Veterinarians as practitioners and as key players in epidemiological surveillance: two tasks, two paradigms to be reconciled

D. Calavas [(1)*], E. Collin [(2)] & P. Hendrikx [(3)]

1) Agence Nationale de Sécurité Sanitaire de l'Alimentation, de l'Environnement et du Travail (ANSES), Laboratoire de Lyon, 31 Avenue Tony-Garnier, 69364 Lyons Cedex, France
2) Société Nationale des Groupements Techniques Vétérinaires (SNGTV), 11 Rue Moufle, 75011 Paris, France
3) Agence Nationale de Sécurité Sanitaire de l'Alimentation, de l'Environnement et du Travail (ANSES), Unité de Surveillance Épidémiologique (SURVEPI), Direction Scientifique des Laboratoires, 29–31 Avenue du Général-Leclerc, 94701 Maisons-Alfort Cedex, France
*Corresponding author: didier.calavas@anses.fr

Summary

Veterinary practitioners are often involved in epidemiological surveillance systems, where their task is to detect animals suspected of suffering from diseases subject to surveillance and to include them in surveillance. However, these two tasks – practising veterinary medicine and taking part in surveillance – are based on different paradigms. Faced with a sick animal, a practitioner tries to maximise the probability of a correct diagnosis, whereas, when implementing surveillance, a veterinarian is required to maximise the inclusion of suspected cases in surveillance systems. Based on an analysis of the difficulties and problems posed by these coexisting tasks, the authors propose potential solutions through veterinary education and training. The implementers and coordinators of epidemiological surveillance systems must take these factors into account.

Keywords

Animal health – Bias – Epidemiological surveillance – Compulsory reporting – Notifiable disease – Regulated disease – Veterinary practitioner.

Introduction

In many countries, veterinary practitioners, who are in contact with farmers in their day-to-day work, are one of the first links in the epidemiological surveillance system, whether in event-driven (passive) surveillance, especially systems based on clinical examination of animals, or in planned (active) surveillance. In France, for example, the surveillance of regulated (notifiable) diseases is organised by the State, and private veterinary practitioners are contracted as 'mandated veterinarians' (holding an animal health accreditation mandate) to represent the State in dealings with their farming clients. In fact, these two tasks/occupations – practising veterinary medicine and participating in epidemiological surveillance systems – are based on two distinct paradigms. When epidemiological surveillance implementers misapprehend this distinction and the role required of veterinarians in surveillance, it can undermine the performance of surveillance systems. After analysing the differences between the objectives and methods of the two tasks, the authors use examples from the surveillance of different diseases in France over the past 20 years, in particular transmissible spongiform encephalopathies, to illustrate the negative consequences of having incorrect expectations for surveillance and to propose solutions for remedying them.

The objectives and diagnostic approach of veterinary practitioners

Put simply, when an animal is presented to them for consultation, the objective of veterinary practitioners is to make a diagnosis to enable them to undertake a suitable treatment process.

The aim of diagnosis (from the Greek word διάγνωσις, meaning to 'discern' or 'distinguish', formed from δια-, meaning apart, and γνώσις, meaning to know or perceive) is to determine the nature of the observed disease from a set of information sources: observed clinical signs, questioning of farmers, and para-clinical data such as results from bioassays or medical imaging. In some cases, the epidemiological context also contributes to the diagnosis.

The basis of medical diagnosis has evolved over the past three centuries as the ability to investigate and understand pathological phenomena has improved, progressing from a purely clinical (semiotic) approach to an aetiological approach based on pathological, microbiological and other data. In the veterinary field, technical and economic capacity may constrain investigations (bioassays, imaging, function tests, etc.), leading to quite a high degree of uncertainty in the diagnosis, which has a particular probability of being correct, as does a bioassay. However, in developed countries, increasing use of simple and affordable bioassays reduces this degree of uncertainty.

