

The emergency visit-based syndromic surveillance of the Lazio region. Results of the pilot phase

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Abstract

Introduction: Syndromic surveillance arose from the need for rapid identification of unexpected clusters of a disease. The emergency department is considered one of the most sensitive and timely sources of information for syndromic surveillance.

Methods: This paper reports the results of the pilot phase (4 months) of an Emergency-based syndromic surveillance system in the Lazio region (5.5 million inhabitants), which aimed to monitor in real time the occurrence of clusters of 13 different syndromes. It collected information online from 34 of the 61 emergency departments in the region. Diagnoses and chief complaints of individual emergency visits were automatically screened daily, the occurrence of clusters were measured comparing the number of visits for the same syndrome with those from the same calendar week from the previous five years; an epidemiology team checks the clusters manually before determining if an alarm should be called.

Results: 500.000 ER visits occurred in the study period, and 15.343 fulfilled one of the case criteria. The most frequent syndrome was gastroenteritis (5051 cases), the least frequent was hemorrhagic diarrhoea (2 cases). There were 253 automatically generated alarms and 17 were confirmed manually as suspected outbreaks. In the same period, the infectious disease surveillance identified 55 outbreaks of infectious diseases; only two clusters were reported by both surveillance systems.

Conclusions: the predicted increase in workload is one more outbreak to be investigated every four months per local health unit. The next step will be to test protocols for the activation of the public health services following an alarm.

Key words: Syndromic surveillance; Emergency; Infectious disease reporting; outbreaks

Introduction

Syndromic surveillance (SS) arose from the need for rapid identification of unexpected clusters of a disease [1-2]. To be useful and efficient an SS must be sensitive and timely, but cannot lose too much specificity to be sustainable in terms of false positive alarms.

It is difficult to validate this kind of surveillance in the field since most of the outbreaks we are looking for are rare or virtually absent, i.e. bioterrorism, flu pandemic etc. [3]. The system must be validated by process indicators or measure the ability to detect some more common clusters (like foodborne disease or meningitis).

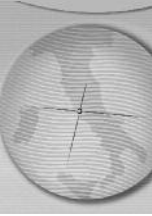
The published SS studies are mostly limited in time [4-5], i.e. during specific events; few organizations have tried to establish a continuous surveillance system, mostly because it is

expensive, time consuming and not well accepted by the health professionals involved.

The emergency department is considered the most sensitive and timely source of information for syndromic surveillance [6], even though it is a very critical setting where introducing additional non-critical administrative tasks may produce negative consequences and not be well-accepted by physicians and nurses.

In the Lazio region there is an Emergency Information System that records daily all admissions from most of the region's emergency departments. This on-line network of emergency departments (ED) was a unique opportunity to build-up a fully automated, permanent and continuous SS.

The aim of this paper is to describe the activity and the results of the four-month experimental



phase of the Lazio SS. We will address the following questions: is it feasible? Is it well accepted by the emergency professionals? Is it useful, i.e. does it add something to the existing infectious disease surveillance?

Methods

Setting and source of information

The Lazio region, about 5.5 million inhabitants, is the region of central Italy that includes Rome (3 million inhabitants).

The syndromic surveillance system of the Lazio region is based on the Emergency Information System (EIS). The information on which it relies and how the information is collected has been described elsewhere [7] (Figure 1). Briefly the EIS collects all the admissions from all 61 EDs in the region, each ED admission record reports personal data (patient name, date and place of birth), information collected at triage (the urgency of the case, the chief complaint grouped into 15 categories, few vital parameters only for very urgent cases), up to five diagnoses (coded according to ICD-9-CM), up to five therapeutic procedures (coded according to ICD-9-CM), the

outcome of the admission (hospitalisation, death, transfer or discharge); some records also include a free-text diagnosis.

