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The role of anticipation in enhancing prevention and preparedness

Fonda A. Munroe[1] & Norman G. Willis[2]

Summary

The goal of the International workshop on animal disposal alternatives (IWADA) has always been to minimise, to the greatest extent possible, the destruction of animals due to incursions of foreign animal disease. Prevention has always been considered the best mechanism to facilitate this goal. The authors introduce the concept of anticipation as a fifth pillar of emergency disease management in addition to the other pillars: prevention, preparedness, response and recovery. The objectives are as follows: to broaden thinking on possible future adverse events and threats, including, but not limited to, disease outbreaks; to identify possible adverse event indicators; and, to enhance prevention and preparedness activities. The role of anticipation is to detect and analyse disease or animal health event indicators. These indicators can thus be used to anticipate possible adverse events in the future. Anticipation must be strongly linked to prevention and preparedness. The approaches to anticipation include surveillance activities, foresight and forecasting, networks and multi-disciplinary teams, framework approaches, computer-based and modelling approaches and intelligence approaches. Practitioners of anticipation will be required to accept uncertainty and incomplete data and must appreciate that although the future cannot be predicted, anticipation of plausible futures is valuable for strategic planning.

Keywords

Animal diseases, Anticipation, Approaches, Indicators, Preparedness, Prevention.

Il ruolo della previsione nel potenziamento della prevenzione e della capacità di risposta

Riassunto

L'obiettivo del Workshop internazionale sulle alternative alla soppressione animale è sempre stato quello di ridurre il più possibile lo sterminio di animali dovuto alla comparsa di una malattia animale sconosciuta. La prevenzione è stata sempre ritenuta lo strumento migliore per arrivare a questo risultato. Gli autori introducono il concetto della previsione come quinto pilastro nella gestione di un'emergenza sanitaria in aggiunta agli altri pilastri: prevenzione, capacità di risposta, reazione e ripresa. Gli obiettivi sono i seguenti: estendere la riflessione su possibili futuri eventi sfavorevoli e rischi, contemplando, ma non solo, l'insorgenza di una malattia, identificare indicatori di possibile eventi avversi e potenziare le attività di prevenzione e la capacità di risposta. Il ruolo della previsione consiste nell'individuare ed analizzare gli indicatori di una malattia o di un problema sanitario nell'animale. La previsione deve quindi essere strutturalmente correlata alla prevenzione ed alla capacità di intervento. Gli approcci adottabili includono le attività di sorveglianza, la capacità di previsione e di pianificazione anticipata, la presenza di networks e teams multidisciplinari, approcci

(1) National Manager, Animal Health Risk Analysis, Science Branch, Canadian Food Inspection Agency, Ottawa Laboratory (Fallowfield), 3851 Fallowfield Road, P.O. Box 1300, Station 'H', Ottawa, Ontario K2H 8P9, Canada
fmunroe@inspection.gc.ca
(2) The Norm Willis Group Inc., 13 Ballymore Avenue, Ottawa, Ontario KIT 3Z5, Canada
nwillisgrp@on.aibn.com

integrati, informatizzati o basati su modelli. A quanti si occuperanno di tale attività di previsione sarà richiesto di accettare aspetti come l'incertezza o l'incompletezza dei dati e si dovrà comunque apprezzare il fatto che, per quanto non sia possibile prevedere il futuro, la previsione di scenari plausibili è utile alla pianificazione strategica.

Parole chiave
Approcci, Capacità di risposta, Indicatori, Malattia animale, Prevenzione, Previsione.

Introduction

In 1999, animal health professionals globally were reaching the realisation that the traditional approaches to large-scale outbreaks of exotic diseases, 'stamping out' and disposal, were increasingly at odds with changing societal values and needed to be re-evaluated. The environmental impacts, unmitigated waste, overwhelming financial costs and logistic challenges, associated with depopulation and disposal approaches, were simply becoming unacceptable and unmanageable.

The outbreak of foot and mouth disease in the United Kingdom, with its disturbing images of burning pyres, emotionally devastated farmers and a ruined tourist trade was yet to come.

Destruction and disposal of animals will always be required under certain circumstances. Animals that are not fit for human consumption because of toxin ingestion and animals infected with zoonotic diseases, are two examples. However, Canadian authorities felt that it was important to seek alternatives to the traditional 'stamping-out' approach. An international workshop was held in Winnipeg, Manitoba, in 2000 to address the problem. The report of this meeting, the International workshop on animal disposal alternatives (IWADA 2000) outlined the rationale behind the need for change and provided recommendations on an approach to move forward (5).

