

The French Epidemic Intelligence System: comparing disease surveillance at national and international level using data from the Program for Monitoring Emerging Diseases

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Summary

In a context of globalisation and climate change, the risk of emerging infectious diseases spreading around the world has significantly increased in the past decades. In response to this growing threat, an

epidemic intelligence team has been set up within the framework of the French animal health epidemiological surveillance platform (ESA platform). The French Epidemic Intelligence System (FEIS) monitors animal health risks in Europe and beyond that threaten animal populations in France (emerging and exotic diseases not yet present). The FEIS expert network covers all 53 category 1 health hazards identified as priority diseases by the French authorities. From January 2016 to December 2017, the FEIS published 126 reports on animal health events related to infectious diseases, of which 76.2% were related to events in Europe. When comparing FEIS reports to posts from the Programme for Monitoring Emerging Diseases (ProMED), a FEIS report was produced for 52.6% of ProMED themes (combinations of disease and country) posted in 2016–2017 on events in Europe. The remaining European ProMED themes did not meet the criterion for the production of a FEIS report because either the disease was already present in France, the risk of introduction into France was considered low or negligible, or the introduction of the pathogen would have low or negligible economic and societal impacts. The FEIS efficiently detected and reported on all health hazards identified by ProMED to alert health authorities and stakeholders when needed (according to the criterion). Compared with international epidemic intelligence systems such as ProMED, which provide general information, the FEIS adds another layer of filtering and interpretation to available information on animal health threats tailored to France's specific needs, in order to communicate only essential information to health authorities.

Keywords

Animal health – Disease surveillance – Emerging infectious disease – Epidemic intelligence – France – ProMED.

Introduction

The current context of globalisation, high mobility of persons and goods and climate change has favoured the emergence or re-emergence of known and unknown infectious diseases (1, 2, 3). Emerging infectious diseases (EID) are 'infections that have newly

appeared in a population or have existed previously but are rapidly increasing in incidence or geographic range' (4). They are mainly of animal origin (60% are zoonoses, i.e. diseases that can be transmitted to humans by animals), and their incidence has significantly increased over time, placing an additional burden on public health and veterinary services (1, 5, 6). The hotspots of EID, particularly zoonoses, are primarily located in South and South-East Asia, South and Central America, and sub-Saharan Africa (7). Over the past 20 years, the expansion of the European Union as well as population increases have had socio-economic and health consequences for Member States, including 'open trade' and increasing movements of humans, goods and animals between countries (2). This has resulted in a growing risk of introduction and spread of EID in Europe. During this period, legal and health requirements as well as surveillance efforts have also increased. In France, several animal infectious diseases have emerged since 2000, such as bluetongue serotype 8 in 2006, Schmallenberg in 2011 and several highly pathogenic avian influenza viruses (e.g. H5N8 in 2016) (8, 9, 10).

Surveillance and response are two key elements to control EID and they depend on rapid detection, diagnosis and control of health-related risks (1). To respond to the increasing threat of EID, existing systems have set up surveillance approaches at different geographical scales (national or sub-national). To improve epidemiological surveillance in France, the French animal health epidemiological surveillance platform (ESA platform) was created in 2011 with six founding members, and four additional members by 2018, representing different sectors of animal health: the Ministry of Agriculture, farmers, veterinarians, scientists, laboratories, hunters, wildlife services and two research centres (11). The main objective of the ESA platform is to ensure that animal health surveillance systems are efficient and are developed according to methodological standards for surveillance.

In 2013, to better anticipate the threat of EID, epidemic intelligence was integrated into the activities of the ESA platform through the French Epidemic Intelligence System (FEIS). The FEIS aims to monitor international animal health events involving diseases not yet

present in the country that threaten animal populations in France, in order to provide timely warning to French authorities. As it focuses on threats not yet present in France, the FEIS does not cover national surveillance. The team behind the FEIS is coordinated by the French Agricultural Research Centre for International Development (CIRAD), the French Agency for Food, Environmental and Occupational Health and Safety (ANSES) and the French Directorate General for Food (DGAL, part of the French Ministry of Agriculture).