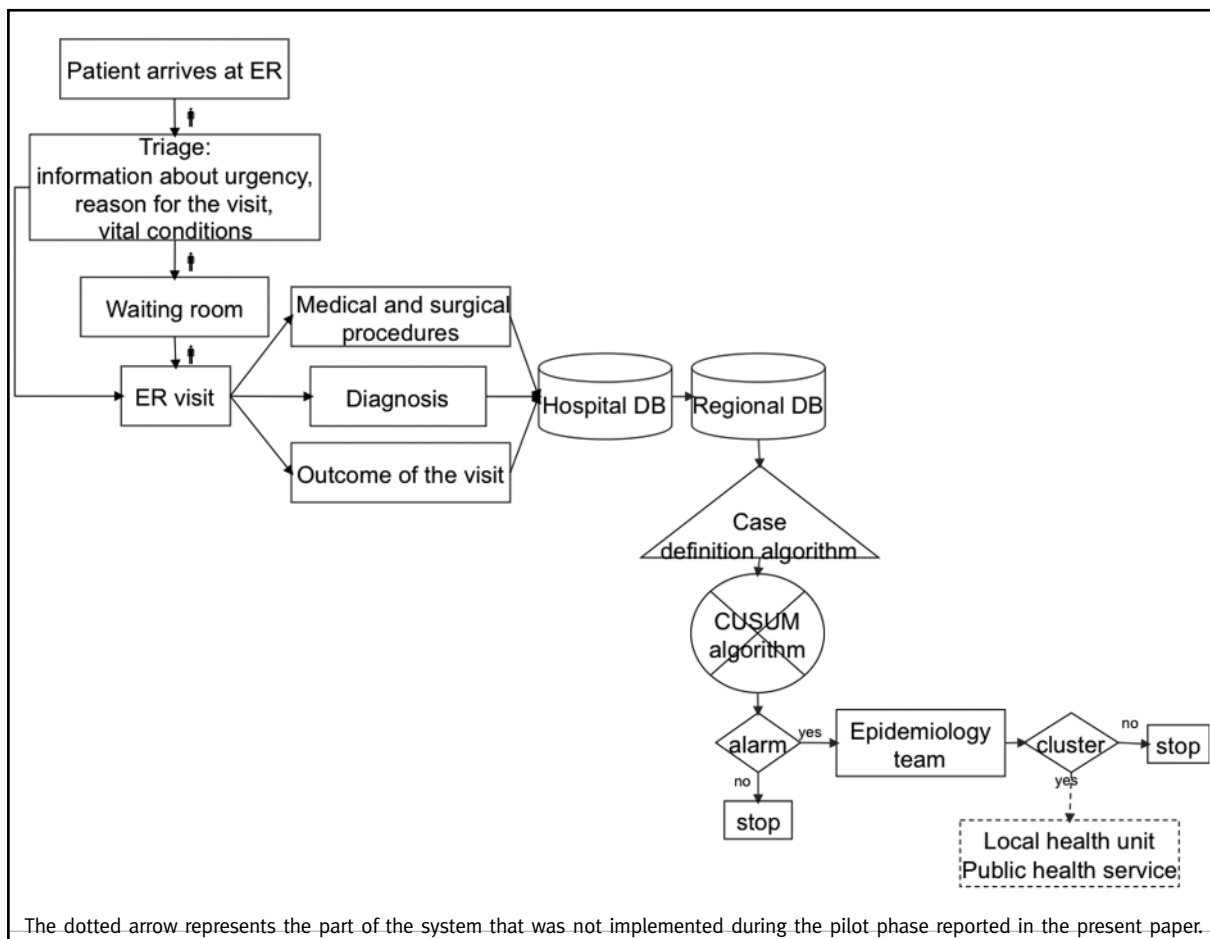
Thirty of the 61 EDs during the pilot phase reported here, transferred all their data for the EIS to the regional level in real-time. These emergency departments are included in the syndromic surveillance.

Syndromes surveyed

The Prevention Task Force of the Italian Ministry of Health (CCM), together with the Ministry of Defence, defined 13 syndromes of interest [5]:

- Respiratory infection with fever [4]
- Gastroenteritis (diarrhoea, vomiting), without blood [4-5]
- Hemorrhagic diarrhoea [4]
- Febrile illness with rash [4]
- Lymphadenitis with fever [4]
- Meningitis, encephalitis, or unexplained acute encephalopathy [4]
- Suspected viral hepatitis (acute) [4]
- Hemorrhagic illness [8-9]
- Botulism-like syndrome [4]
- Localized cutaneous lesion [8-9]

Figure 1. Flow chart of the syndromic surveillance in Lazio region.