From ancient Egyptian times to the 16th Century, it was long considered that the diagnostic approach should be based on hypothetico-deductive reasoning. The Edwin Smith Papyrus, dating from the 18th Dynasty of ancient Egypt (1600 BC), states: 'If you examine a man with [a particular symptom], then you should say concerning him: he has this'. Similarly, the investigative method developed by Sir Francis Bacon (1561–1626) stipulates that all observations should be collected impartially before being interpreted and evaluated objectively to arrive at a single diagnosis or a small number of diagnoses most consistent with the set of data available.

In fact, work on clinical reasoning (1) showed that practitioners of human medicine (this applies equally to veterinary practitioners) do not collect all the available information and examine all the hypotheses but instead are quick to select one or two based on the initial information (it is acknowledged that, in general, a maximum of five to seven hypotheses are considered). These hypotheses lead practitioners to then seek further information to confirm or refute them, and so on. Further investigations will be linked with these hypotheses; there is, therefore, a risk that practitioners will fail to take into account certain observations to avoid having to formulate different hypotheses, even if they are more likely to explain the observed phenomena. In the same vein, exaggerated importance could be given to certain facts in order to support the chosen hypothesis (which is tantamount to over-interpreting certain pieces of information and considering them as explanatory, even when they play no part).

While this mode of reasoning is entirely suited to the objective of diagnosis and treatment (and allocated resources), in reality the least probable hypotheses tend to be rejected (see Appendix). If the treatment (or merely the sequence of events) 'validates' the diagnosis, we can consider that it was reasonable to have rejected these minor alternative hypotheses. If this is not the case, a step-by-step approach will enable previously rejected hypotheses to be reconsidered. However, in some cases (e.g. when the 'final' decision is taken to proceed with slaughter or euthanasia when the final diagnosis has not been reached), uncertainty will remain about the aetiology.

To summarise, the objective of practitioners is to maximise a combination of diagnosis and decision-making, contingent upon: the means of diagnosis and treatment available to them; economic factors (cost of the animal and treatment); prognostic factors (expected efficacy of the treatment as opposed to slaughter or euthanasia); and the objectives of the animal owner.

The objectives and principles of epidemiological surveillance

Epidemiological surveillance can be defined as the collection, analysis and interpretation of data to monitor the health of a defined population, in particular to detect the onset of disease processes and study their development in time and space with a view to adopting appropriate control measures (2).

The first objective of event-driven epidemiological surveillance is to include (recruit) in the surveillance system animals likely to be infected by the disease under surveillance (suspected cases). These are defined on the basis of criteria of suspicion, and veterinarians involved in surveillance are asked to recruit such animals.

In France, for example, the recruitment criteria for clinical surveillance of bovine spongiform encephalopathy (BSE) are defined by statute – the Order of 3 December 1990 laying down animal health measures for bovine spongiform encephalopathy (3). Article 1 states that bovine species should be suspected of BSE if live, slaughtered or dead animals display or displayed neurological or behavioural disorders or a progressive deterioration in their overall condition associated with an attack on the central nervous system, for which the information collected (on the basis of a clinical examination, response to treatment, post-mortem examination or ante- or post-mortem laboratory analysis) rules out any alternative diagnosis.

For veterinarians, suspected cases will most often be sick animals presented to them for consultation by farmers. The recruitment basis can be extended to include cases where veterinarians are asked to perform a systematic bioassay and interpret the results themselves, subsequently incorporating their interpretation into the surveillance system. One example of this is intradermal tuberculin testing to detect bovine tuberculosis.

A point of note is that farmers may play only a passive role in surveillance (they call in their veterinarian for an animal they consider to be sick) but they may also play an active role: for instance, farmers are asked to report abortions in ruminants to detect brucellosis, even when the therapeutic intervention of a veterinarian is not required. In both their passive and active roles, farmers are the first link in the surveillance system and in decision-making on the extent to which a veterinarian should be used to treat sick animals or handle suspected cases that farmers are asked to report (e.g. abortions). It is also primarily farmers who determine the sensitivity of surveillance. The extent to which a veterinarian is used depends largely on a set of parameters linked to the technical and economic relationship between farmers and their veterinarians (the number of veterinarians in the area, the practice of farmers treating their own animals, the cost of veterinary interventions, etc.).

