MEDINFO 2010
C. Safran et al. (Eds.)
IOS Press, 2010

doi:10.3233/978-1-60750-588-4-442

Improving general practice based epidemiologic surveillance using desktop clients: the French Sentinel Network experience

Clément Turbelin[a,b] and Pierre-Yves Boëlle[b,c]

[a] *UPMC Univ Paris 06, UMR S 707, F-75012 Paris, France*
[b] *INSERM, U707, F-75012 Paris, France*
[c] *AP-HP, Hôpital Saint-Antoine, Paris, F-75012, France*

Abstract

Introduction: Web-based applications are a choice tool for general practice based epidemiological surveillance; however their use may disrupt the general practitioners (GPs) work process. In this article, we propose an alternative approach based on a desktop client application. This was developed for use in the French General Practitioners Sentinel Network. Methods: We developed a java application running as a client on the local GP computer. It allows reporting cases to a central server and provides feedback to the participating GPs. XML was used to describe surveillance protocols and questionnaires as well as instances of case descriptions. An evaluation of the users' feelings was carried out and the impact on the timeliness and completeness of surveillance data was measured. Results: Better integration in the work process was reported, especially when the software was used at the time of consultation. Reports were received more frequently with less missing data. This study highlights the potential of allowing multiple ways of interaction with the surveillance system to increase participation of GPs and the quality of surveillance.

Keywords:
Sentinel surveillance, Software, Communicable diseases

Introduction

The use of computerized information systems is increasingly common in General Practitioners (GP) practices [1]. Such systems may run as local applications on desktop computers and guarantee very quick response time and good integration in the clinical process. This is for example the case with most electronic patient record software. By contrast, other systems are based on interaction with distant servers through web browsers with typical larger response time that may limit integration in everyday's practice.

In the French Sentinel Network (FSN), an electronic epidemiologic surveillance system operating in France since 1984, a web based interface has been the preferred way of interaction since 1996 [2]. The FSN is based on a nationwide network of voluntary GPs who report cases of several conditions, mostly childhood and acute infectious diseases. Estimates of disease incidence are computed from GPs reports and used for public health decision making.

The satisfaction surveys of GPs participating in the surveillance alerted us to the fact that interaction with the website could be a limitation to the doctors' persistence in surveillance. Indeed, with this system, GPs must periodically log in to a secure web site and report cases using a dedicated interface (see Figure 1). This process is difficult to perform during consultation, and leads to delays in reporting. As public health decision makers are increasingly expecting near real time reporting and analysis of data [3-4], it is relevant to try and integrate the surveillance process more directly in the GP clinical process, so that cases may be reported almost in real time.

In this article, we describe how we redesigned the electronic web based surveillance system for better integration into the GPs work process, using a java-coded application run as a client on the local GP computer. While making case reporting easier to the GP, the solution also allows for real time data collection (on a daily basis). Furthermore it allows deployment of new surveillance items in real time. Finally, we report how this software was received by participating GPs.

Materials and Methods

Surveillance information model

The surveillance information model is split in two abstract models. The metadata model describes the surveillance protocol and the report data model describes the structure of the reported data. The implementation of the above model is presented using Unified Modeling Language (UML) in Figure 2.

Metadata model

The metadata model describes the surveillance protocol for a disease (or a medical condition). It consists of the definition of a **Disease** class holding the case definition in plain text, a unique identifier and a flag indicating whether reportable items, used to collect individual data about reported cases have been defined.

These reportable items are described by a set of combined classes. A first class (**Form**) acts as a container for **Item** classes which specify the labels and types of data (text, numeric). Presentation and validation information is linked with the list of reportable items via classes **Group** (grouping items for display), **Choice** (set of acceptable values), **Parameter**, (named parameters like limits, validation pattern) and **Dependency** (dependencies between fields).

