, PhD, University Professor (Department of Infectious and Parasitic diseases, Unit Parasitology and parasitic diseases)	Belgium	Parasitology	Parasitology, parasitic zoonoses, vectors, biologic control, ectoparasites	EP
J. Mainil	Univ	M	DVM, PhD, University Professor (Department of Infectious and Parasitic diseases, Unit Bacteriology and bacteriologic diseases)	Belgium	Bacteriology	Bacteriology, pathogeny, genetics (prokaryotes), molecular epidemiology, plasmidology	EP
D. Marlier	Univ	M	DVM, PhD, Dipl, ECZM (small mammals), University Professor (Clinical Department of small animals and equids, Unit birds, lagomorphs and rodents); University Vet Clinics	Belgium	Avian and lagomorphs medicine	Aviculture, rabbit farming, birds, rabbits, rodents	EP

Y. Milleman	Univ	M	DVM, Lecturer (Head of Department of animal productions and public health, unit cattle and poultry diseases); Unit Food Microbiology - safety and quality	France	Pathology of ruminants	Cattle, *Salmonella*, pathology of ruminants	EP, PC, EC
B. Moinet	Wallonia	M	DVM, Cabinet of Ministry of Agriculture	Belgium	Agriculture economy	Agriculture politics, agriculture economy, ministry of agriculture	EC, SO
J.-L. Moyen	Dep, Lab	M	DVM, Head of Dordogne Departmental Laboratory	France	Laboratory of diagnosis	Tuberculosis, interferon, immunoserology, ruminants, PCR	PC
P. Mullier	CVO	M	DVM, Belgian Federal Agency for the safety of the food chain, Director or the French- and German-speaking communities)	Belgium	Control	Veterinarian, public function, sanitary policy, epidemiosurveillance, epidemiovigilance	PC
B. Nicks	Univ	M	DVM, PhD, University Professor (Department of animal productions, Unit veterinary ecology and ethology)	Belgium	Animal welfare and ethics	Animal husbandry, environment, animal welfare, animal health	SO
L. Plee	FAO	M	DVM, Epidemiologist, Animal Health Service (AGAH) and ECTAD Technical Staff, situation officer at the Crisis Management Centre - Animal Health (CMC-AH), FAO	International	Animal epidemiology	Epidemiology, zoonoses, risk assessment, veterinary legislation, subacute encephalopathies	PC, SO
A. Raskin	CVO	M	DVM, Belgian Federal Agency for the safety of the food chain	Belgium	Control	Classical swine fever, stamping out, identification, brucellosis, database	PC
J.-M. Robijns	CVO	M	DVM, Belgian Federal Agency for the safety of the food chain	Belgium	Control	Database management, animal identification and recording, animal products and by-products traceability, fight against animal diseases, support programs	PC
B. Soumaré	Univ	M	DVM, MSc, PhD; Regional Influenza Advisor, USAID West Africa Office	Belgium	Animal epidemiology	Zoonoses, pandemic threats, epidemiology, risk analysis, socioeconomic analysis	PC
J. Tafforeau	ISP	M	DM, Scientific Institute of Public Health, Head of Unit Public health and surveillance	Belgium	Human Epidemiology	Epidemiology, chronic diseases, health determinants, investigations, health priorities	PH
E. Thiry	Univ	M	DVM, PhD, University Professor (Department of Infectious and Parasitic diseases, Unit virology and viral diseases)	Belgium	Virology	Virus, animal, emerging diseases, genetics	EP
M. Vandenheede	Univ	M	DVM, PhD, Lecturer (Department of animal productions, Unit veterinary ecology and ethology)	Belgium	Ethology – animal welfare	Domestic animals, behavior, welfare, ethology	SO

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L. Vanholme	CVO	M	DVM, Belgian Federal Agency for the safety of the food chain	Belgium	Control	Zoonoses, reporting, animal health monitoring, animal health eradication, emerging disease	PC
P. Vannier	ANSES	M	DVM, ANSES, Head of animal health and welfare	France	Animal epidemiology	Animal health, virology, epidemiology, risk analysis, vaccinology	EP, EC, PC, PH, SO
S. Zientara	INRA	M	DVM, Master in molecular virology, master in Epidemiology, PhD, Central Laboratory of Veterinary Research, Maisons-Alfort Topic (Equine viral diseases); Head of Virology and of the National Reference Laboratory for Foot-and–Mouth disease, Bluetongue, West Nile and African Horse Sickness	France	Virology	Foot-and-mouth disease, bluetongue, west Nile fever, equine viral diseases	EP