The objective of event-driven surveillance is usually to detect as many actual cases (suspected cases where infection is confirmed by the reference test) as possible, and so maximise the recruitment of suspected cases by prioritising sensitivity (i.e. suspected cases included in the surveillance as a proportion of the number of animals showing signs compatible with the definition of a suspected case) when defining and recruiting these suspected cases, at the expense of specificity (i.e. confirmed cases as a proportion of the suspected cases included in the surveillance).

Obviously, the extent to which these principles can be applied in reality is reliant on the resources allocated to surveillance, which depend on: the issues at stake (morbidity and mortality associated with the disease, zoonotic potential, economic consequences [e.g. a ban on international trade if official disease freedom is lost]); the consequences of failing to detect a case (which can be devastating in the case of highly contagious diseases like foot and mouth disease); and available technical, financial and other resources. This leads to the definition of criteria of suspicion whose sensitivity/specificity ratio is compatible with the objectives assigned to surveillance and the resources allocated to it.

Consequences when the same person performs both tasks

A veterinary practitioner who is asked to play a part in an epidemiological surveillance system is actually performing two tasks, each with different objectives based on different paradigms:

a) as a practitioner, the objective is to maximise the probability of a correct diagnosis, generally excluding aetiologies with a low probability of occurrence, in a context of technical and economic constraints

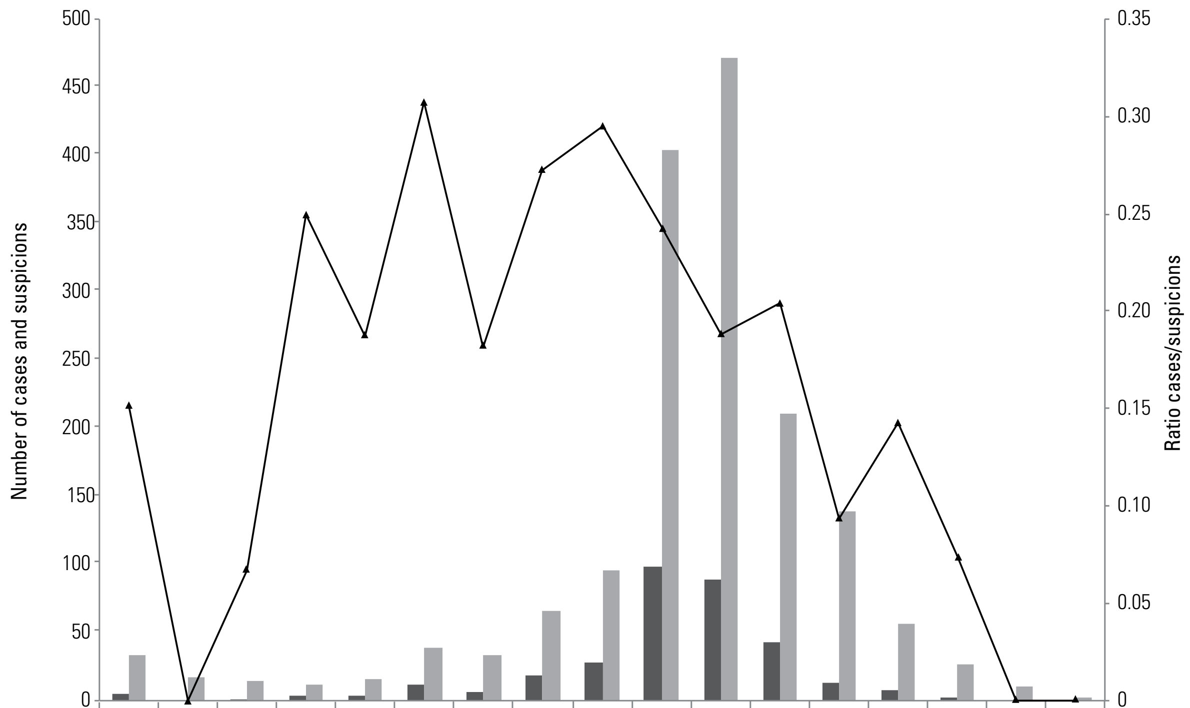
b) as a health professional involved in epidemiological surveillance, the veterinarian's objective is to maximise the recruitment of suspected cases, often by including suspected events with a low probability of occurrence, in a different context of technical and economic constraints.