Report Data model

Cases of disease are observed by an Agent (here a GP) during a given observation period. Reports to the surveillance system are described by the **Declaration** class and is composed of an **ObservationPeriod** holding start/end dates and activity during the period (full time or not) with a set of **DiseaseCases** (for each disease included in the protocol). This last class is a set, possibly empty, of **Cases**, observed for the disease. A Case may hold individual data according to the **Items** in the form model associated with the disease. Each **Declaration** instance also includes references to the version number of the surveillance protocol, an agent identifier and the count of cases by disease.

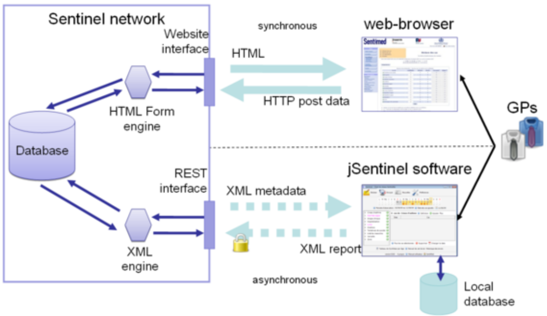

Figure 1-Overall architecture of the French Sentinel Network for epidemiologic surveillance. GPs may report data using a web based interface or a desktop client.

Client/Server model implementation

Two packages were defined and used to generate the set of XML schema files used in validation process (Figure 1 & 2). Files conforming to the **Metadata** model package are deployed from a central server to client applications to update surveillance protocol, while data sent from client application to the central server are expected to conform to the **Report** package description.

Available operations (authentication, push data to server, etc) are handled using a REST (Representational State Transfer) service interface: HTTP operations (GET, POST) are used to make an operation on a resource identified by an URL (Uniform Resource Locator), for example, the GET request to the URL https://[server]/metadata is used as the endpoint to get last metadata version. All exchanges use HTTPS protocol.

Metadata package XML files are instantiated on the server side from protocol descriptions stored in a database. Getting a file from the server is split in two operations: first, the server send an XML manifest file containing the version number available requested file and then the requested file is sent if it is new to the client.

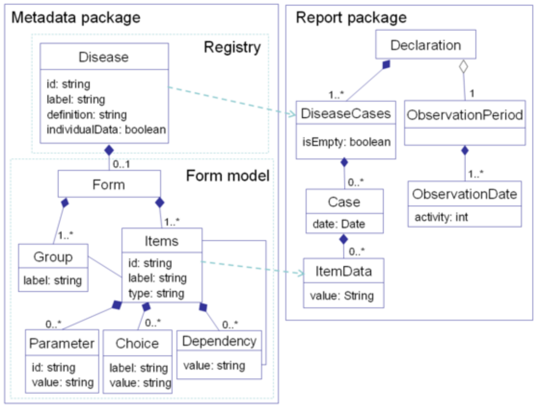

Figure 2- Surveillance information model. This model is used to generate XML files structure and XSD files

Desktop client implementation

We developed "JSentinel", a lightweight desktop Java application for surveillance and report. The application uses a modular architecture: a core component provides the basic functions like networking (http client), version management and updates, XML and Graphical User Interface (GUI) support.

A graphical library was developed using Java Swing components to display forms. This library transforms reportable items (conforming to the Form model) described in the metadata package (Figure 2) into a graphical form for data entry. It also handles data validation according to constraints defined in Dependency and Parameter class in the model, and displays an alert when an error is detected.

Main functionalities are packaged into "modules" which are interfaced with the core component and graphical user interface library. The four available modules (surveillance, news, update and preference) are described below.

Modules description

The Surveillance module allows data collection according to the surveillance protocol. It provides a GUI to collect case descriptions conforming to the **Metadata** XML package. If individual reportable items are required, the corresponding XML file containing the reportable items description according to the form model (Figure 2) in the Metadata package is passed to the GUI library to dynamically create a form and return the data entered. Data corresponding to reported cases are stored locally in an XML file conforming to the report package.

The Update module handles the synchronization of data with the server, downloading and inserting new files as required.

The News module provides a news reader user interface using Really Simple Syndication (RSS) and can be configured to read several RSS sources and this source definition could be deployed within synchronization.

The Preferences module provides a user interface to define options and connection parameters.

