Original Articles

Surveillance report

Syndromic surveillance based on emergency department activity and crude mortality: two examples

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Recent public health crises have shown the need for readily available information allowing proper management by decision-makers. One way of obtaining early information is to involve data providers who already record routine data for their own use.
We describe here the results of a pilot network carried out by the InVS (Institut national de veille sanitaire) which gathered data available in real time from hospital emergency departments and register offices.
Emergency departments data were registered from patients' computerised medical files. Mortality data were received from the national institute of statistics (Insee). Data were transmitted automatically on a daily basis. Influenza data from outbreaks in 2004/05 and 2005/06 were compared with data from the sentinel network for the same periods. Environmental health data were compared with meteorological temperatures recorded in Paris between June and August 2006. A mortality analysis was conducted on a weekly basis.
Correlation between influenza data from emergency departments and data from Sentiweb (sentinel network) was significant ($p<0.001$) for both outbreaks. In 2005 and 2006, the outbreaks were described similarly by both sources with identification of the start of the outbreaks by both systems during the same weeks. As for data related to heat, a significant correlation was observed between some diagnoses and temperature increases. For both types of phenomena, mortality increased significantly with one to two weeks lag.
To our knowledge, this is the first time that a study using real time morbidity and mortality data is conducted. These initial results show how these data complement each other and how their simultaneous analysis in real time makes it possible to quickly measure the impact of a phenomenon.

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Introduction

The social and political impacts of health events are essential parameters to take into account in health surveillance [1]. Recent health events such as the European heat wave of 2003 and widespread outbreaks of chikungunya, emphasise the need to provide information to health authorities to help with decision making [2]. One of the possibilities for obtaining early information is to involve physicians and others relevant data providers who record routine data for their own use, which can be transmitted automatically and daily [3, 4]. The French national institute for public health surveillance (Institut de Veille Sanitaire, InVS) initiated a pilot network in July 2004, gathering different sources of data available in real time from hospital emergency departments, registry offices, emergency general practitioners (a service known in France as 'SOS médecins'). This article presents an evaluation of this surveillance based on emergency departments and mortality recording from registry offices for influenza outbreaks (2005 and 2006) and health impact of the 2006 heat wave.

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Material and method

Description of the network

Emergency Departments (ED)

Data were collected directly from patients' computerised medical files filled in during medical consultations. Selected hospitals use appropriate software. Two architectures for gathering data were used. The first was based on a regional server in Ile-de-France (Paris area) developed by regional health authorities. This server centralises data from hospitals in the area, which are then transferred to InVS. The second data gathering method consists of a direct connection between hospitals and the central server at InVS.

Mortality recordings

The national institute for statistics (Institut National de la Statistique et des Études Économiques, Insee) is responsible for the administrative recording of deaths from all causes in France. For several years, Insee has managed a system for recording and centralising daily mortality. Data processing was near real time. Data from 1152 cities were transmitted daily to InVS.

Variables

Items collected included the diagnosis coded according to ICD-10, with a score of severity ranked from 1 to 5 after medical examination, the date of admission to hospital, age, sex, post code, and the chief complaint. For mortality, only data on age, sex, and date and city of death were available.

Each patient or death corresponded to a single recording, including all variables.

Data transmission and processing

Data were transmitted encrypted to InVS over the internet using file transfer protocol (FTP), seven days a week. Computer assisted extraction and transmission were performed using specific programmes. These data were then included in a database, using SAS programmes.

For hospitals, each file transmitted to InVS included all patient visits to the emergency department logged during the previous 24-hour period (midnight to midnight). Data were sent according to the hospitals between 4 am and 6 am. They were transmitted twice, at day +1 (temporary file) and day +2. This double sending allowed the files already transmitted to be supplemented; the second file automatically superseded the first one.

Mortality data were transmitted daily and the file included deaths recorded for the last 30 days.

Data analysis

The study covered the period from July 2004 to the end of July 2006.

Hospitals

We analysed data categorised by week, for the Paris area, in relation to influenza outbreaks (2005 and 2006), measured through emergency departments (ICD-10:J10 / J11) compared to data from the Réseau Sentinelles (sentinel network) which is the reference for studying influenza in France [5]. A correlation coefficient was performed between the two datasets. We completed a daily analysis of a number of influenza diagnoses done in emergency departments with the Cusum method developed by the United States Centers for Disease Control and Prevention (CDC) within the framework of the EARS“ programme (Early Aberration Reporting System) (6). This allowed us to define the first days of alert for influenza compared to onsets published by SentiWeb.