The difficulty inherent in the 'coexistence' of these two tasks is complicated by the fact that, in many cases, they are performed on the same animals: the origin of an epidemiological suspicion is often an animal presented to the veterinarian for consultation because it is sick. This requires the veterinarian to switch instantly from one mindset and one paradigm to another.

By looking at some of the observations and examples, we can conclude that this is no easy exercise, and that the inability to switch has consequences for the performance of surveillance systems, in particular a lack of sensitivity when the principles of the diagnostic approach are applied in an epidemiological surveillance situation (see Appendix).

To take the example of clinical surveillance for BSE in France (Fig. 1), between 1991 and 2007 the average diagnostic confirmation rate was 20% (329 out of 1,647 cases). One might ask if this is not an excessively high rate for a disease whose clinical manifestations are not pathognomonic; many animals with signs consistent with BSE will not have the disease, so a high confirmation rate suggests that many suspected cases were not included in the surveillance system. Indeed, all countries which have introduced clinical surveillance for BSE and which have high confirmation rates should question whether or not all suspected cases are being reported. The European Commission ruled that, for a country to be deemed to provide effective clinical surveillance, it must report a minimum number of suspicions annually, depending on the size of its cattle population and the prevalence of diseases with neurological signs that can be confused (clinically) with BSE (4). In some areas of France, this lack of sensitivity in clinical surveillance for BSE was identified after additional planned surveillance protocols, based on sampling and systematic testing of fallen stock, led to the identification of further cases that had been missed by clinical surveillance, even though the animals in question might have displayed the characteristic disease symptoms prior to death.

Low sensitivity in clinical surveillance is even more of a problem for scrapie in sheep. In France between 1996 and



