Automatic Microbiological Laboratory-Based Surveillance: The Micronet Project

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***Abstract*- In Italy in 2004, the Istituto Superiore di Sanità (ISS), supported by Ministry of Health, started up an automatized surveillance system based on microbiology laboratories. It consists of epidemiological surveillance of infectious diseases based on computerized and early collection and transmission of data on infectious diseases, pathogens and antimicrobial resistance from microbiology laboratories LIS (Laboratory Information System). A group of microbiologists and epidemiologists produced 11 standard tables, regularly updated and the suppliers developed a new proceedings for exporting data from their LIS. At the end of 2006, seven laboratories are already effective and 2 more will be in first quarter of 2007. Actually the server contains 3 months of data as pilot study. The prototype of the web site was realized and tables for tests, results, pathogens, antimicrobial resistance profile, can be stratify by material, month and hospital. For specific requirements, data could be exported on statistical packages for analysis. Micronet represents an important starting point for regional networks that could be merged into a national one. It serves as an important instrument for rapid detection of epidemics and trends of infections, providing data more timely, complete and up-to-date. Micronet will be able to product data and perform time series analysis from the first quarter of 2007. During 2007, it plans to recruit other laboratories for a complete national coverage, representative of the whole of Italy. Moreover Micronet could improve local and national monitoring of hospital acquired infection, that, at national level, are the basis for public health use including the estimation of trends of diseases or early warning system.**

I. INTRODUCTION

In Italy the routinary notification of case of communicable diseases is based only on clinical notifications that converge to the official informative sources as Italian SIMI (infectious diseases computerized system) [1]. However this system refer to a limited number of diseases and in order to know about etiological causes special surveillance system were activated taking more data from laboratories, like for meningitis [2], or for antimicrobial resistance [3] using paper forms. Furthermore there are at local level many efforts to monitoring of hospital acquired infections through the laboratory data generated for the medical assistance because it is demonstrated that hospital acquired infections have high impact from the economics' perspective:

- infections affect 5% - 8% of inpatients [4];
- each infection costs an average of 17,2 days more in terms of LOS [5];
- foreseeable infection episodes' percentage is 30% [4].

To bypass this addition of burden on the activities of clinical microbiologist, the Istituto Superiore di Sanità (ISS), the Italian National Public Health Institute, by the collaboration of Ministry of Health is developing an automatized surveillance for multicentric collection of data from microbiology laboratories. It consists on a epidemiological surveillance of infectious diseases based on computerized and prompt gathering and transmission of results on etiology of infectious diseases, of antimicrobial resistance and of hospital acquired infection from LIS of the laboratories.

Local monitoring of hospital acquired infection is therefore only the "starting point" of the surveillance system, at national level, for public health use including the estimation of trends of diseases or early warning system. Data for public health purpose must be collected from many centers at regional or national level. In order to aggregate data from different laboratories it is needed to organize the information flow and harmonize the data concerning the microbiological infections and antibiotic resistance. A standard for data transmission and data interpretation for epidemiological and microbiological purposes still doesn't exists, therefore data must be normalized in format and in "meaning of each result".

II. METHODS

Micronet is a new project of ISS, designed to be a sentinel surveillance system that collect all laboratory test results (positive and negative) from a convenience sample of peripheral microbiological laboratories. The approach is based on the clinical requests. All data are collected from the informative system (LIS) of each laboratory. Before the transmission to the central server, all data are converted automatically in Micronet data format using standardised tables. The data transmission is designed to be on daily basis.

A. MicroNet's concept and overall architecture

A group of microbiologists and epidemiologists produced 11 standardised tables in order to realize specifics for the exchange of the data. They are regularly updated and available on line. One of the key characteristic is considering what was looked for with each test in term of pathogen or group of pathogen. A flexible XLM format was also defined as format to exchange data from laboratory and the central server. It was asked to all participant laboratory to develop an exporting procedures conforming the provided specific. In this way the software houses in charge of installing and maintaining the informative system of every laboratory were involved in the developing of the exporting procedures. All these information are available on Internet for the participants or for whom needs more information to implement the system.