Epidemic intelligence encompasses all activities related to the early identification, verification and assessment of potential health hazards. It provides countries with a conceptual framework to complement traditional surveillance systems and help adapt them to face the challenges of emerging infections (12, 13). Epidemic intelligence equally integrates both indicator-based surveillance (IBS) and event-based surveillance (EBS), as both components can result in the detection of a signal that leads to a health alert: IBS refers to structured data collected through routine surveillance systems; EBS refers to unstructured data gathered from sources of intelligence of any nature (e.g. newspaper articles, reports, stories, rumours about health events) and, because these data are unstructured, they require filtering and validation (13).

The FEIS combines IBS and EBS, and monitors both official sources (e.g. the World Organisation for Animal Health [OIE], the Food and Agriculture Organization of the United Nations [FAO], the European Food Safety Authority [EFSA], the European Commission) and unofficial sources (e.g. media, personal communication). Once collected, the information is verified and analysed by a network of national and international experts.

The FEIS publishes reports to inform the authorities and health professionals when an event marks a quantitative or qualitative change in the epidemiological situation of a specific disease (i.e. emergence or re-emergence, geographical spread or increase in number of outbreaks). The dissemination of FEIS reports can be either public, on the ESA platform website (www.pplateforme-esa.fr), or confidential

(sent to FEIS members and the ESA platform steering committee), depending on the source of the information they contain. In addition to these reports, the FEIS produces a weekly epidemic intelligence bulletin, available online since October 2018.

The FEIS operates a network of experts to validate and contextualise the information related to animal health events. Through CIRAD and ANSES, the FEIS expert network includes several reference laboratories at national, European and international level (OIE/FAO reference laboratories or centres) (14). In addition, ANSES has 65 national, eight European and 26 international reference mandates; CIRAD has four national, one European and six international reference mandates. Experts from these laboratories can provide disease-specific expertise for a wide range of animal diseases, including zoonoses.

To better anticipate the threat of diseases not yet present in France (and in the rest of Europe), it is crucial to monitor the circulation of animal diseases outside Europe, specifically in regions of high risk of spread to Europe (e.g. Asia for avian influenza, Turkey for lumpy skin disease or African horse sickness, Northern Africa for foot and mouth disease or bluetongue). To do so, the FEIS expert network includes geographical referees. These referees are CIRAD agents based outside Europe, who can provide regional expertise with firsthand on-the-ground information acquired through their local network of contacts. The geographical referees cover six regions worldwide: the Indian Ocean, the Caribbean, the Mediterranean, Southern Africa, Western Africa and South-East Asia.

The Program for Monitoring Emerging Diseases (ProMED), an official programme of the International Society for Infectious Diseases (ISID), is an internet-based surveillance approach launched in 1994 to disseminate information on the detection of unusual health events related to emerging and re-emerging infectious diseases and toxicities affecting humans, animals and plants (15). Based on innovative and informal disease surveillance, it enables dissemination of information faster than traditional surveillance systems. Many other digital

surveillance systems exist but, as described by Barboza *et al.*, ProMED is the most complete source and reports ‘95% of all threats in a timely manner’ when combined with the European Centre for Disease Prevention and Control (ECDC) roundtable reports (16, 17). In order to evaluate the performance of the FEIS in the framework of this study, the authors considered ProMED to be a gold standard in terms of event-based detection and monitoring of EID worldwide, and compared the FEIS to ProMED.

This study includes two analyses: an analysis of the coverage of the FEIS expert network and a comparison of FEIS reports with ProMED posts over a period of two years (from 1 January 2016 to 31 December 2017).

Materials and methods

Description of the French Epidemic Intelligence System

As part of the daily routine, the FEIS team monitors different types of information source, both official sources (e.g. OIE, FAO, EFSA, the European Commission) and unofficial sources (e.g. media, personal communications). A signal is information relating to a health event that could threaten animal populations in France. When a potential signal is detected it is discussed with the network of experts, which includes national and international disease experts. Once the signal is verified and if the event meets the criterion to alert health professionals, the FEIS writes a report in collaboration with the experts. This report will contain information relating to the event, such as date and place of occurrence, animals affected and control measures implemented, but will also include information from other sources to interpret the event in a more global context. Figure 1 illustrates these steps, from data collection to communication of validated and interpreted information.