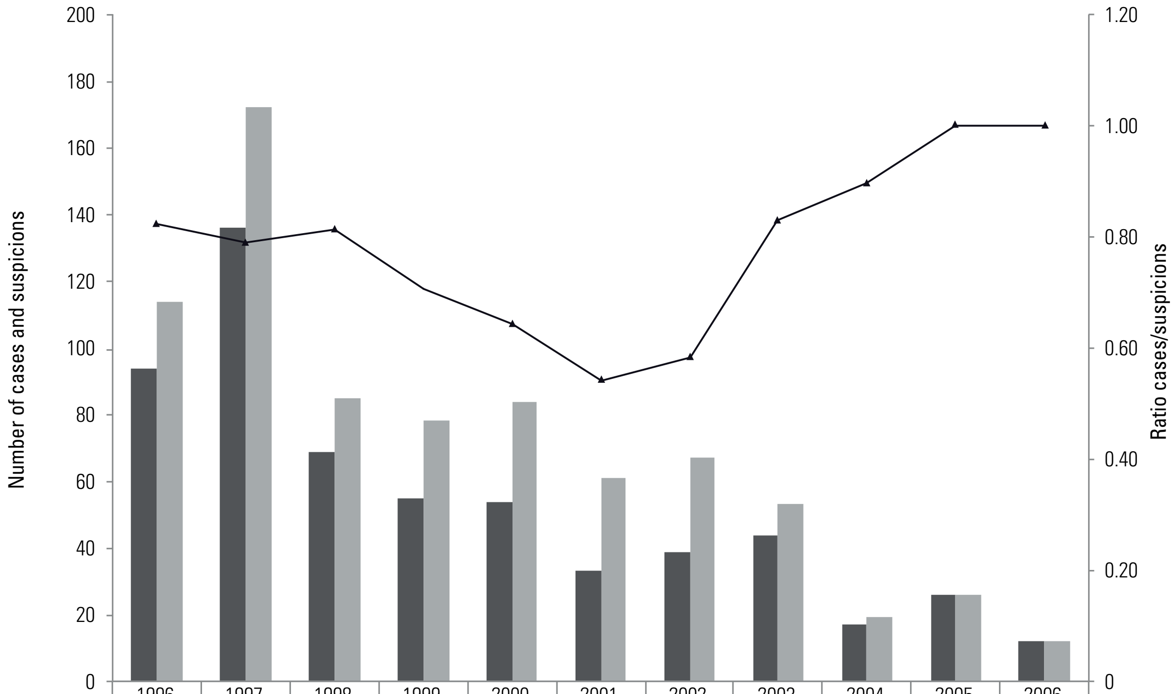
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cases	5	0	1	3	3	12	6	18	28	98	89	43	13	8	2	0	0
Suspicions	33	17	15	12	16	39	33	66	95	404	472	211	139	56	27	10	2
Ratio cases / suspicions	0.15	0	0.07	0.25	0.19	0.31	0.18	0.27	0.29	0.24	0.19	0.20	0.09	0.14	0.07	0	0

Fig. 1
Number of suspicions, confirmed cases and ratio of confirmed cases to suspected cases in the course of clinical surveillance for bovine spongiform encephalopathy (BSE) in France between 1991 and 2007

2006 (Fig. 2), the average diagnostic confirmation rate was 75% (579 out of 771 cases). Given that clinical diagnosis of scrapie is very difficult at the individual level (that of the animal), it is clear that veterinarians had, on the whole, only included very strong suspicions in the surveillance system, presumably after excluding a number of alternative diagnoses and also after observing a number of animals with clinical signs at the flock level.

The same finding applies when veterinarians are asked to rule on an animal's status based on the result of a bioassay that they themselves are responsible for interpreting. This is the case with bovine tuberculosis, a disease for which veterinarians perform allergy testing (intradermal tuberculin tests), which, if positive, leads to the animal being classified as suspected of being infected. Given the specificity of the tests, a number of false positive reactions is usually to be expected (in a context of zero prevalence, the expected number of false positives is equal to the number of tests performed × [1 – specificity of the test]). In France in 2011 (5), the rate of positive reactions was 0.35% in areas practising the single intradermal tuberculin test. According to sources, the estimated specificity of this test is between 75% and 99.9%; as the sensitivity value falls between these two values, in all likelihood the rate of positive reactions is (severely) under-estimated. It has long been recognised (6) that veterinarians had 'adapted' official surveillance for bovine tuberculosis, not entirely unreasonably, because in a context of very low prevalence the positive predictive value of a positive test is also very low. As a result, the detection threshold was adapted, with only the strongest reactions reported. This has weakened the overall sensitivity of the surveillance system, which may have contributed to the resurgence in bovine tuberculosis outbreaks in France over the past ten years.