The IWADA 2000 meeting achieved overwhelming consensus on two points. The first was that change was needed. The second was that change could only be achieved through international co-operation and collaboration. Australia, Canada, New Zealand and the United States agreed to an ongoing commitment to collaborate and move forward with the recommendations of the IWADA 2000 meeting.

A second IWADA meeting was held in Ottawa, Ontario, in 2002; a third was held in Vancouver, British Columbia, in 2004. This paper reflects the thinking of the members of the international working group on animal disposal alternatives from the first two meetings (5, 6). It is a modified framework with the addition of anticipatory activities, to assist in bringing about the goals of the original IWADA vision. The authors discuss the role of anticipation and some proposed approaches, tools, and potential data and information.

Many developed countries use an established framework for addressing outbreaks of exotic or foreign animal diseases and other adverse animal health events. The framework consists of four pillars, as follows: prevention, preparedness, response and recovery. This paper introduces anticipation as an addition to the overall framework (some would suggest the concept of 'prediction' as an alternative to 'anticipation' – this was the original thinking in the 2002 IWADA meeting; however, prediction focuses on one path and creates a mind set of one most likely outcome – anticipation embraces uncertainty in an effort to broaden perspectives). For the most part, the paper refers to disease events, but anticipation can be used to identify indicators of multiple adverse events, including disease.

The objectives of this pillar are as follows:

- to broaden thinking on possible future adverse events and threats, including, but not limited to disease outbreaks
- to identify possible adverse event indicators
- to enhance prevention and preparedness activities.

Discussion – anticipation

To a large extent, scientists are aware that certain circumstances and factors lead to disease emergence (including re-emergence),

introduction and spread. For example, on the possible emergence of trichinellosis, Dupouy-Camet suggests that modification of consumer habits, reforestation in Europe and an increase of wild game, importation of infected products, failure of veterinary control programmes, human error and social upheaval are all potential explanations (2). Many other factors, which may interact, can be implicated in disease emergence, introduction, and spread. Many of the impacts of globalisation in general could be cited as contributing factors. A few examples include the following factors:

- climate change
- increased international travel
- multi-cultural societies
- rise of terrorism
- development of new products
- global conflict
- eco-tourism
- deforestation
- intensive productions systems
- misuses and accidents associated with genomics and biotechnology
- accidental escape of pathogens from laboratories
- industry demographics
- animal movements
- changing interface between livestock and wildlife
- criminal activities
- mass migration of displaced persons
- speed of technology development and ease of acquiring it
- speed of communication and information exchange.

The intellectual and philosophical approaches to anticipation are very important components of this pillar. The process must attempt to determine possible or probable event indicators. It will take many different approaches and will study the behaviour of a range of systems and organisations from simple to very complex ones. In addition, the interactions between these systems and organisations will be equally important. Trends and patterns may appear. Events and outcomes may be proposed as 'possible', at best 'probable', and rarely 'definite'.

It will not be easy, however, to make the leap from these factors and indicators to accurate disease anticipation. It will require a certain level of innate ability, the right tools, training and practice, good raw material (data and information), vision, imagination, perception and, above all, sound analysis.

The art and science of anticipation will be imprecise at first and the veterinary authorities of participating countries must recognise this while continuing to support the effort. This may appear to be an obvious observation. However, if an assumption of anticipation is, in effect, 'not knowing the future', many managers will be extremely uncomfortable with the process (10). In a discussion of complexity theory and the management of communicable diseases, Simmons states, 'management, afflicted by increasing complexity and information overload, can react by becoming quite intolerant of ambiguity. Factors, targets, organisational structures all need to be nailed down. Uncertainty is ignored and denied' (10).

Anticipation must be closely linked to prevention and preparedness. Figure 1 illustrates the steps between anticipation and prevention and preparedness. The possible animal health indicators and events determined by the anticipation process must be evaluated and prioritised so that the limited, available resources for prevention and preparedness can be focused on the most important pathways. Prioritisation criteria will vary from country to country and each country must prepare a comprehensive list. This is essentially a risk assessment and management exercise. Some examples include the following considerations:

- the epidemiology and nature of the disease (for example, zoonotic or non-zoonotic)
- the various impacts of a specific disease occurrence
- the most probable disease event
- ease or difficulty of control or mitigation
- the number of approaches to mitigation
- the nature and value of a specific industry
- possibility of wildlife becoming infected.

In the final analysis, the value of anticipation will be directly proportional to two factors.