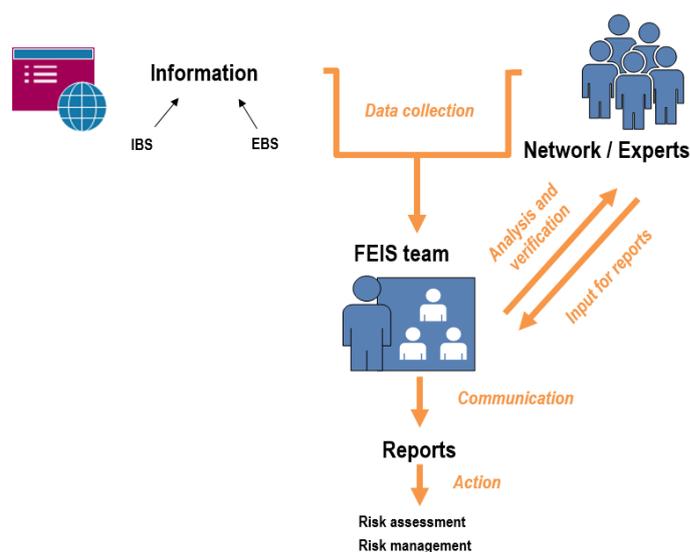


Fig. 1

Description of the French Epidemic Intelligence System

EBS: Event-based surveillance

FEIS: French Epidemic Intelligence System

IBS: Indicator-based surveillance

To illustrate the added value of the FEIS when compared with international systems such as ProMED, the example is used of a FEIS report published on 23 August 2016 on the outbreak of foot and mouth disease in Mauritius in the Indian Ocean (www.plateforme-esa.fr/article/foyers-de-fievre-aphteuse-dans-l-ocean-indien-a-rodrigues-et-a-maurice-point-01-2016-au-22). The report describes the outbreak using information from the OIE report. As it was written in collaboration with the FEIS experts, in this case involving the OIE reference laboratory for foot and mouth disease, the report also contains details regarding the laboratory confirmation of the serotype/topotype of the virus responsible for the outbreak, and an overview of the circulation of the specific viral strain in other countries. This background information is useful to animal health professionals in France because it provides context and allows readers to better interpret the significance of the event and the potential risk of disease spread. This example demonstrates how the FEIS provides an extra layer of expertise to disease reporting by including information

from other sources in addition to ProMED and by adding expertise from its network.

Analysis of the network of experts involved in the French Epidemic Intelligence System

The 53 diseases of main concern for French animal health authorities (referred to as category 1 health hazards) (18) were compared with the FEIS expertise network to evaluate the coverage of the network and the capacity of the FEIS to monitor animal health threats for France. These category 1 health hazards were established in 2013 for terrestrial and aquatic animals of all categories (farm, sport, pet and wild animals).

An expert was defined as an animal health professional who has knowledge and skills on a specific disease or disease-related field (e.g. epidemiology, entomology, virology, parasitology) and works in an animal health institution (e.g. research institute, government agency, university, laboratory). The role of experts is to verify and interpret animal health events detected by the FEIS according to their field of expertise. They can also provide information on new events.

Comparison of the reports of the French Epidemic Intelligence System with posts from the Program for Monitoring Emerging Diseases

The outputs of both the ProMED and FEIS systems from 1 January 2016 to 31 December 2017 were compared to evaluate the coverage of FEIS reports in relation to animal health events reported by ProMED. The authors extracted from the FEIS report dashboard (a spreadsheet updated daily by the FEIS coordinators) all reports, confidential and public, published during the study period on events involving infectious diseases. For ProMED, all posts made during the study period that were related to infectious animal diseases, including zoonoses, were included. Posts relating to events in France were excluded from the study because the FEIS is not in charge of national surveillance. The ProMED posts were extracted from archives and sent to the FEIS by ProMED staff.

To compare the FEIS and ProMED, the number of reports or posts was not used because they are strongly linked to the epidemiological context (ongoing epidemics during the study period). Instead, the number of themes was used, defined as the combination of the disease and the geographical location of the event, which were extracted for each post and report.

Results

The FEIS expert network covers all 53 category 1 health hazards identified as priorities by the French government; CIRAD and ANSES are reference laboratories for 45 out of the 53 animal diseases identified as category 1 health hazards. The remaining diseases concern aquatic animals and are covered by the French Research Institute for Exploitation of the Sea (IFREMER), a member of the animal health network in France, and therefore part of the FEIS expertise network by extension.

