

Literature review of surveillance systems and approaches for the early detection of new, exotic and re-emerging diseases

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INTRODUCTION

In recent years, novel methods have been developed to improve the early detection of exotic, new and re-emerging diseases. These approaches, which are mainly risk-based, have allowed to characterise better the patterns of disease presence and spread, as well as the populations and areas at higher risk, in order to prioritise surveillance and optimise resources. The aim of this review was to **evaluate recent progress regarding novel early detection methods** that could improve **sensitivity and cost-effectiveness** while respecting the legal requirements that apply to conventional surveillance methods.

MATERIALS AND METHODS

- Systematic search in CAB Abstracts and Scopus databases (Boolean query) of animal health surveillance scientific articles in English and published between 1993 and 2012 = 3,183 articles
- Three screening rounds to exclude non-relevant articles, 19 exclusion criteria specific for animal health surveillance and early detection, applied to title, abstract and full text = 128 articles
- Information was extracted based on a list of 45 variables.

RESULTS

DESCRIPTIVE

- Most frequent date of publication: 2011-2012 (n=62).
- Most frequent location: Europe (n=57) and North America (n=33) (**Figures 1a and 1b**).
- Most frequent diseases targeted: West Nile (n=21), bluetongue (n=16), avian influenza (n=15).
- Most frequent host species: Ruminants (n=31) and wild birds (n=15). Many articles covered several wild and/or domestic species (n=25).

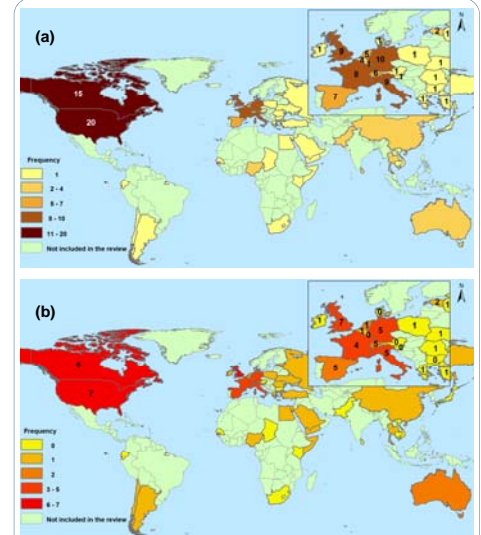


Figure 1. Frequency of study countries in the review. (a) Considering all the papers, or (b) only the risk-based papers

General category	Specific category	Count	Risk-based	%	Multiple nature	%
EPIDEM. METHODS	Spatial epidemiology (GIS)	22	14	63.64%	7	31.82%
	Statistical modelling	14	10	71.43%	10	71.43%
	Digital surveillance	12	3	27.27%	9	75.00%
	Simulation modelling	8	6	75.00%	2	25.00%
	Risk assessment	7	7	100.00%	1	14.29%
	Scenario tree modelling	6	5	83.33%	0	0.00%
	Cluster analysis	5	4	80.00%	2	40.00%
	Environmental modelling	4	4	100.00%	2	50.00%
	Literature review	4	0	0.00%	4	100.00%
	Others	6	5	83.33%	4	66.67%
ACTIVE	Vector surveillance	17	2	11.76%	6	35.29%
	Sentinels	16	10	62.50%	1	6.25%
	Serosurvey	13	5	38.46%	1	7.69%
	Pathogen determination	12	2	16.67%	3	25.00%
	Participatory surveillance	8	1	12.50%	5	62.50%
Others	3	1	33.33%	1	33.33%	
PASSIVE	Syndromic surveillance	18			18	100.00%
	Clinical investigation	10			0	0.00%
	Mortality investigation	5	0	0.00%	0	0.00%
	Parameter monitoring	2			1	50.00%
Others	3			2	66.67%	

Table 1. Frequency of different methodologies found in the review

By CATEGORY (Table 1)

1. **Epidemiological methods** that support surveillance (n=69). Most relevant results:
 - **Spatial epidemiology and GIS-based approaches** (n=22), most of them risk-based (n=14). Pros: risk mapping performance. Useful to multi-factorial and/or vector-borne diseases. Descriptive visualization properties and possibility of combining these methods with other epidemiological models and approaches. Cons: quality of data, assumptions.
 - **Statistical models** (n=14). Pros: innovative applications to surveillance. Most of them risk-based (n=10) and with multiple nature (n=10). Cons: model assumptions and data quality.
2. **Active surveillance** activities (n=54). Most relevant results:
 - **Vector surveillance** (n=17) and **sentinels** (n=16). Pros: most of sentinels are risk-based (n=10). Methods used for surveillance of vector-borne diseases. Cons: location of traps and sentinels (spatial and temporally) is crucial for surveillance effectiveness.
 - **Participatory surveillance** (n=8). Pros: alternative method, especially for developing countries. Quick overview of the epidemiological situation. Collaboration between institutions related to animal and/or public health. Cons: non-response rate, efficiency of reporters, disincentives for outbreak reporting.
3. **Passive surveillance** activities (n=33), of which 18 were about **syndromic surveillance**: Pros: multi-purpose method. Cost-effective reduction in the detection time. Possibility to integrate it into systems of digital surveillance in real time. Cons: Lack of harmonization of criteria to define the "syndromes" and exclusion of "false alarms".

DISCUSSION AND CONCLUSIONS

Risk-based approaches have been frequently described in last years (**Figure 2**), especially in methodological articles. However, the integration of risk-based approaches into existing surveillance systems is uncommon and its use is not standardised across countries.

Risk-based methods were the major approach used for surveillance of vector-borne diseases. The combination of sentinel and vector surveillance (n=8) seem to be an effective tool for early warning, particularly with wildlife involvement. Risk-based methods for early detection applied to wildlife populations have become an emerging area of research in recent years, and is highlighted for vector-borne diseases, foot-and-mouth disease and avian influenza.

This was the first systematic review of the scientific literature on animal health surveillance that has considered all approaches and methodologies targeting early detection. This information will be used in the framework of the RISKSUR project [1] to provide a new generation of these methodologies and tools to improve animal health surveillance in a cost-effective and risk-based manner.

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REFERENCES

[1] RISKSUR project, KBBE.2012.1.3-01. Annex I "Description of work".

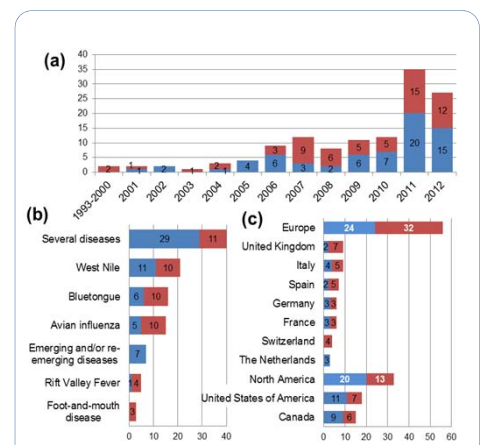


Figure 2. Distribution of the papers by approach: risk-based (in red) or non risk-based (in blue); (a) Per year (b); per disease (c); per country or region.