What is true for endemic diseases, even those with a low prevalence, is even truer for exotic diseases (such as foot and mouth disease) in France, where the specificity of the epidemiological and clinical interpretation of the situation encountered by veterinary practitioners on the farm has led to a very small number or, depending on the year, even zero suspicions being reported (Fig. 3). This makes Bayes' theorem (see Appendix) very useful for modelling the practitioner's clinical approach because zero prevalence of the disease leads to a very low probability of detection. In this case, the role of veterinary practitioner may be said to have taken precedence over that of mandated veterinarian.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Cases	94	136	69	55	54	33	39	44	17	26	12
Suspicions	114	172	85	78	84	61	67	53	19	26	12
Ratio cases/suspicions	0.82	0.79	0.81	0.71	0,64	0.54	0.58	0.83	0.89	1.00	1.00

Fig. 2
Number of suspicions, confirmed cases and ratio of confirmed cases to suspected cases in the course of clinical surveillance for scrapie in sheep in France between 1996 and 2006

Defining a case: an example of failing to take into account the specific requirements of epidemiological surveillance as compared with clinical diagnosis

In many cases, insufficient consideration is given (even by the designers and implementers of surveillance systems) to difficulties and problems arising from the requirement for veterinary practitioners to perform an additional epidemiological surveillance task. This is aptly illustrated by clinical surveillance for BSE in France.

The Order of 3 December 1990 laying down animal health measures for bovine spongiform encephalopathy (3) contains another definition of criteria for clinical suspicion of BSE in Article 5: 'BSE should be suspected in the following circumstances: (…) live cattle with clinical signs of a neurological disorder, such as anxiety, hypersensitivity, agitation or aggression, lasting more than two weeks, and all other characteristic manifestations of a neurological syndrome, whether or not they affect motor function and/or general condition'. This second definition was the definition that appeared in the first version of the Order of 1990 but it was retained in Article 5 of subsequent versions. Although it does not contradict the definition in Article 1, in actual fact it could lead to legitimate BSE suspicions being dismissed simply because its definition of criteria of suspicion of BSE is restrictive while, on the contrary, the definition in Article 1 leads to BSE being suspected in all cases where it cannot be ruled out, which is much more consistent with the objective of surveillance and of detecting as many cases as possible.

As regards communication with veterinarians, the system's implementers made another error at the start of clinical surveillance for BSE in 1990. Back then, veterinary practitioners were presented with an 'ideal standard' clinical picture of the disease, bringing together all the characteristic clinical signs. This was illustrated with a video by British colleagues presenting a pathognomonic clinical picture. This is more of a diagnostic objective than

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Suspicions	26	13	6	8	6	5	0	2	112	10	4	1	3	1	3	1	0	3	5	5

Fig. 3
Number of suspicions of foot and mouth disease in France between 1993 and 2012
(G. Zanella & F. Moutou, French Agency for Food, Environmental and Occupational Health and Safety [ANSES], personal communication)

an epidemiological surveillance one. Awareness-raising among veterinarians was amended after the shortcomings of the initial approach were recognised. Consultations with the French National Society of Veterinary Technical Associations (SNGTV) led to a completely different way of presenting the situation to veterinarians required to report suspected cases: BSE should not be suspected only in cases where the probability of it actually being BSE was high; it should be suspected in all cases where an alternative definitive diagnosis could not be made. In other words, the only cases where BSE should not be suspected were those where a BSE diagnosis could be ruled out for certain (e.g. when an animal recovers following treatment). What is more, in this second awareness campaign, the emphasis was placed on atypical clinical forms (abnormal duration of the clinical course, presence/absence of a particular sign) and on the fact that, depending on the stage of the disease at which the veterinarian intervened, some signs may not (or no longer) be observed (e.g. late in the clinical course, hypersensitivity to sound or touch has usually disappeared in recumbent animals).

Proposals for improving the effectiveness of epidemiological surveillance by veterinary practitioners

The participation of veterinary practitioners in epidemiological surveillance is essential, both through their day-to-day presence in the field working with herds to treat animals and through their expertise in identifying and characterising clinical suspicions. However, first they should fully understand the objectives of the surveillance systems in which they participate, as well as the principles and rules with which they must comply in order to ensure efficient surveillance. What is expected of them in terms of epidemiological surveillance should be made a part of their education and training.