Using the client

The client software is a point & click / menu driven application. The surveillance module user interface, presented in Figure 3, shows the list of diseases created from the downloaded metadata XML file, and the reported number of cases for each disease. If required, reportable items for the selected disease are listed in the right panel and may be filled in by clicking on the panel. A top bar shows a calendar displaying the observation period and activity level (half-time or full-time on a daily basis). Help and documentation is available, as well as summary displays of past reports for each GP.

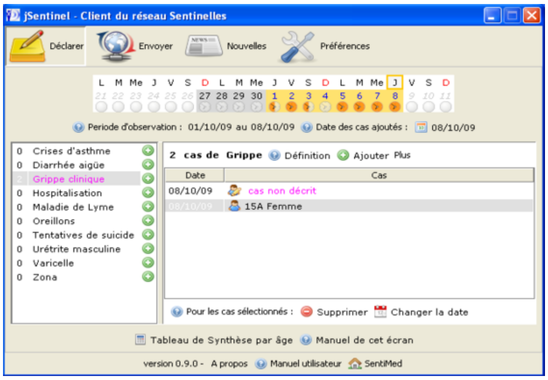

Figure 3-Screenshot of the jSentinel software. Diseases are listed in the left column. Two Influenza Like Illnesses (=Grippe) are currently being reported with one individually described Results

Deployment of the software

The software was developed and tested with 20 voluntary GPs, it was then made available for download and use for all GPs in the network. Two months after deployment, we invited all GPs who had used the client at least once to participate in a short survey. This survey explored GPs satisfaction with the new client software on several dimensions: time spent collecting and reporting cases, access to information about the network. Objective indicators related to the use of the system were also computed: frequency of connection, number of reported cases, completeness of reports (% cases with individual data) and persistence of use. When possible, we compared these indicators between GPs using JSentinel client and those using the web based interface.

Results

Software Utilization

209 GPs (out of 415 providing data) used JSentinel at least once over the first 9 months of availability (January - September 2009). During this period, 133 GPs used JSentinel more regularly than the web interface (those will be referred as JSentinel users) and 279 used the web interface (referred further as Web users). 3 GPs used both equally (but had very few connections) and were excluded from comparisons. Among JSentinel users, 60% used only the JSentinel software to report their cases. Proportion of weeks with at least one report for each GP was not significantly different during the evaluation period (median 63% inter-quartile range (IQR) [25%; 83%]) from the previous year (median 70% IQR [27%; 90%]) for JSentinel users.

Impact on surveillance data

The median time lag between 2 successive declarations for GPs using the website was 6 days with an inter-quartile range (IQR) of [3;8], but it was 0 days ([0;2]) for JSentinel users ($p < 0.001$) showing that daily declarations were common for the client software users. From January to September 2009, the median number of cases by week of observation was 5.13 cases for web users and 5.50 for client's users (not significant). These results are presented in Table 1.

Age and sex (common reportable items for all conditions included in the surveillance protocol during the year 2009) were fulfilled for 96% of reports from JSentinel and 91% from website declarations ($p < 0.001$).

Qualitative evaluation

107 GPs (out of 168 who used the client at least once during the 2 months following the deployment) responded to the evaluation survey. 95% reported spending less time reporting cases using the client, 59% agreed to say the client helped them to provide exhaustive reports and 83% agreed to say the client helped them not to forget reporting. Reasons most frequently mentioned to explain the client's help were the ability to report cases during consultation and desktop availability.

Table 1- Characteristics of participating GPs and changes in surveillance according to Web / JSentinel use.