To monitor the health impact of hot weather, we defined an indicator as follows: total number of daily cases of three pathologies linked to high temperatures (hyperthermia, dehydratation and hyponatraemia). The study was focused on the Paris area and data were correlated to daily temperatures measured in Paris from June to August 2006 by Météo France® (the French meterological office). Results were compared with the official periods of alert launched by the French Ministry of Health (MoH).

Mortality

All-causes mortality analyses were conducted on a weekly basis. The analysis was based on the method of historical means, adapted from the CDC and used to monitor infectious diseases [7,8]. For each week, the expected number (historical mean) of deaths corresponded to the mean of 3 weeks (comparable, previous, and next weeks) for the past 5 years. The ratios were computed as 1, plus or minus 2(SD/X), (SD=standard deviation and X=mean of the 15 considered weeks). When the ratio is outside the thresholds, the elevated (or diminished) portion of the ratio is significant.

An alert was defined as a threshold-crossing by ratio. The EARS® programme was run on a daily basis for the whole period.

Results

Hospitals

Overall, 46 emergency departments participated in the study. Thirty one were within Paris area and 15 in other regions, including one overseas territory in the Indian Ocean (Saint Denis-Reunion Island). Over the monitoring period, 3.2 million visits were recorded with an average of 4024 visits per day including 980 paediatric visits (< 15) (+/- 25.3%), 2668 adult visits (+/- 15.1%), and 377 visits (+/- 16.7%) to people above 75 years. The medical diagnosis was missing from 26% of records, and the chief complaint from 12% of records. The severity score was missing in 17% of cases, and data on sex and age were missing in less than 1%. Fifty four percent of patients were male and 46% female (P<0.001).

Figure 1 shows the relationship between data from emergency departments and the Réseau Sentinelles. The two curves were similar, with a coefficient of correlation of 0.94 (P<0.001). The scales were different but data from both sources followed a similar kinetic. The outbreak started in week 3 of 2005, followed by a dramatic increase 3 weeks later. Peaks were reached in week 7 of 2005 and then decreased for 4 weeks. In the 2006 influenza outbreak, although curves were very similar, there were some differences. The emergency department influenza visit curve was above the Réseau Sentinelles from week 45 of 2005 to week 5 of 2006. A gap was observed in week 7 of 2006 with Réseau Sentinelles data and appeared a week later with emergency department data. A peak was shown by the Réseau Sentinelles in week 9 of 2006 but not by emergency departments. Subsequently, an abrupt fall was described by both sources.

For both outbreaks, EARS® programme was run on a daily basis. In 2005, the first alerts were detected on 16 January 2005 (positive for C1, C2 and C3 methods), which corresponded to week 3, the first week of the influenza outbreak onset this season (9). During the following outbreak, alerts were detected on 29 and 30 January and on 1, 2 and 3 February (positive for C2 and C3) which corresponded to week 5, the first week of the 2006 outbreak [10].

Regarding the health impact of the 2006 heat wave, the indicator showed three peaks [FIGURE 2]. The first one was on 19 June, the second on 3 and 4 July. The first two peaks were correlated with increased temperatures. The third peak lasted longer (starting 18 July

FIGURE 1

Weekly evolution of number of influenza diagnosis in emergency departments (ED) and number of influenza diagnosis (extrapolated) from the Réseau Sentinelles – Paris area, seasons 2004/05 – 2005/06