At the education stage, they should be taught the theory of the diagnostic reasoning approach. Parallels should be drawn with the objectives, issues at stake, constraints and resources involved in epidemiological surveillance in order to demonstrate the differences between the paradigms underpinning the two tasks. This awareness-raising could also be included in a continuing education module for veterinarians mandated by the State to conduct epidemiological surveillance tasks. Moreover, all infectious diseases, including exotic ones, should be included in differential diagnosis processes.

When setting up event-driven surveillance systems, it is also crucial to explain clearly to veterinarians what is expected of them, not in a generic and theoretical way but based on examples (when to include a suspected case and when it can be excluded) and specific cases spanning the entire range of potential situations (see previous section). Surveillance protocols should also take into account veterinarians' practical constraints, while favouring simple procedures that are harmonised or standardised among the multitude of surveillance systems to which veterinarians are expected to contribute. Then, when a system is in place, it is important to ensure ongoing coordination of the network of mandated veterinarians, for example through regional coordinating veterinarians, in order to encourage the recruitment of suspected cases, collect information on the evolution of clinical manifestations of diseases under surveillance, and so on.

It is also important to introduce performance indicators for the system, to help to assess whether the participation of veterinarians meets system specifications (e.g. an expected number of suspected cases in line with the number of animals examined and the performance of a diagnostic test).

In conclusion, when setting up an epidemiological surveillance system, all obstacles to the system's optimal operation should be analysed, taking into account expectations, perceptions and difficulties in implementing protocols, not only for veterinary practitioners but for all those in the system. Other factors need to be taken into account to understand the constraints on the participation of all those who participate in surveillance systems, including the immediate regulatory consequences for farmers in reporting a suspected case (such as a ban on animal movements), which, in some cases, can severely undermine the sensitivity of a surveillance system. This is especially important considering that it is the veterinary practitioner's customer who will suffer the consequences when the disease under surveillance is detected. The impact on the surveillance system's sensitivity can be significant and this should be made a consideration, in particular to ensure that the consequences are not disproportionate at the suspicion stage. Finally, the objectives and methods of a surveillance system need to be tailored to the prevalence of the disease, especially in a situation of very low or zero prevalence, where the positive predictive value of a suspected case is very low and tends to zero as prevalence decreases.

Acknowledgements

The authors wish to thank Anne Bronner, Céline Dupuy, Morgane Dominguez, Viviane Hénaux and Paul Martin (ANSES, the French Agency for Food, Environmental and Occupational Health and Safety) for fruitful discussions on the subject of this article.

References

1. Elstein A.E., Shulman L.S. & Sprafka S.A. (1979). – Medical problem solving: an analysis of clinical reasoning. Harvard University Press, London.

2. Toma B., Dufour B., Bénet J.-J., Sanaa M., Shaw A. & Moutou F. (2010). – Épidémiologie appliquée à la lutte collective contre les maladies animales transmissibles majeures. Association pour l'Étude de l'Épidémiologie des Maladies Animales, Maisons-Alfort.

3. Anon. (1990). – Arrêté du 3 décembre 1990 fixant les mesures de police sanitaire relatives à l'encéphalopathie spongiforme bovine. NOR: AGRG9002272A. *J.O. Rép. fr.*, 16 December 1990, 15482-15484. Available at: www.legifrance.gouv.fr/affichTextedo?cidTexte=JORFTEXT000000353179&fastPos=1&fastReqId=1630568087&categorieLien=id&oldAction=rechTexte (accessed on 30 July 2013).

4. European Commission (EC) (1998). – Commission Decision 98/272/EC of 23 April 1998 on epidemio-surveillance for transmissible spongiform encephalopathies and amending 94/474/EC. *Off. J. Eur. Union*, **L 122**, 59–63. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31998D0272:EN:NOT (accessed on 30 July 2013).