The first is the sensitivity of the anticipation tools and the skill with which they are manipulated. The second is the ability of veterinary and public health authorities to identify the most important possible events on which to focus their efforts and resources. This does not necessarily mean determining and acting upon what is most likely, but rather on what is most important.

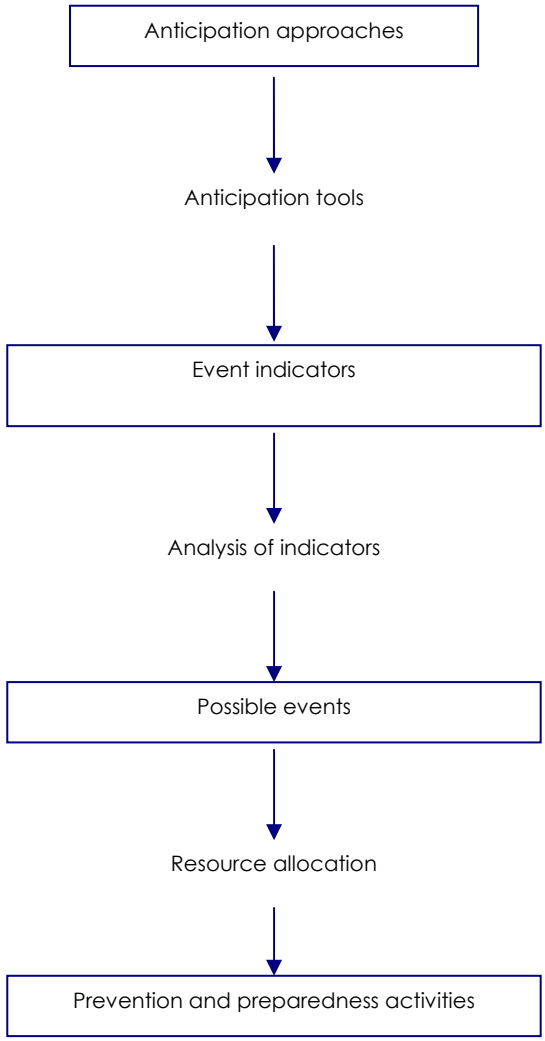

Figure 1
Relationship between anticipation and prevention and preparedness

Approaches, tools and raw material

Multiple approaches to anticipation must be made to maintain broad thinking. Tools, such as models, may be deterministic or stochastic. Raw material, data and information, may vary in their completeness, precision and accuracy. A constant appreciation of these factors is essential and the anticipation practitioner must be comfortable with uncertainty.

Approaches to anticipation may be new to disease management, or may be modifications to existing activities. Some examples are given below.

Surveillance and monitoring

Surveillance and monitoring have long been recognised as important tools for disease detection and as aids to disease prevention. Large investments in surveillance systems have been made as a result of events such as the attacks of 11 September 2001 and the emergence of the highly pathogenic avian influenza virus, H5N1.

Surveillance systems have been enhanced by developing methods to link multiple disciplines and databases, such as public health systems linked to animal disease systems. Linking multiple countries as suggested in a recent publication of the Farm Foundation Project, would provide a 'North American Free Trade Agreement (NAFTA)-wide' diagnostic, monitoring and surveillance network (3). As proposed, it would be a comprehensive approach to disease management. 'The network could provide stockpiles of vaccines and treatment agents for many diseases; serve as a clearinghouse for effective quarantine and animal disposal protocols to limit disease spread; and NAFTA-wide planning for dealing with outbreaks, which may allow options to address only affected sections of a country or region' (3).

Zessin discusses the importance of surveillance for disease management. He states, 'As presently the epidemiological perspective does not permit reliable prediction and prevention of the most damaging new pathogens, and as the evolutionary perspective only provides rough theoretical estimates for selective processes in pathogen populations, surveillance and monitoring remain the most important methods to recognise early that "something has happened" '(13).

It may be possible, however, to hone surveillance activities even further. If the

conditions under which new pathogens emerge, or under which recognised pathogens emerge in a new environment, can be identified, perhaps it will be possible to intervene in some manner to prevent an unwanted event. That is, if we could develop surveillance systems to detect the circumstances under which something might happen in the future, we would potentially be able to answer the question, 'is it possible that something will happen here?' or 'do the criteria exist here for a disease incursion to occur?' If the answer is affirmative, preventive measures can be implemented prior to the incursion or establishment of disease. For example, vaccination in advance of a disease incursion could prevent or mitigate a disease incursion.

