

A Computer Network for the Surveillance of Communicable Diseases: The French Experiment

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Abstract: The description and first results of the French Communicable Diseases Network are reported. The network, initiated in November 1984, currently includes the National Department of Health, the local health offices and various clinical, biological, and epidemiological partners. Surveillance of influenza, viral hepatitis, acute urethritis, measles, and mumps is based upon reports from sentinel general practitioners throughout France who are equipped

with terminals and can communicate their data on a 24-hour basis. The network distributes electronic bulletins summarizing the surveillance data, the regional statistics concerning other diseases, and epidemiological and administrative news. Electronic mail is used for data validation and enhances communication between the parties of the network. (*Am J Public Health* 1986; 76:1289-1292.)

Introduction

Surveillance has been defined as a "continued watchfulness over the distribution and trends of incidence through the systematic collection, consolidation and evaluation of morbidity and mortality reports and other relevant data."¹ Surveillance allows health administrators to optimally allocate health resources²; in communicable diseases, effective surveillance is necessary to prevent the spread of diseases.³

In most countries, including France, a notifiable disease reporting system is the basis for surveillance. It is recognized that the quality of reporting is generally high for severe and/or rare diseases but low for diseases of higher frequency and lesser severity. The sources of information for the surveillance of communicable diseases as well as the preventive measures involve a large number of individuals and institutions: physicians in hospitals or in private practice, clinical laboratories, and both medical and nonmedical sources. In the case of the more common illnesses such as influenza, viral hepatitis, or (in France) measles, general practitioners (GPs) are the most likely physicians to uncover the cases, yet their links with public health offices or with biological laboratories are weak. This imposes a major limitation on the effectiveness of control measures.

When the French National Department of Health (DGS) was reevaluating⁴ the surveillance of communicable diseases, we proposed⁵ a new system of information and surveillance based on a computer network that would include all the partners involved in the control of communicable diseases. The feasibility of such a project was facilitated because of the ambitious policy of the National Company of Telecommunications (Direction Générale des Télécommunications) to distribute and promote the use of home terminals (the avowed goal of offering one free terminal per phone user will be reached within two or three years). This paper reports the experience of the first year (November 1, 1984 to November 1, 1985) of this network.

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Background

The National Department of Health operates through its national office, 22 regional (DRASS) and 100 departmental offices (DDASS). These three levels are represented in the network. The notifiable communicable diseases are reported by the physicians through Municipal Health Offices in cities having more than 20,000 inhabitants, elsewhere directly to the DDASS. The DDASS is in charge of data validation and forwarding to the National Department of Health. Part of the transmission from the local to the national level is now performed through the network. The National Reference Centers (NRC) are specialized laboratories which collect strains and/or sera from peripheral French laboratories or collect data from laboratories or physicians. In November 1985, nine out of the 35 NRCs were active participants.

The Communicable Diseases Network

Data Gathering

Surveillance of selected communicable diseases is based upon data collected from sentinel general practitioners (SGP) as suggested by a first experiment with influenza surveillance.^{5,6} The SGPs are expected to communicate with the host machine at the day and hour of their choice, but at least once a week. Five illnesses have been selected for surveillance: influenza (criteria for inclusion of cases are those of WHO⁷); presumed viral hepatitis (criteria for inclusion are: acute disease, no toxic etiology, aminotransferase enzyme levels more than twice the highest normal value of the laboratory); measles (criteria for inclusion are those of the United States Centers for Disease Control (CDC)⁸); male acute urethritis and, more recently (July 1985), mumps (criteria for inclusion are those of CDC.)⁹

The SGPs report the sex and age of patients for each of the new cases they have observed since their last connection to the computer. Additional questions, varying with the disease, are asked by the computer, e.g. the possibility of a previous immunization in the case of measles, the presence of an urethral discharge in the case of acute male urethritis, the existence of complications for mumps. Additional information can be reported by using the electronic mail system, and validation of any information can be requested by DGS staff through the same channel.

Specific surveys of SGPs can be carried out to plan new developments of the system. For example, before starting the surveillance of mumps, we made a survey to learn the practicability of the intended inclusion criteria. We have also used the system to survey the attitudes of the general practitioners (GPs) on selected public health problems.

The gathering of regional statistics—Since February 1985, departmental offices have been part of the network, and since the autumn of 1985, they can (and in the near future, will be required to) send to the host computer their weekly statistics of the notifications by physicians concerning the following seven diseases: tuberculosis, meningococcal meningitis, tetanus, brucellosis, shigellosis, foodborne and waterborne outbreaks.

The detection of "alarming" situations—Those who encounter an "alarm" situation can send a message to the staff of the communicable diseases office, at the National Department of Health who, after validation, will forward the information to all potentially interested parties on the network.

The Distribution of Information

We distribute four electronic bulletins on the network and deliver information on demand through electronic mail:

- The "weekly surveillance electronic bulletin" summarizing the results of the surveillance by the SGPs is released on the network each Friday morning. It includes the results of the week ending the previous Sunday. The bulletin is menu-driven and allows the user for each disease to find the mean regional incidences expressed as number of cases per physician and per week as well as the time course of the national total incidence during the previous 28 weeks.

- The "departmental statistical electronic bulletin", also released weekly on the system, gives the numbers of notifications by the GPs of seven diseases (see regional statistics above) as reported by each department.

- The "epidemiological news" contains the recent epidemiological information of the Office of Communicable Diseases of the National Department of Health as well as information that the biological or administrative partners of the network wish to distribute. It also comments on selected scientific papers in the recent literature.