	Web	JSentinel	p value
Use of Electronic Medical Record *% (N)* [1]	95.5% (233)	99% (126)	0.06
Days between consecutive reports, *median [IQR]*	6 [3;7]	0 [0;2]	< .001
Reported cases per week, *mean ± sd*	5.5 ± 5	5.1 ± 3	0.5
Report completion	91 %	96 %	< .001

[1] *data available for 89% of GPs*

Discussion

Making GPs persistent in reporting cases is a continuing challenge in voluntary based epidemiological surveillance systems [5]. Our users' survey confirmed that better integration of surveillance within the GP clinical process was a key element for participation. Indeed, desktop availability made it possible to describe cases quickly, allowing the additional work required for surveillance to fit in the consultation time. Another positive effect of the better integration of surveillance in the clinical process was the reduction in reporting delays. Indeed, most GPs sent data the day they were input, when the delays could be larger using the web based interface. However, some GPs preferred the web interface over JSentinel: these included GPs with a non computerized practice, as well as those who felt that using JSentinel took more time than reporting cases only once a week. Loss of time is often reported as an obstacle to adopt eHealth solutions [1].

In designing JSentinel, we aimed at developing a content management system for epidemiologic surveillance rather than a closed software for the FSN. For example, JSentinel includes an automatic newsreader functionality using a RSS stream reader. This function is used to provide rapid feedback to the GPs, and to deploy epidemiological alerts, as well as to maintain motivation in surveillance data collection. It has been suggested that making this information available may improve clinical decision rules, for example in the presence of epidemics [6].

The content management system approach of our architecture is further illustrated by the way the surveillance details are described. Indeed, these were all packaged (details on surveillance data presentation, capture and transmission) in XML files that are dynamically interpreted within the JSentinel software. Thus, the system is easily extendable to include new diseases. For example, modification of the influenza-like illness surveillance protocol to include influenza pandemic specific questions (risk perception, specific vaccine, etc) could be achieved in a few hours. JSentinel may also serve as a platform for data collection outside the routine surveillance protocol.

We developed our own data description using XML based on an abstract but simple model for continuous disease surveillance. There is indeed no well adopted standard for epidemiological surveillance, with most systems using ad hoc descriptions [7]. Contrary to clinical epidemiology, where Operational Data Modeling CDISC standards [8] has been put forward due to requirements by the Food and Drug Administration, initiatives for public health data standardization are still in their infancy. Our set of XML files may serve as a first step for allowing integration of heterogeneous systems in a unique framework.

Electronic data collection methods have become increasingly common for epidemiologic surveillance. Terminal based solutions were rare but existed before the internet [9]. Web based solution are now broadly used in surveillance system. Thanks to the web architecture based on W3C standards, web forms provide simple and flexible way to collect data since web browsers are only in charge of presentation and all data treatment could be done on the server side (forms definition, validation of data and storage). In our experience this data collection method has some limitations when especially when the working process of the users is not fully web-oriented and/or when permanent internet connection is not available or acceptable (for security reason or patient's home visits).

Another promising solution is the use of existing EMR software for surveillance purpose [10-12] . This solution has for example been implemented for syndromic surveillance to collect data (sex, age, chief complains, etc...) in existing software from Emergency Department or General Practice.

The real extent of the overlap between data required for public health surveillance and that entered in the Electronic Medical Record (EMR) content is an debate [13]. In case of emerging health issues and research the actual overlap is not clear cut.

In such cases, some specific data may be valuable which are of little use for the care of the patient: these would include for example contacts for a transmissible disease, detailed data on exposure or the environment, and so on. This type of data would be difficult to extract from the EMR, as the GP is unlikely to request them unless it is in a well defined surveillance protocol.

For surveillance of common diseases, one may expect that most of the data required may be in the EMR although it may be entered with little structure so that automated extraction is difficult.

Better integration of surveillance in the GP work process is therefore likely to pass by direct interaction with the EMR. This calls for standardizing the way data is stored in the EMR, so that automated extraction is possible; this also requires standardizing interaction between EMRs and surveillance systems to guarantee interoperability. Some solutions have been tested using the Clinical Document Architecture [14] or Archetype-based models [15] but they are generally based on a unique or few type existing software.

We did not pursue this goal here because there is a very large diversity in EMRs used in France by GPs; these have no capabilities for interoperability; and proprietary formats for data storage are common. Implementing a dedicated tool to extract from each EMR is clearly a dead-end, as it is not maintainable.