- Sepsis or unexplained shock [4]
- Comatose status [5]
- Unexplained death with history of fever [4-5]

The surveillance is based on a fully automatic routine search for cases among ER visits. The case definitions are based on the information collected at triage (i.e. the first patient/nurse contact where the following data are collected: up to three reasons for the ER visit, some vital parameters, and treatment priority); the final diagnoses of the visit (five at most), and the outcome of the visit.

Alarm thresholds

The alarm thresholds were calculated according to the following algorithm:

$$St_{ijk} = (Xt_{ijk} - (\mu_{ijk} + \alpha \sigma_{ijk})) / \sigma_{ijk}$$

Where:

St is the actual value of the test variable, for the i^{th} ED (i varying from 1 to 30), the j^{th} syndrome (j varying from 1 to 13) and the k^{th} week (k varying from 1 to 14).

Xt_{ijk} are the observed cases from the beginning of the current week, in each Emergency Department for each syndrome,

μ_{ijk} is the mean number of cases observed in the 5 previous years calculated for each week in each Emergency Department for each syndrome,

σ_{ijk} is the standard deviation according to a Poisson distribution (i.e. the square root of the mean) calculated for each week in each Emergency Department for each syndrome,

α is the mean variation parameter, set at 2. The value was defined according to literature data [10] and to the number of alarms observed in a test on retrospective data.

An alarm is given if $St \geq 1$ AND if the number of observed cases is > 1 .

Although a test was performed for each syndrome and each ED every day, actually the comparison was weekly; in fact the observed number of cases from the beginning of the week are compared with the expected number based on the mean number of cases observed during the same week in the previous five years. Consequently the comparison is complete (7 days vs 7 days) only at the end of the week, but an alarm is given when the test variable reaches 1, regardless of when that occurs.

The automatic e-mail system and the analysis of the clusters by the epidemiology team

Every morning an automatic e-mail system sent messages for every single cluster of cases to all members of the central epidemiology team, composed of a public health medical physician, an

epidemiologist, a statistician and an information technology expert, and to the principal project investigator and scientific director of the Agency of Public Health. The e-mail listed the number of cases per day over the last seven days and the average number of cases reported in previous years in the same week for each of the 13 syndromes. The epidemiology team worked six days a week.

The clusters were initially analysed for the time and spatial distribution of cases (in particular looking for similar clusters in the closest EDs). Then we checked if the patients' characteristics, age, gender and residence had some particular distribution. We checked the consistency of triage and outcome of the visit with the suspected syndrome. If additional information was required, we checked the secondary diagnoses, the ED visit procedures, and any previous hospitalizations (from the hospital database). In many cases the presence of chronic conditions explained some of the cases, eliminating the suspected cluster. For a limited number of cases, we could check the free-text diagnosis. This variable was also used to identify clusters.

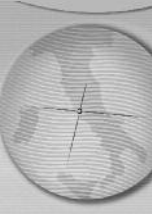
The clusters that remained after these procedures were classified as suspected outbreaks. When the surveillance is fully operational the Local Public Health Unit will be notified of suspected outbreaks, to start an epidemiologic field investigation. During this experimental phase we did not notify public health services.

Link with the mandatory infectious disease notification system (NDS)

The mandatory NDS system collects reports of acute infectious diseases theoretically from all physicians who report a diagnosis of infectious disease, according to a national law that requires case notification to the Local Health Unit [11], suspected outbreaks of any infectious disease should be reported immediately. The NDS was searched for the suspected outbreaks. Outbreaks not reported by the NDS were considered to be the contribution of the SS. We also compared the timeliness of the two systems measuring the delay from symptoms onset to notification as reported in the NDS reports; the delay was compared with the maximum delay permitted by our algorithm, i.e. 7 days.