From 1 January 2016 to 31 December 2017, the FEIS published 126 reports related to infectious diseases, including 104 public (82.5%) and 22 confidential reports (17.5%). In total, 76.2% of reports were about events that occurred in Europe. The reports about events outside Europe discussed events in Africa (Algeria, Tunisia and Cameroon), the Indian Ocean and Turkey. The majority of reports were about avian influenza (50 reports, 39.7%) (Fig. 2). Indeed, an outbreak of highly pathogenic avian influenza H5N8 started in Europe in October 2016, with sporadic cases still reported by the end of 2017 (12). The study period was also marked by lumpy skin disease (21 reports, 16.7%), which spread through the Balkans in 2015–2016 (19), and foot and mouth disease (18 reports, 14.3%), which caused outbreaks in Mauritius, an island near the French island of La Reunion, and in Algeria (20, 21).

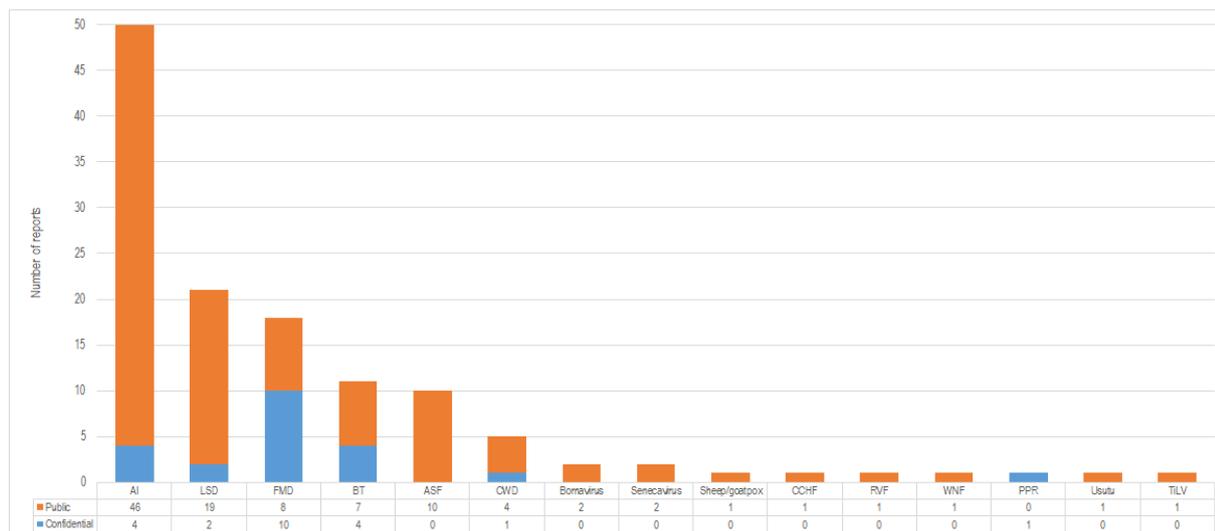


Fig. 2
Number of French Epidemic Intelligence System reports by disease and type of report (confidential in blue; public in orange)

- AI: avian influenza
- ASF: African swine fever
- BT: bluetongue
- CCHF: Crimean Congo haemorrhagic fever
- CWD: chronic wasting disease
- FMD: foot and mouth disease
- LSD: lumpy skin disease
- PPR: peste des petits ruminants
- RVF: Rift Valley fever
- TiLV: tilapia lake virus
- WNF: West Nile fever

In 2016 and 2017, ProMED sent 3,104 posts relating to infectious animal disease events worldwide, reporting on 195 diseases/syndromes in 159 countries/regions (905 themes). Of those posts, 593 were related to events that occurred in Europe, with 64 diseases/syndromes and 44 countries/regions (255 themes) (Table I). In Europe, the diseases for which the most frequent posts were published in 2016–2017 were avian influenza (155 posts, 26.1%), African swine fever (93 posts, 15.7%) and lumpy skin disease (51 posts, 8.6%). This reflects the epidemiological context of 2016–2017. Indeed, several avian influenza viruses circulated in Europe during the study period, some causing major outbreaks, including highly pathogenic H5N8 virus. There were also several major outbreaks of African swine fever which continued to spread through Eastern Europe, affecting Moldova in September 2016 and Romania in July 2017, and lumpy skin disease which spread through the Balkans in 2015–2016. Figure 3 presents the main diseases for which the largest

numbers of ProMED posts were sent regarding events in Europe in 2016–2017.