A recent example of the indicators which may have helped anticipation of a disease outbreak is the emergence of bluetongue (BT) in Europe. Mellor *et al*. state that BT 'exists around the world in a broad band covering much of the Americas, Africa, southern Asia, northern Australia and, occasionally, the southern fringe of Europe. It is considered to be one of the most important diseases of domestic livestock. Recently, the virus causing this disease has extended its range northwards into areas of Europe never before affected and has persisted in many of these locations causing the greatest epizootic of the disease on record' (7). Since 1998, BT has spread to 12 countries and 800 km further north in Europe than previously observed. Purse *et al*. suggest that the reasons for this expansion include the following factors: 'recent changes in European climate that have allowed increased virus persistence during winter, the northward expansion of *Culicoides imicola*, the main bluetongue virus vector, and beyond the vector's range, transmission by indigenous European *Culicoides* species – thereby expanding the risk of transmission over larger geographical regions' (8). All of these factors could have been considered in anticipation of the expansion of the range of this virus and should be considered in other countries which are experiencing the same changes and conditions.

We know many of the criteria which predispose disease incursion threats. These include climate change, ecosystem disruption and impacts associated with human activity. These can be anticipated in specific areas in the world by using models and through actively monitoring and measuring changes. Scholze *et al.* discuss climate-change risks for world ecosystems (9). They state that they 'cannot provide an unambiguous definition' of dangerous climate change, but their analysis 'may help to inform policy discussions by drawing attention to the steeply increasing risks to ecosystem services associated with global climate changes beyond the range to which the climate system is already committed'. In other words, it is possible to anticipate events or conditions related to climate change which may predispose to disease incursions or disease vector movements. It is valuable to do this not only to anticipate a possible event, but to hone the skills and tools used in the anticipation process.

Foresight or forecasting approaches

The goal of the foresight process is not prediction. It is the construction of possible, plausible futures based on broad thinking, expert input, trend analysis and the consideration of unlikely (but possible) as well as likely events. It builds robust possibilities of alternate futures – it does not predict one. Broad thinking of this nature enables people to develop strategic plans and programmes in the present which will enable them to best understand and cope with many possibilities in the future.

The processes of foresight include scenario building, expert panels, challenge questions and Delphi studies. Scenarios look at multiple possible futures. As a process, foresight enables participants to think broadly and to anticipate outcomes based on mega-drivers, such as economics, demographics and the environment.

On the use of foresight for anticipation, the Scoping Workshop Report for the Animal Health Foresight Project stated that with foresight, 'it is possible to anticipate multiple,

contingent scenarios. With this information in hand, we can at least prepare for the future. By applying foresight techniques, we can recognise an emergent scenario much more quickly and thus respond with much greater agility' (R.P.A. Bouchard, personal communication, 2004).

Networks and multi-disciplinary teams

The use of networks and multi-disciplinary teams is an effective approach to anticipation. Networks are an excellent mechanism to use in a forecasting approach to develop sensitivity to what has been termed 'weak signals' (R.P.A. Bouchard, personal communication, 2004). These are early warnings. 'They may be anomalies, small problems or unique issues, that by themselves might be deemed insignificant, but if recognised as part of a larger pattern or a potentially growing phenomenon, they become important indicators that can and should stimulate action' (R.P.A. Bouchard, personal communication, 2004). Networks allow analysts to recognise these weak signals from multiple domains and, 'if recognised as portents of possible larger events, can provide a critical 'heads up' (R.P.A. Bouchard, personal communication, 2004).

Multi-disciplinary teams are a logical and coherent approach to studying disease emergence, introduction and spread. Professionals and scientists in animal health, public health, ecology, social sciences and physical sciences should work together to understand the complex systems and interactions which are leading to these disease events. Once identified, this understanding should lead to plans for prevention.

Framework approaches

Approaches can also utilise different frameworks. This is particularly useful in situations where deterministic approaches provide outputs or answers which are rapidly out of date. An interesting example of this is in the report of the United States Institutes of Medicine and National Research Council of the National Academies, entitled, *Globalisation, biosecurity, and the future of the life sciences* (4). Recognising that a list of future disease or bio-threats would have a very short lifespan, simply because of the rapid pace of research and scientific discovery, the Committee chose 'to develop a logical framework for analysis to consider as they evaluate the evolving technology threat spectrum'. The Committee concluded that 'there are classes or categories of advances that share important features that are relevant to their potential to contribute to the future development of new biological weapons. These shared characteristics are based on common purposes, common conceptual underpinnings, and common technical enabling platforms. Thinking of technologies within this framework should help in evaluating the potential they present for beneficial and destructive applications, of technological surprise(s)' (4).