A client software was developed by the project to transmit the exported data to the central server using a secure connection.

All the data are stored into the Micronet central database and a web site was set up to provide feedback in terms of analysis on aggregated data. Only the first positive test for the same patient, material and pathogen is counted, however all the results, included the negatives tests are stored in the database: this permits to calculate rate between positive and number of tests..

For specific requirements, data could be exported on statistical packages for analysis. All the laboratories recruited were in Piemonte region (Italy) and 6 of them were equipped with Mercurio which is *NoemaLife*'s hospital acquired infections' survey and monitoring system permitting an easier exportation to Micronet format.

B. Role and description of Mercurio

Mercurio supports data dispatch to Micronet providing the laboratories tools for local analysis functions and, at the same time, the opportunity to exchange data with regional or national networks using the Micronet data format.

Mercurio aims at the valorization of the "Hospital's information" and supports risk management by integrating different systems. The integration is carried out by automatic processes which solve the problems of information coding, homogenization and standardization. Furthermore, as a distinctive characteristic, Mercurio allows availability of clean and consistent data, thus supporting every single laboratory and institution, in monitoring and surveying their own data.

Microbiology reports are the main information source for the hospital acquired infection monitoring and survey system; they are acquired from the LIS (Laboratory Information System) or directly from the instruments' database. Data are opportunely filtered for a correct identification of the infectious episodes. Mercurio is a modular and scalable.

Epidemiological Observatory for the Microbiology Data includes the Data Base structure, the Statistical nucleus and the Investigation and Reporting System, and allows to personalize the epidemiological studies. Single infectious episodes are individuated by the data reporting filtering (filter and strain calculation is fixed). Data are selected and shown according to parameters, settable by the user. For every isolation is calculated the bacteria strain in the form of phenotype SIR (susceptibility/resistance to antibiotics).

Integration with Hospital Information System (HIS) and Pharmacy Information System (PhIS) extends the analysis functions to the information concerning the treatment information which contain clinical and administrative data relating to actions carried out within the Hospital (according to ICD9). In this way it is possible to correlate reporting with pathologies, operations and hospitalisation in the departments. The coding system, can be used as easy comparison between epidemiological studies in the territory. Integration with PhIS allows the analysis of the antibiotic drug consumption, per ward.

Expert System for the identification of Alarm events allows implementation hospital protocols for alert identification: dangerous species (MRSA, VRSA), multi-resistant, etc. and identifies immediately possible epidemical centres within the hospital. Comparison with the former isolations of the same micro-organism on the same patient, relating to the phenotype.

Expert system to support the microbiological reports validation. The system is configured with rules according to international standards (e.g. CLSI) "localized" for the geographical context, to which specific rules (e.g defined within the hospital), can be added. The system is able to explain in a "non-computer language" the outputs' motivation. The results carried out by the expert system are a support to the Healthcare Specialist who still maintains the total control of all the validation process phases.

Active Survey Forms allow to manage and entry specific data concerning sentinel events and according to the protocol of Active Survey defined by the local Hospital Infection Committee (HIC).

Furthermore, Mercurio has been designed focussing on high data elaboration performances: for example, retrying statistics on 4 years data of a 1800 beds Hospital, requires 1 minute of elaboration.

III. RESULTS

During the pilot test, the tables and the specifics were implemented in 7 laboratories, sending 3 months of data

corresponding, removing duplicates, to more than 50,000 records. The majority of data collected were gathered from the Laboratory of the S. Anna Hospital in Torino (22.8%), followed by the Laboratory of Novara Hospital (20.2%), corresponding to more than 20,000 records. The other five laboratories participated with around 30,000 records (Table 1).