Table I

Number of themes and reports/posts written, respectively, by the French Epidemic Intelligence System and the Program for Monitoring Emerging Diseases from 1 January 2016 to 31 December 2017

	All events		Events in Europe (% of all events)	
	No. themes	No. reports/posts	No. themes	No. reports/posts
FEIS	44	126	28 (63.6%)	96 (76.2%)
ProMED	905	3,104	255 (28.2%)	593 (19.1%)

FEIS: French Epidemic Intelligence System
 ProMED: Program for Monitoring Emerging Diseases

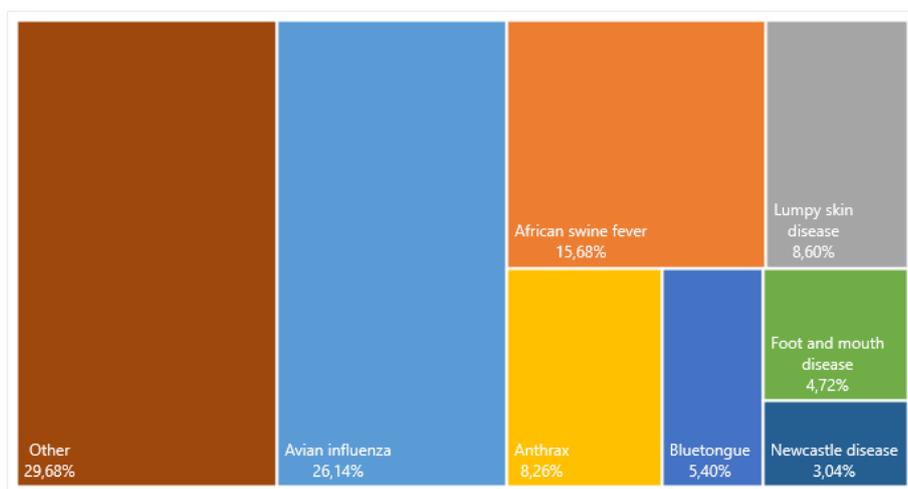


Fig. 3

Graph of the diseases with the most alerts produced by the Program for Monitoring Emerging Diseases concerning events that occurred in Europe from 1 January 2016 to 31 December 2017

For events that occurred in Europe, the FEIS produced a report for 52.6% of the 255 ProMED themes (Table II). The ProMED themes for which the FEIS did not produce a report were either about:

- i)* diseases that were already present in France (and therefore out of the scope of the FEIS) (31.4% of themes)
- ii)* events for which the risk of introduction into France was considered low or negligible (14.1%) or
- iii)* events for which the economic and societal impact would be low or negligible (2.0%).

Table II

Analysis of Program for Monitoring Emerging Diseases themes and posts according to whether a French Epidemic Intelligence System report was produced or not (with the reason why not)

	ProMED themes		ProMED posts	
	No.	%	No.	%
FEIS report written	134	52.6%	414	62.3%
Disease already present in France	80	31.4%	165	24.8%
No FEIS report				
Risk of introduction of the disease into France considered low or negligible	36	14.1%	81	12.2%
Economic and societal impact of the pathogen considered low or negligible	5	2.0%	5	0.8%

FEIS: French Epidemic Intelligence System
ProMED: Program for Monitoring Emerging Diseases

Discussion

The objective of this study was to analyse the coverage of the FEIS expert network and to compare FEIS reports with ProMED posts published from 1 January 2016 to 31 December 2017. The coverage of

the FEIS network was analysed in relation to the 53 category 1 health hazards identified as priority diseases for France. Themes (disease and country) were extracted for each FEIS report and ProMED post to compare the health-related events covered by each epidemic intelligence system.

Coverage of the French Epidemic Intelligence System's network and monitoring of the global epidemiological context

The FEIS expert network *in extenso* covers all 53 category 1 health hazards identified for France, which is a good indicator of the performance of the system.