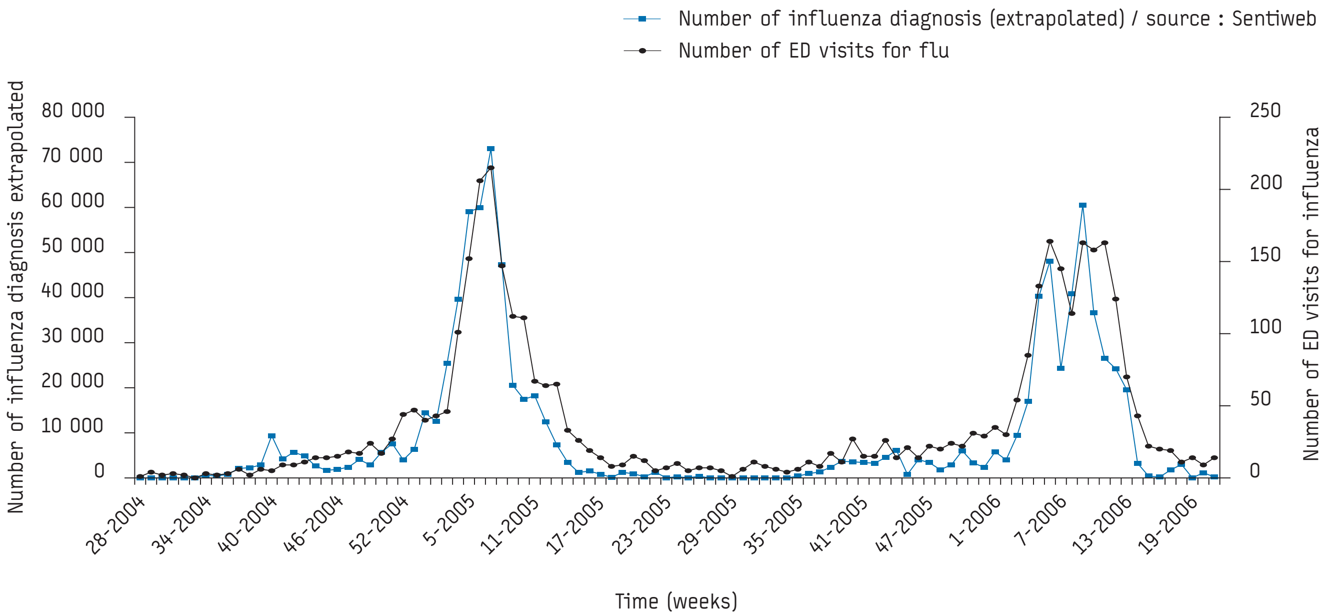


FIGURE 2

Daily evolution of the health impact hot weather indicator, temperature and days of alert (MoH and EARS) – Paris area, June to August 2006