Results

During the study period the missing values for the variables used in the operational case definition were: 1.8% for the principal diagnosis,



0.01% for the outcome of the visit, 0.5% for the chief complaint; while only 7.0% reported the exact body temperature and 3.6% reported at least one secondary diagnosis.

Out of 500,000 ER visits that occurred between February and June 2007, 15,343 fulfilled one of the case definitions. The most frequent syndrome was gastroenteritis (5051), followed by respiratory syndrome with fever (4664) and skin lesions (2036), the least frequent syndrome was hemorrhagic diarrhoea (2). All but one (hemorrhagic diarrhoea) of the syndromes gave at least one alarm, but there were suspected outbreaks of only three syndromes (2 meningitis, 6 gastroenteric and 9 fever with rash) (table 1).

The overall positive predictive value for a suspected cluster (as judged by the epidemiology team) was 6.7%. In the future these clusters will be communicated to the local public health services, but that was not done since this was the pilot stage of the surveillance, therefore we cannot say how many would have been confirmed outbreaks.

In the same period the NDS identified 55 outbreaks of infectious diseases; in particular, 9 foodborne disease outbreaks, 24 varicella, 5 measles and 3 scarlet fever outbreaks occurred (table 2). None of the 6 suspected gastroenteritis clusters had similar dates of onset or location reported to the NDS; no outbreaks of neurological disease were reported to the NDS; two clusters of rash with fever had the same date of onset and occurred in the same geographical area of two varicella outbreaks reported to the NDS.

Despite the fact that outbreak notification is

mandatory within 12 hours of the suspected epidemic, the mean delay between symptom presentation and notification to the local level was 30.4 days (median 6 days) and 38.4 days to the central (regional) level (median 14); specifically, the average delays for notification of foodborne outbreaks were 3.8 days (median 2 days) and mean 5.9 (median 3 days) to the local and regional levels, respectively; while the average delays in the notification of outbreaks of disease with exanthema were 29.9 days (median 6) and 37.6 days (median 13.5), to the local and regional levels, respectively.

The time delay from the ED visit to e-mail notification to the regional SS is, by definition, between 1 and 6 days, depending on the slope of the ascending part of the epidemic curve. We do not know the time lag from symptom onset.

Discussion

The international literature reports several experiences of ED-based syndromic surveillance, and most of them were designed to monitor special events, like the winter Olympic Games in the Turin experience [5], and consequently were limited to a short time period making the criteria for their feasibility substantially different. On the other hand, there are few reported surveillances designed to be permanent [12]. Furthermore, for most ED-based syndromic surveillance the case definitions rely only, or mainly, on the chief complaints. Regarding this point our system is one of the few that built its case definitions on a ICD-9-CM coded diagnosis and on chief complaints [12].

Table 1. Results of the emergency-visit based syndromic surveillance in the Lazio region, Feb 2007 – June 2007.

Syndrome	Weeks of surveillance	Visits fulfilling case definition	Weeks of alarm	Clusters confirmed by the epidemiology team
Fever and respiratory symptoms	420	4664	47	0
Localized cutaneous lesion	420	2036	40	0
Neurological syndrome	420	613	34	2
Haemorrhagic illness	420	758	32	0
Gastroenteritis without blood	420	5051	24	9
Botulism-like illness	420	689	18	0
Acute onset jaundice	420	336	17	0
Acute coma	420	194	12	0
Fever and rash	420	831	11	6
Sepsis or unexplained shock	420	69	10	0
Lymphadenitis with fever	420	67	5	0
Unexplained death	420	33	3	0
Gastroenteritis with blood	420	2	0	0
Total	5460	15343	253	17

Table 2. Outbreaks reported to the National Infectious disease Surveillance in the period February 26, 2007 to June 3, 2007, Lazio.

