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

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Abstract

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. The java-coded application runs as a client on the local GP computer, it allows reporting cases to a central server and 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. 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.

MESH Keywords Computer Communication Networks ; Database Management Systems ; Disease Notification ; methods ; Electronic Health Records ; General Practice ; methods ; Sentinel Surveillance ; Software ; User-Computer Interface

Author 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.

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.

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.

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.

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.

Overlap between public health data needs and Electronic Medical Report (EMR) content is an active question [9]. Most of data required for surveillance may be in the EMR although with little structure. The case of emerging health issues is less clear cut. Integrating surveillance further in the GP work process is likely to pass by direct interaction with the EMR, as already done in the GPRD [10]. We did not pursue this goal here, as there is a large diversity in EMRs used in France by GPs (a few percent are still using paper based records), most of which use proprietary formats for data storage. However, our protocol XML files may be a first step to base interoperability of such EMRs with surveillance system.

Future developments will proceed along two lines: 1 - industrial data standard to represent metadata considering specific (CDISC) or generic solutions (XForms) [11] as recommended by Retrieve Form for Data Capture published by Integrating Healthcare Enterprise initiative [12]; 2 - improve integration or communication with existing EMR.

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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.

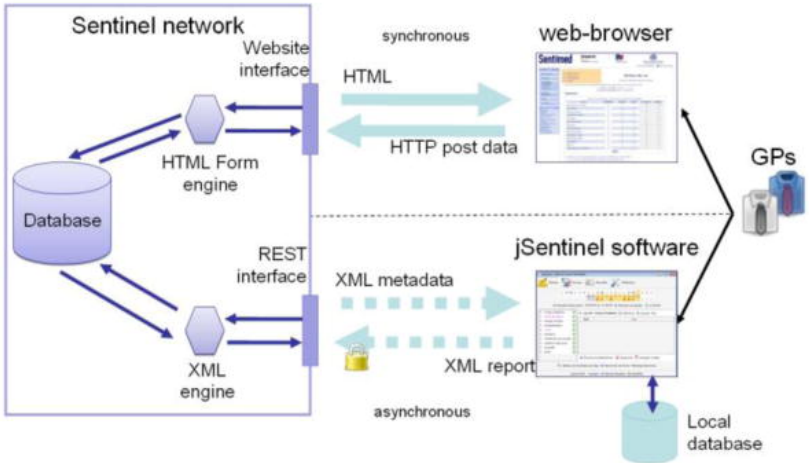

Figure 2

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

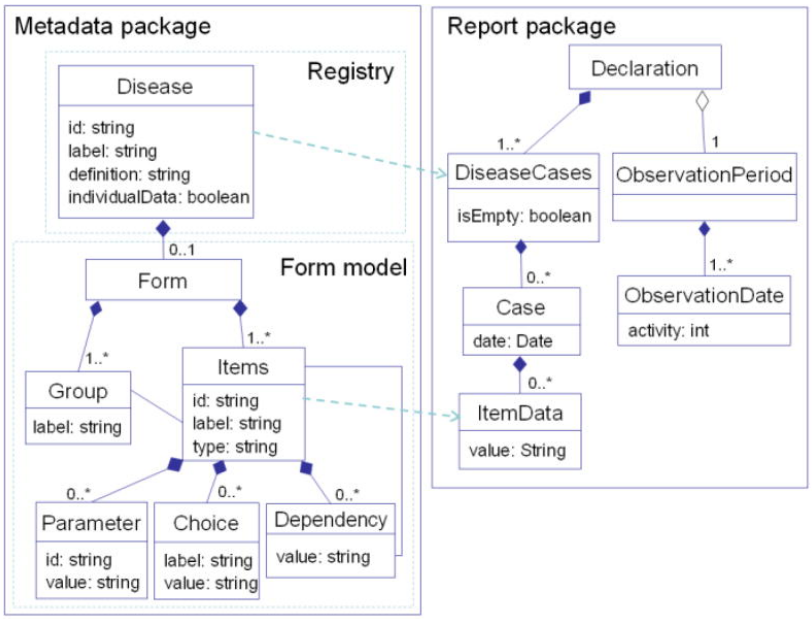

Figure 3

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

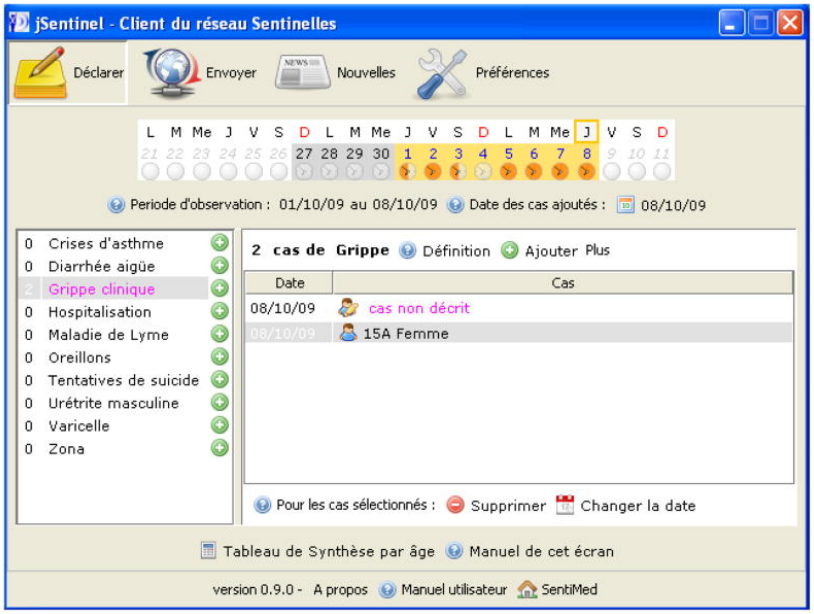

Table 1

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