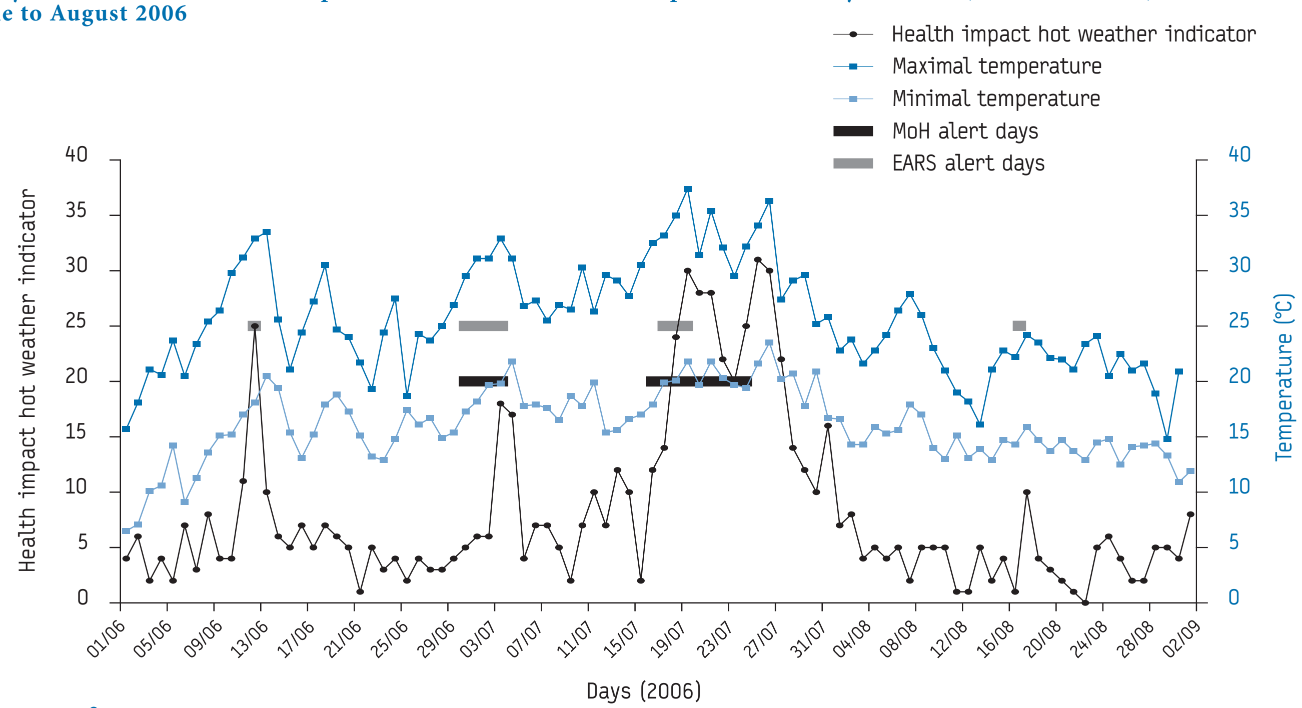
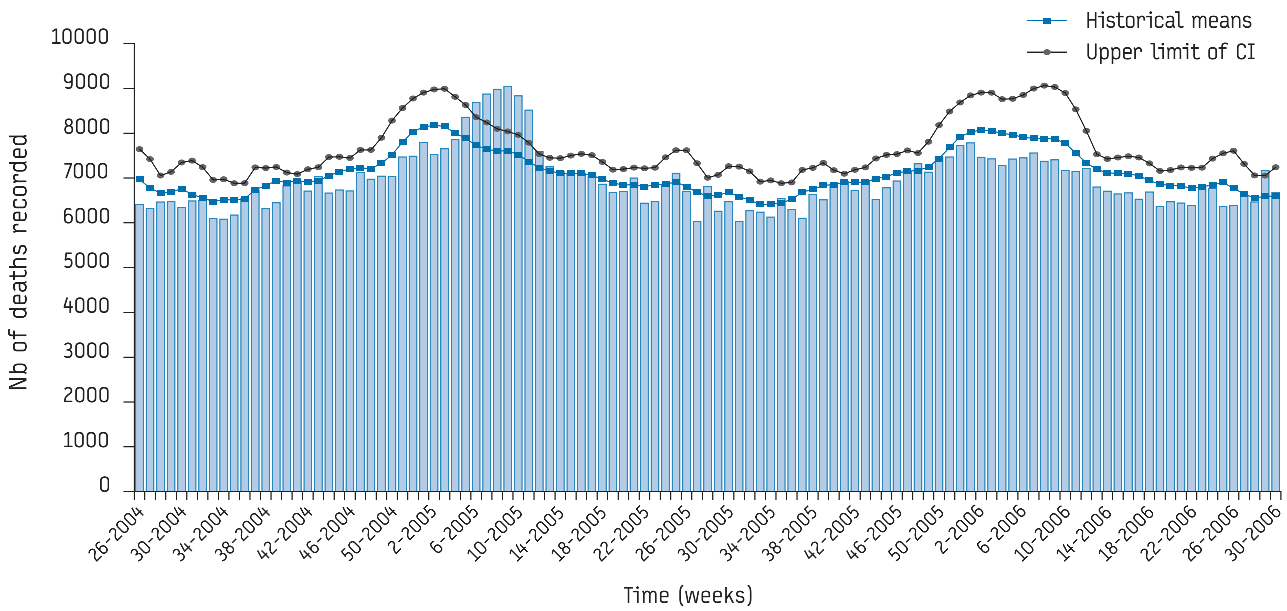


FIGURE 3

National mortality surveillance - weekly evolution of deaths recorded, France, June 2004-July 2006



and continuing for nearly 10 days) and was on a large scale. Between 21 and 23 July, the indicator fell by 35.7%, while temperature rapidly decreased. Coefficients of correlation between indicator and daily temperatures were significant (0.67 ($P<0.001$) for maximal and 0.72 ($P<0.001$) for minimal). The EARS® analysis showed one alert in June (11 and 12 June), two in July (1 to 4 and 18 to 20 July) and one in August (17 August). During this period, the MoH launched two alerts: 1-4 and 17-25 July.