Records collected included also the distribution of results (i.e. positive or negative), type of material and exam requested (i.e. stools: cultural for *Salmonella* or for *Shigella*), frequency of isolated microorganisms (i.e. *Salmonella* and/or *Streptococcus pneumoniae*), profile of antibiotic resistance, and, other personal data (i.e. age, gender, date of recovery and days of hospitalization).

All the data are stored into the Micronet central database and a web site was set up to provide feedback in terms of analysis on aggregated data (Figure 1) regarding tests, results, pathogens, antimicrobial resistance profile. All the results could be stratify for month, hospital, material.

Different level of data consultation were considered. The potential users of Micronet are Regional Authorities (integrating existing clinical and laboratories surveillance system) National authorities (trend analysis, alert and support of the infectious diseases notification system) and participant laboratories (comparing local data with regional/national average).

TABLE 1
Distribution of records for different Laboratories

Laboratory	Number of records	%
S. Anna (TO)	11,530	*22.8*
Novara	10,239	*20.2*
Omegna	9,452	*18.7*
Molinette (TO)	7,167	*14.1*
Cuneo	4,340	*8.6*
Mondovì	4,211	*8.3*
S.G. Bosco (TO)	3,733	*7.4*
Total	50,672	

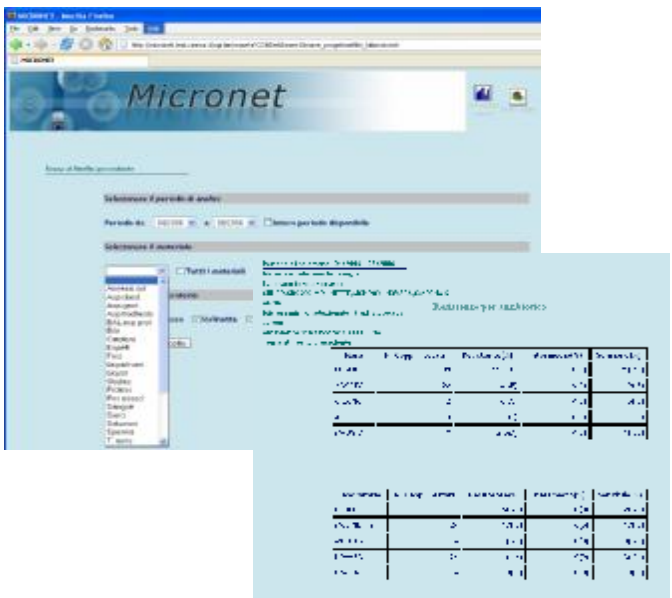

Figure 1. An example of the website

IV. Conclusions

Micronet represents an important national network providing instruments for rapid detection of outbreaks and assessment of microbiological trends.

In this project several caveats need to be mentioned. First of all, the representativeness, however in the next months, from June 2007, Micronet will be fully operative, when it is also planned to recruit other laboratories in order to improve the representativeness of the system. The second caveat is represented by the comparability of data and the methods for duplicates clearing. Another caveat is the management of the standardized tables at local level, but the results obtained in the pilot phase show its potentialities.

Moreover the data collected, at a national level, might be compared to similar experiences in other European countries as Netherland [6], that developed a similar project, however with some difference (i.e. the collection only of the positive laboratory test results). The use of such projects at a European level could be important to improve the use of a simple and tested early warning surveillance system at an international level, particularly in order to proper respond to new emerging infectious disease.

The Micronet project, also, shows the important benefits of a synergy between the standardization and the hospital acquired infection solutions as Mercurio, with a full meeting of interest. The large experience of NoemaLife in laboratory data management with Mercurio was useful in the development of the procedures, especially from a technical point of view. In fact, the rapid implementation of the 11 standardized tables by the coordination group, in this pilot phase, implicated a real time synchronization at a laboratory level with an important role of supporting of every single laboratory and institution, in monitoring and surveying their own data.

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