*ID, identification; Univ, University; DVM, Doctor of Veterinary Medicine; PhD, Doctor of Philosophy; EP, epidemiology; Min, Ministry; EC, economy/trade; Lic, license; SO, society; DM, Medical Doctor; PH, public health; Lab, Laboratory; DMV,; EuroC, European Commission; FAO, Food and Agriculture Organization; PC, prevention/control; Dipl, diploma; EVPC, European Parasitology Veterinary College; CVO, chief veterinary officer; RESPE, Réeseau d'Epidemio-Surveillance en Pathologie Equine; ANSES, French Agency for Food, Environmental and Occupational Health and Safety; OIE, World Organization for Animal Health; ARSIA, Regional Association of Animal Health and Identification; ECZM, European College of Zoological Medicine; Dep, Department; AGAH,; ECTAD, European Centre for Transboundary Animal Diseases; CMC,; AH,; USAID, United States Agency for International Development; ISP, Institute of Public Health; INRA, Institut National de la Recherche Agronomique.

[Q6. Table 3. Please provide definitions for DMV, AGAH, CMC, and AH. Is DMV the same as DVM? Please clarify. Also, what does International mean in the country column? Please specify.]

[Q7. Table 3. You have a paragraph earlier in the paper with the names of the 40 experts in alphabetical order. In in the first column, you list the experts with numbers from 1 to 40. For clarity and to provide the reader more information, the names from the paragraph have been added to the first column. Please verify that the order of the names in the first column is correct. Modify as needed.]

Figure 1. Weighting (mean no. points) of disease criteria for 5 aspects of a pathogen proposed by experts. A) Epidemiology by 18 experts. B) Prevention–control by 16 experts. C) Economy–trade by 14 experts. D) Public health by 10 experts. E) Society by 13 experts. Error bars indicate SD. **[Q8. Please provide a new Figure 1 with the following changes (per journal requirements): use Arial font; do not use bold; in all panels, change gray bars to white bars (with black outlines), turn all items along the baselines so that they read horizontally, and change the items along the y-axes to No. points (turned 90°); in panel A, delete (%) in the two items along the baseline, change Morbidity rate to Illness rate, and change Evolutive Potential to Evolutive potential; in panel C, change Impact to Impact on, and change Zoonotique to Zoonotic; in panel D, delete (%) in the two items along the baseline; the**

new figure must have a minimum resolution of 600 dots (pixels) per inch; and return the new figure in a form we can edit (e.g., Excel, jpg, or Powerpoint files). Do not return as eps, png, pdf, or Word files.]

Figure 2. Classification and regression tree analysis showing grouping of diseases into 4 subgroups by using overall weighted scores per disease as input. Error bars indicate . **[Q9. What do the asterisks after FMD and Newcastle disease in panel A indicate? What do the horizontal lines and squares indicate? What do the numbers at the top indicate? Please specify. This information will be added to the figure legend.] [Q10. Please provide a new Figure 2 with the following changes (per journal requirements): use Arial font; do not use bold; in each panel, add commas to the numbers along the top where needed (e.g., 2,000) and to the numbers along the right where needed (e.g., 17,455); change +/- to ± in the numbers along the right (make sure that there is a space on either side of the ± symbol; all genus and species names on the left must be in italics; in Panel A, change West Nile Fever to West Nile fever; change Tularaemia to Tularemia, change Rift Valley Fever to Rift Valley fever; in panel B, change Marek's to Marek; the new figure must have a minimum resolution of 600 dots (pixels) per inch; and return the new figure in a form we can edit (e.g., Excel, jpg, or Powerpoint files). Do not return as eps, png, pdf, or Word files.]**

[Author; please provide the two new figures in seven separate files: one each for Figure 1, panels A, B, C, D, and E, and on each for Figure 2, panels A and B. All requested changes in the figures must be made before they can used in the paper.]