Mortality

Since the beginning of the study more than 560 000 deaths were recorded. Out of these deaths, 53% were male and 47% were female ($P< 0.001$), representing nearly 1000 deaths per day and two thirds of the French daily mortality. For any given day, 50% of data were recovered within a period of 3 days, 90% within a period of 7 days and 95% within a period of 10 days.

At the national level, the mortality exceeded the alarm threshold during a 7 weeks time interval (week 6 to week 12 in 2005) and week 29 in July 2006 for the entire period. No other threshold-crossing was identified [FIGURES 3, 4].

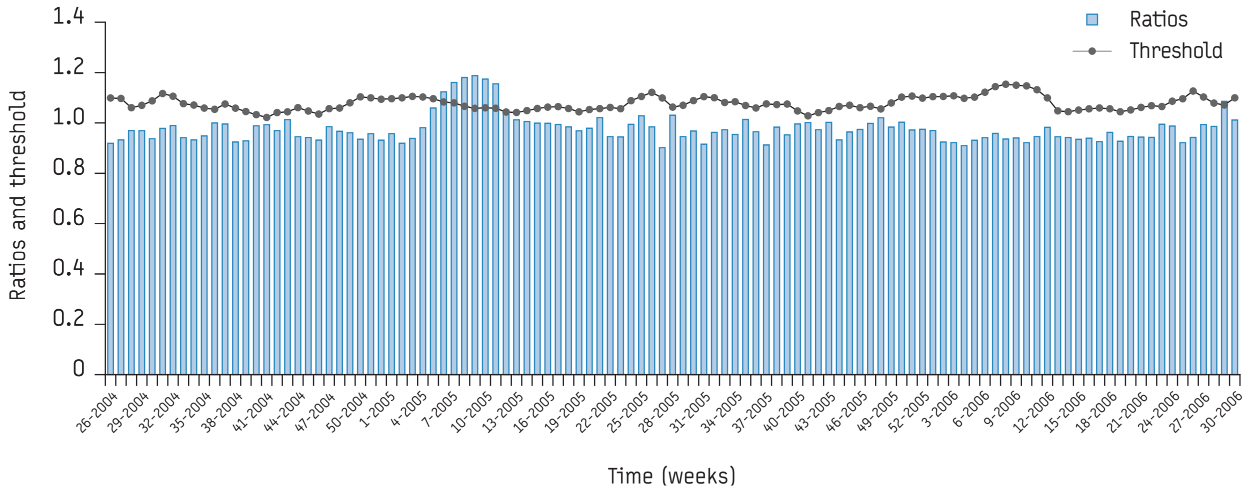
Discussion

At this point, networks represent nearly 10% of emergency department visits in France, and around 66% of the daily mortality.

Among various syndromic surveillance systems tested, none was associated to two matched data sources in real time (emergency department visits, crude mortality) [11]. Our first results illustrate the sensitivity of the system for evaluating the health impact of

Figure 4

National mortality surveillance - Method of historical means. Two years of follow up, 2004-06, France



known events or detecting a public health threat by its health impact [12]. Consequently, each emergency department or registry office can be used to capture information, each patient or death being a source of information [13]. For example, our system contributed to measure the crude mortality during the chikungunya outbreak in Reunion in 2005, with no effort expended by the data providers [14]. In 2003. the monitoring and analysis of the impact of the heat wave was made possible thanks to the efforts of both data providers and epidemiologists, and the situation could be understood only after several weeks [15].

Moreover, the processing for data collection in real time frees the data collection from one of the major difficulties for health surveillance: the reporting delay, which can distort the true picture [16].

The lack of 26% of key information (medical diagnosis) can be explained in two ways: some patients leave emergency departments before a diagnosis is made (discharge without medical staff authorisation), and others, for whom no diagnosis was established, are kept in hospitals for further medical examination; and two hospitals consistently failed to fill in the diagnosis section of the forms provided. A positive trend of this percentage has been observed compared to July 2004, when around 40% of this information was missing, Whatever the rate of missing information, the medical diagnosis coded in ICD-10 is preferably used than the one based on chief complaint because of its greater reliability.