Computer-based and modelling approaches

Computer models have been considered a useful tool for disease control and management for many years. Success varies depending on the application but, in general, part of their value is that they lead to a better understanding of the systems they may be simulating. 'Modelling is useful for the analysis of large, complex data sets but may lack the flexibility to incorporate qualitative data' (R.P.A. Bouchard, personal communication, 2004).

Real-time information sources can assist significantly in anticipating near-term events and long-term trends. An example of this is telegeoprocessing. Xue *et al.* define telegeoprocessing as 'a new discipline based on real-time spatial databases updated regularly by means of telecommunications systems in order to support problem-solving and decision-making at any time and any place. It involves the integration of remote sensing, geographic information systems (GIS), global positioning systems (GPS) and telecommunications' (12). This suite of technologies can provide 'a global, repeat and continuous data coverage for the Earth's surface'. It can support problem-solving and decision-making, but also anticipation of the outcomes associated with the observed data and events.

Intelligence approaches

Much can be learned for the anticipation pillar using approaches taken from the traditional intelligence community model. These include law enforcement intelligence, trends intelligence systems and agri-intelligence networks.

The processes of intelligence include scanning, filtering, collecting, evaluating and analysing information and data to produce a value-added product which end-users may act upon to achieve specific goals and objectives. The objectives and goals depend on the end-users and their core business.

The Criminal Intelligence Service Canada (CISC) prepared a report for the Canadian intelligence community entitled *Strategic early warning for criminal intelligence: theoretical framework and sentinel methodology* (1). The report was prepared because 'there is a growing recognition in the law enforcement community that, to be truly proactive, police must be prepared to act against emerging and future threats – if we wait until a threat becomes full-blown, then we have failed the communities we serve to protect'. They stated that it was necessary to have more than current intelligence. 'In order to be proactive, therefore, law enforcement must be armed not only with the best current intelligence, but with foresight on the threat environment of tomorrow' (1).

The report distinguishes between the traditional intelligence cycle and the warning intelligence process. The traditional intelligence cycle focuses on known threats. Strategic early warning is different in that it is 'concerned with the unknown or unexpected changes over the horizon – that is, that which has *not* yet been deemed a priority issue, or perhaps even contemplated by the law enforcement community'. The warning intelligence process, which is clearly articulated in this report, could be adapted for use in veterinary medicine to identify and monitor possible future threats.

Trends intelligence systems are 'designed to turn exhaustive data collection and distil it into useful digestible information for decision-making' (11). Trends intelligence systems involve a five-step process. These include: identifying issues relevant to the organisation, collecting data, analysing data, facilitating discussion and consensus and, merging trends intelligence into planning. 'These systems allow organisations to tune in and monitor change bubbling beneath the surface. Undoubtedly there are conditions and events which predispose disease outbreak situations. Trends intelligence systems would be well positioned to explore and clarify these conditions, criteria, and events'.

Integrated agricultural intelligence (agri-intelligence) is a specific field of intelligence dedicated to an enhanced understanding and proactive recognition of the threats and risks to national security associated with a broadly defined agriculture. It recognises the clear linkages amongst public health, safety and security, environmental security and economic security. Agri-intelligence receives inputs from many disciples and sectors.

Agri-intelligence is needed because of the rapid changes in society today, including but not limited to science and technology, the interconnectedness of the mandates of different sectors and the fact that agriculture is very vulnerable from many perspectives. Agri-intelligence combines inputs from a diverse and broad spectrum of disciplines and promotes not only an exchange of information but an analysis of this information. This analysis provides a mechanism to proactively anticipate threats, an enhanced understanding of these threats, more informed policy development and superior operational outcomes.

Conclusion

The IWADA goal has always been to decrease the number of animals killed as a result of foreign animal disease incursions. It was always understood that prevention of a disease incursion or event was the preferred option to attain this goal. Scientists are now recognising that the factors which contribute to disease outbreaks and disease movement are interconnected and can be monitored for

trends and patterns. These act much like a list of criteria which may provide early warning of adverse events. Not only may the events be anticipated but in many cases they may be prevented or the negative outcomes mitigated.

There is no doubt that the practice of anticipation will take time to develop. It will require the support of veterinary authorities both philosophically and in terms of resources. The original IWADA workshop of 2000 stated strongly that to decrease the number of animals killed as a result of disease incursions, international co-operation and a change in approaches would be required. Anticipation is a new approach and will be most successful if there is international co-operation.

In this paper, the authors have attempted to initiate discussion on the methodologies of anticipation and to hopefully encourage countries to work together on some of these approaches and to develop many more.

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