Type of outbreak	community	N outbreaks	N cases	Attack rate x 100 (*)
Infectious diarrhoea	Household	1	2	66,7
Rotavirus	Hospital	1	3	
Viral hepatitis A	Household	1	2	66,7
Micobacteriosis (not TB)	Hospital	1	2	
Measles	Other	1	10	
	nomadic community	1	2	
	Household	3	6	
Pediculosis	School	6	24	16,9
Scabies	hotel and lodging	1	3	0,6
	Household	2	4	50,0
Scarlet fever	Nursery	1	3	15,0
	Household	1	2	
	Missing information	1	3	
Tinea	Missing information	1	3	
Foodborne	Restaurant	2	11	73,3
	Bar	1	2	
	Household	5	25	80,0
	Cafeteria	1	20	23,8
Varicella	Household	21	45	50,7
	Missing information	2	4	
	School	1	2	
		55		

(*) the attack rate is calculated only for outbreaks with a known number of exposed people in the community.

The automatic alarm system has a low positive predictive value (PPV), but internal manual screening of clusters makes the surveillance sustainable. Only 17 suspected epidemics were identified in 5 months by the epidemiology team, translating to about 3 epidemic alarms for each Local Health Unit in a year.

During the same period the NDS reported 63 outbreaks of infectious diseases. The overlap between the two systems is very small; in fact, only two clusters of varicella were detected by both systems.

We can confirm that the system had been feasible and sustainable at the regional level during this trial phase. Furthermore, during the pilot period emergency department professionals responded to it well, who currently are not actively involved in surveillance. Now 40 EDs are connected and can participate in the surveillance.

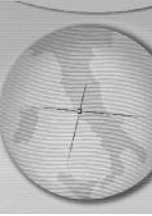
The predicted increase in workload for the public health services officers was relatively small, <25% increase in outbreaks, that is one more outbreak to be investigated every four months per local health unit.

The two systems, NDS and SS, detect different things and in different ways. The outbreaks identified by the SS are, by definition, clusters of more than two cases receiving ED visits,

compared to the mean dimension and severity of the outbreaks notified to the NDS, these can be considered quite relevant. The communication delay, in particular to the regional level, is so long for the NDS that it is impossible to imagine any reaction able to control an outbreak. Unfortunately the efforts to improve the NDS have been discontinuous both at the national and regional level. Foodborne diseases are the exception, probably because there are specific guidelines for outbreak investigation that have improved surveillance [13].

Therefore, in answer to the third question posed in the objectives, is the SS useful? Emergency-based syndromic surveillance does not duplicate the existing NDS, and actually can be used as a tool to improve the NDS.

Finally, it is evident that some syndromes fit the system better than others. Common diseases such as gastroenteritis or exanthematic diseases, where history of the exposure [14], signs and symptoms immediately raise alarm are easier to be detected at the regional as well as at the ED level and can have a reasonable positive predictive value. On the other hand, very rare syndromes with close to zero clusters expected, such as hemorrhagic diarrhoea, where symptoms are not evident and a more precise diagnosis, often based on a simple



laboratory test, is needed, seem to be difficult to monitor; for those rare cases no statistical algorithm is needed and it is reasonable to think that the report of a single case should give an alarm.

We are now working together with public health service professionals to define communication protocols and the epidemiologic field investigation procedures for each syndrome. The next step will be to test the protocols for the activation of the public health services following an alarm: is the additional work for the public health services acceptable? Are the suspected outbreaks identified as true epidemics? In other words, is the surveillance system able to translate information into action?

Limits

This pilot study is aimed to test the feasibility of the system, but does not validate the system itself for several reasons: we used an algorithm derived by the Cusum but this formula and the threshold used were set to produce a reasonable number of alarm per time unit, consequently we cannot consider this study as a validation of the

algorithm. In this study we did not validate the information reported in the EIS and we did not measure the validity of the operational case definition (these will be the goals of other planned studies).

Acknowledgements

We want to thank all the staff from the Emergency Information System whose every day work makes surveillance possible. We also thank Assunta De Luca, coordinator of the Emergency network of the Lazio region, Jessica Mantovani, data manager of the Infectious Disease Information System at the Agency for Public Health and Luisa Sodano, Centre for Disease Control and prevention (CCM) of the Italian Ministry of Health. We thank Margaret Becker for the English editing.

Conflicts of interest and funding

The authors declare they have no conflicts of interest. The project has been financed by the Italian Ministry of Health Centro per il Controllo e la Prevenzione delle Malattie (CCM).

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