Similarity between influenza data based on ED and data from the Réseau Sentinelle on a weekly basis was confirmed by the EARS® results. For both outbreaks, the first alerts detected corresponded to the week of the official onset of these outbreaks.

The correlation between our 'health impact hot weather' indicator and temperatures showed that emergency departments are a very relevant source of information for environmental health impact surveillance. We identified a period of alert in June whereas the MoH did not. In July, two alert periods were identified: the first one on the same day as the MoH did (1 July 2006) and the second one on 18 July i.e. one day after the MoH. It is more likely that the August alert detected only by EARS® analysis was an artefact considering that temperatures were very low.

These validations with two different kinds of disease (infectious and environmental) allow us to use this data to monitor other infectious diseases and health impacts of environmental conditions. Furthermore, its non-specific character made it interesting as a routine surveillance tool, because it detects less common or emerging diseases [17].

As for mortality, each different threshold-crossing detected corresponded to widely recognised phenomena (2005 influenza outbreak, 2006 heat wave).

Interestingly, no mortality increase appeared to correspond with the very small influenza outbreak in the winter of 2005/2006, and during the period monitored, no health threat with potential impact (infectious or environmental) on mortality was identified [18].

These three facts demonstrate the interest of this mortality surveillance.

With the implementation of this new surveillance system of all-cause mortality, we have demonstrated the availability of mortality data in real time and thus that health impacts of events are becoming quantifiable in real time. Few systems currently use crude mortality data for health surveillance in real time, which makes our approach original [19, 20].

This is the first experiment of its kind with syndromic surveillance in France. The usefulness of emergency departments data for surveillance had previously been validated by other international experiences. Here, we corroborate those previous findings in the context of the French healthcare system and also demonstrate the interest of ongoing surveillance of crude mortality. The complementarity of the two data sources, emergency departments and registry offices, is relevant. In the case of influenza and hot weather, we first observed an effect on morbidity, followed the week after by an effect on mortality. Progress is now needed to develop national coverage of the system, so that it can be efficient in all regions.

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Original Articles

Surveillance report

Surveillance of ambulance dispatch data as a tool for early warning

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Early detection of disease outbreaks is essential for authorities to initiate and conduct an appropriate response. A need for an outbreak detection that monitored data predating laboratory confirmations was identified, which prompted the establishment of a novel symptom surveillance system.

The surveillance system monitors approximately 80% of the Danish population by applying an outbreak detection algorithm to ambulance dispatch data. The system also monitors both regional and national activity and has a built-in, switch-on capacity for implementing symptom surveillance reporting in case of an alert.

In an evaluation with outbreak scenarios it was found that decreasing the outbreak detection sensitivity from a prediction limit of 95% to one of 99% moderately reduced the time to detection, but considerably diminished the number of false alerts.

The system was able to detect an increased activity of influenza-like illness in December 2003 in a timely fashion. The system has now been implemented in the national disease surveillance programme.

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Key words: Ambulance, bioterrorism, outbreak surveillance, statistical data analysis.

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Introduction

New infectious threats such as SARS and human H5N1 infections have necessitated detection systems that respond in a timely way to emerging epidemics, allowing authorities to respond at the earliest possible stage. Worldwide developments concerning biological weapons and terrorism were an additional driving force for improving public health surveillance and outbreak response. In case of a covert attack with biological agents the impact is likely to be multinational due to extensive land, sea and air transport. Several terrorist organisations have publicly stated their intent to use unconventional weapons including biological and chemical agents and the risk of an attack therefore is generally considered as credible.

A number of diagnostic-based disease surveillance systems already operate in Denmark, including a sentinel surveillance scheme for influenza and influenza-like illness and a detection system for outbreaks of gastrointestinal illness such as salmonellosis. These surveillance systems are disease specific and do not serve as indicators of disease of unknown origin, including emerging diseases. Furthermore, the delays between outbreak, confirmed laboratory diagnosis, collection and analysis of results, and, eventually, notification of the authorities have in the past resulted in impediments for implementing countermeasures. Unfortunately only a minority of the established disease surveillance systems in Denmark had a capability for regional surveillance. If implemented, it could improve sensitivity in symptoms surveillance and direct diagnostic investigation to a predefined area.

Given this background, our aim was to develop a disease detection system that had the capacity to react promptly following an outbreak