From 1 January 2016 to 31 December 2017, the FEIS produced a report for 52.6% of ProMED themes related to events in Europe. For the remaining European ProMED themes, the situation did not call for the FEIS to write a report, i.e. the disease was already present in France, the risk of introduction into France was low or negligible due to the nature of the pathogen involved, or the introduction of the pathogen would have low or negligible economic and societal impacts. This means that the FEIS was efficient enough to detect, analyse and report on health hazards when needed, i.e. if the threat needed to be analysed and reported to health authorities and stakeholders. It is important to note that, regardless of whether a report is written or not, the FEIS analyses all collected information concerning animal health-related events. Therefore, the themes covered by FEIS reports reflect only a portion of all signals analysed.

The events mentioned in ProMED posts or FEIS reports strongly depend on the global epidemiological context (new and ongoing outbreaks). If there is an outbreak of a specific disease, it is more likely that one or more posts or reports will be written on this subject. The epidemiological context therefore defines which diseases, countries and, in turn, themes are covered by ProMED or the FEIS.

Epidemic intelligence at national vs international level

By monitoring animal health risks for France at the international level, the FEIS is also monitoring animal health threats for Europe in a broader sense. Therefore, the information provided by the FEIS to French authorities can in turn be useful for other health agencies or professionals in Europe and worldwide.

Several papers have discussed the importance of both international and national surveillance (22, 23), but few discuss the added value of international disease surveillance done at national level, i.e. for a specific country's needs. Like ProMED, other international agencies have set up epidemic intelligence systems to monitor and report a wide range of health events worldwide, such as the OIE, the FAO, the ECDC and the World Health Organization (WHO). However, these supranational systems cannot meet the specific needs of individual countries, which vary depending on each country's context and strategies (3). To provide a system tailored to the needs of French authorities and stakeholders, the FEIS filters the available information on animal health events worldwide, for instance in terms of priority diseases or potential risk of introduction into France and beyond in the European Union, in order to communicate only essential information. In addition, the FEIS provides verified and interpreted information by contextualising the event with the help of its network of experts. This rapid interpretation of the event, without going further into risk analysis, provides decision-makers with timely and easily understandable information, allowing rapid action such as implementation of control or prevention measures. This extra layer of analysis and contextualisation justifies the use of many different information sources other than ProMED and emphasises the role of the FEIS in documentation, in addition to an alerting system.

Strengthening epidemic intelligence activities through tool development and a One Health approach

The FEIS is still expanding, given its recent implementation, and is considering development prospects such as widening its geographical scope by including the Pacific region or integrating other health-

related issues in its monitoring activities, such as antimicrobial resistance (AMR). Indeed, the emergence of AMR among many different pathogens has significantly increased and spread over the past decades (6). The FEIS is also strengthening its ties with regional epidemic intelligence networks such as the Caribbean animal health network (CaribVet) and the public health surveillance, alert and response network SEGA (*Surveillance Épidémiologique et Gestion d'Alertes*) One Health in the Indian Ocean (24, 25).

The future will bring several challenges to epidemic intelligence activities with the expanding era of big data and the development of new technologies. The FEIS and its partners have developed automatic tools for data collection, analysis and visualisation in order to integrate automatic processes into daily epidemic intelligence activities. The platform for automatic extraction of disease information from the web (PADI-web) is a data collection tool developed to identify, collect and extract information from online media reports about health-related events (26). Another example of tool development is a spread rate model that estimates the velocity of spread of a disease through an area using the date and geographical coordinates of outbreak occurrences (19). Nevertheless, epidemic intelligence is a complex and time-consuming process, based on formalised protocols from detection of signals to communication (12). Significant resources need to be dedicated, despite the use of automated tools, in order to ensure the efficiency of the system in providing quality information in real-time (23).

Given the animal origin of many emerging infectious diseases and the increasing interactions between animal and human populations, there is a strong need for the exchange of animal and human data to better detect, manage and prevent the spread of diseases at national, European and global level (27, 28). The FEIS can further integrate a One Health approach by strengthening existing collaborations with public health agencies and other national or international agencies involved in epidemic intelligence (e.g. WHO, ECDC) through the sharing of information, expertise and/or tools.

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