5. Fediaevsky A., Bénet J.-J., Boschiroli M.L., Rivière J. & Hars J. (2012). – La tuberculose bovine en France en 2011, poursuite de la réduction du nombre de foyers. *In* Bulletin épidémiologique, santé animale et alimentation, Vol. 54 (Spécial Maladies réglementées et émergentes – Bilan 2011), 4–12.

6. Ducrot C. (1996). – Lutte contre la tuberculose. Évaluation technique et économique du nouveau système de lutte contre la tuberculose en Bretagne. Centre d'Écopathologie Animale, Lyons.

Appendix
Diagnostic approach and Bayes' theorem

It is now recognised that medical reasoning (the diagnostic approach) relies implicitly on Bayes' theorem, at least in part. If the demonstration is limited to a single clinical sign:

$$p\,(A|B) = \frac{p\,(B|A) \times p\,(A)}{p\,(B)}$$

In other words, the probability of diagnosing disease A after observing sign B (such as a clinical sign, or else a biological constant, the result of a function test) is equal to the probability of observing sign B in the case of disease A, multiplied by the probability of disease A, all divided by the probability of sign B.

Applied to medical reasoning, practitioners, through their training, experience and perceptions, are able to quantify the probabilities A, B and B|A, and hence A|B itself.

A number of conclusions may be drawn from this mode of reasoning:

a) the higher the probability of disease A, p (A), i.e. the higher its incidence and prevalence in the population, the more likely the practitioner will be to diagnose disease A. This approach is entirely logical but in actual fact it prioritises the commonest diseases. Consequently, the diagnosis will depend on the real or perceived incidence of the disease at the time of diagnosis, that is to say, in its wider epidemiological context. This may go some way to explaining the increase in the number of suspicions of a disease the greater its occurrence or spontaneous consideration by practitioners. For instance, it is common for there to be an actual or apparent spike in the occurrence of a disease (especially as a result of media coverage), which disappears once the disease's prevalence reverts to earlier perceptions. In contrast, the probability of detecting a disease that is rare or exotic to a territory will be reduced or even zero by applying strictly the formula: if $p\,(A) = 0$, the $p\,(A|B) = 0$. This may also help to explain the low to very low number of suspicions of exotic diseases. The number of clinical suspicions of foot and mouth disease in France over the past two decades (Fig. 3) illustrates these two points: the very low number of clinical suspicions compared with the size of the cattle population (more than 10 million adult cattle) increased dramatically during the 2001 epizootic in Great Britain, before returning quickly to its previous level once the epizootic had been contained;

b) similarly, the higher the probability of observing sign B in the case of disease A [p (B|A)], i.e. the more specific the sign is to the disease, the more likely the practitioner will be to diagnose A in the event of sign B. While this is very logical, it will result in giving less weight to non-specific signs, so reducing the probability of diagnosing other diseases with this sign;

c) lastly, the less frequently sign p (B) is observed, the higher the probability of diagnosing any disease with this sign, which amounts to potentiating the numerator, leading to the consequences seen in paragraphs (*a*) and (*b*).

This reasoning can be extended to include a combination of observed signs. Logically enough, the diagnostic approach consists of maximising the probability of diagnosis in the light not only of the practitioner's knowledge of the disease but also of the context in which the diagnosis is made. As a corollary, the least common diseases will be ruled out and the least specific and commonest signs will carry less weight, contradicting the goal of epidemiological surveillance, which, on the contrary, is to promote the system's sensitivity.

Moreover, a number of biases may affect the estimated *a priori* probabilities A, B and B|A:

– the bias of limitations in a veterinarian's knowledge: a veterinarian who is unfamiliar with the clinical manifestations of a disease (exotic) will be less likely to diagnose that disease;

– the bias of motivation: lack of awareness of a disease will further reduce the probability of it being diagnosed, while media coverage of a disease will have the opposite effect (in some cases excessive compared with the risk);

– the bias of prejudgement: this leads veterinarians to select irrelevant indices because of their preconceptions of a clinical situation.