A further issue is that privacy of medical data is a stronghold in French regulations, so that third party software may not be allowed to perform automated scanning of EMRs. Pushing information from the EMR to the surveillance system would be better in this respect, although an authorization would still be required.

Implementing a standalone software was therefore the only viable solution that could be used by every Sentinel GPs regardless their choice of EMR. Our XML files may be a first step to base interoperability of such EMRs with surveillance system. Example files and schemas could be found at http://www.sentiweb.fr/xml/jsentinel

Future developments will proceed along two lines: 1 - industrial data standard to represent metadata considering specific (CDISC) or generic solutions (XForms) [16] as recommended by Retrieve Form for Data Capture published by Integrating Healthcare Enterprise initiative [17] ; 2 - improve integration or communication with existing EMR.

References

[1] Bodenheimer T, Grumbach K. Electronic technology: a spark to revitalize primary care? JAMA. 2003:290(2):259-64.

[2] Flahault A, Boussard E, Vibert JF, Valleron AJ. Sentiweb remains efficient tool for nationwide surveillance of disease. BMJ. 1997:314(7091):1418.

[3] Lober WB, Trigg LJ, Karras BT, Bliss D, Ciliberti J, Stewart L, et al. Syndromic surveillance using automated collection of computerized discharge diagnoses. J Urban Health. 2003:80(2 Suppl 1):i97-106.

[4] Revere D, Turner AM, Madhavan A, Rambo N, Bugni PF, Kimball A, et al. Understanding the information needs of public health practitioners: a literature review to inform design of an interactive digital knowledge management system. J Biomed Inform. 2007:40(4):410-21.

[5] Chauvin P, Valleron AJ. Monitoring the compliance of sentinel general practitioners in public health surveillance: which GPs persevere? Int J Epidemiol. 1997:26(1):166-72.

[6] Fine AM, Nigrovic LE, Reis BY, Cook EF, Mandl KD. Linking surveillance to action: incorporation of real-time regional data into a medical decision rule. J Am Med Inform Assoc. 2007:14(2):206-11.

[7] Status of state electronic disease surveillance systems--United States, 2007. MMWR Morb Mortal Wkly Rep. 2009:58(29):804-7.

[8] Clinical Data Interchange Standards Consortium. http://www.cdisc.org.

[9] Garnerin P, Valleron AJ. The French communicable diseases computer network: a technical view. Comput Biol Med. 1992:22(3):189-200.

[10] Lazarus R, Klompas M, Campion FX, McNabb SJ, Hou X, Daniel J, et al. Electronic Support for Public Health: validated case finding and reporting for notifiable diseases using electronic medical data. J Am Med Inform Assoc. 2009:16(1):18-24.

[11] Hripcsak G, Soulakis ND, Li L, Morrison FP, Lai AM, Friedman C, et al. Syndromic surveillance using ambulatory electronic health records. J Am Med Inform Assoc. 2009:16(3):354-61.

[12] The UK General Practice Research Database, A powerful e-Clinical Research Tool. Clinical Research Focus. 2002 (13):48-50.

[13] Kukafka R, Ancker JS, Chan C, Chelico J, Khan S, Mortoti S, et al. Redesigning electronic health record systems to support public health. J Biomed Inform. 2007:40(4):398-409.

[14] Klein A, Prokosch HU, Muller M, Ganslandt T. Experiences with an interoperable data acquisition platform for multi-centric research networks based on HL7 CDA. Methods Inf Med. 2007:46(5):580-5.

[15] Chen R, Klein GO, Sundvall E, Karlsson D, Ahlfeldt H. Archetype-based conversion of EHR content models: pilot experience with a regional EHR system. BMC Med Inform Decis Mak. 2009:9:33.

[16] XForms. http://www.w3.org/MarkUp/Forms/.

[17] Integrate Healthcare Enterprise, Retrieve Form for Data Capture. http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_Supplement_RFD_TI_2009-08-10.pdf.

Address for correspondence

Clément Turbelin
Réseau Sentinelles, UMR S 707
Faculté de medecine St Antoine
27 rue Challigny
75571 PARIS CEDEX 12
turbelin@u707.jussieu.fr