- The "administrative information" is delivered by the National Department of Health to communicate newly issued health regulations and the procedures for the various immunization programs.

Access to existing databases is provided on demand to the SGPs through the electronic mail: a documentalist may correspond with the requester to clarify details, then retrieve the information by querying the corresponding database (e.g., MEDLINE, etc.) and finally return the results to the requester. This service is restricted to the SGPs and is currently provided without charge in return for their help.

Communication Between Partners

The electronic mail is used to enhance the quality and speed of transmission of the health information between the different partners of the network.

Public Bulletin Boards are maintained on various health issues. A Bulletin Board displays a collection of messages sent by users who share a common interest. It can be read by every member of the group and thus serves as general discussion media.

Network Partners

Project Staff

As of early 1986, the project staff consisted of two physician epidemiologists in charge of the relationship with the SGPs and with the departmental offices, one biomathematician, one programmer, one computer technician, one biostatistician (graduate student), one secretary, and one documentalist (part time).

Sentinel General Practitioners

The sentinel general practitioners, recruited on a voluntary basis, are the backbone of the effort. They numbered 40 on November 1, 1984 and 100 on January 15, 1985. Since March 1, 1985, there have been 150 SGPs scattered throughout the entire country. There are some differences between their geographical distribution and the overall distribution of the GPs in France.¹⁰ In expressing our results, we have adjusted regional data to the distribution of French general practitioners.

Network Technical Characteristics

The facilities devoted to the project consist of a local network of three microcomputers, linked to a main-frame computer (IBM 3081) where the time series analyses and the mathematical modeling are done. The first microcomputer forms the front end of the network. It has a central memory of 448 Kbytes, two 5" floppy disk drives, and a hard disk of 40 Megabytes. It allows four simultaneous asynchronous accesses. The second microcomputer is a specialized videotex pages composer using C-language. It has a central memory of 512 Kbytes, color graphics and two floppy disks of 8". The third microcomputer has a central memory of 128 Kbytes, one hard disk of 10 Megabytes, two floppy disks of 8" and 5". It is used to edit and update the various files. The total cost of the hardware specifically used for the project is roughly 500,000 French francs (\$70,000 US).

The partners of the network communicate with the host computer through MINITEL terminals, or through personal computers with modems and programs that emulate the MINITEL. The MINITELS are terminals with special incorporated modems which function under the French VIDEOTEX-TELETEL norm.¹¹ The MINITEL will become available free of charge within the next two years to any user of the French National Telephone Company. At present, a first group of approximately 1,500,000 MINITELS have been distributed free of charge in selected geographical areas. Users who are not in these areas can obtain a MINITEL for 85 French francs per month (approximately \$12 US).

The communication between users and the host computer is done through standard commuted telephone lines. SGPs have access to toll free lines. The use of toll free lines has been shown to enhance the quality of reporting.¹²

The software of communication discriminates among users. For example, the SGPs are the only users who can send surveillance data. Reciprocal information is released selectively, according to its nature. For example, only the regional public health officers are given access to the notices which are brought to their attention by the National Department of Health.

Surveillance Results

Activities of SGPs

The distribution of the hour of the day at which SGPs initiate a connection (Figure 1a) shows that a large majority of these connections occurs outside the office hours of the health administrations. SGPs initiate their connection (Figure 1b) throughout the week, including Saturday and Sunday.

The duration of a SGPs connection varies from less than 1 minute to more than 20 minutes, the mean being 12 minutes (Figure 2). This duration depends upon the services of the network which are used by the SGPs.

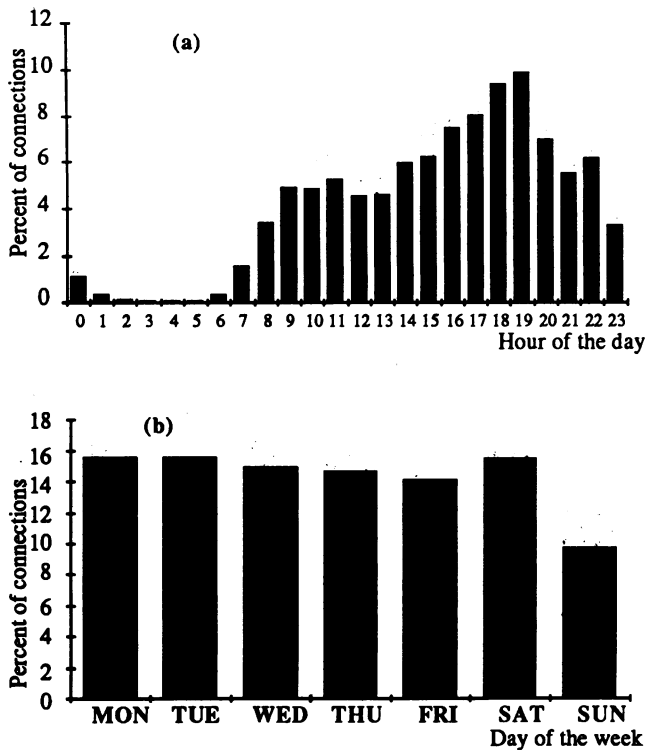


FIGURE 1—Hour of the Day (panel a) and Day of the Week (panel b) at which Sentinel General Practitioners (SGPs) Initiated a Connection with the Host Computer (data correspond to the period November 1, 1984 to November 1, 1985)

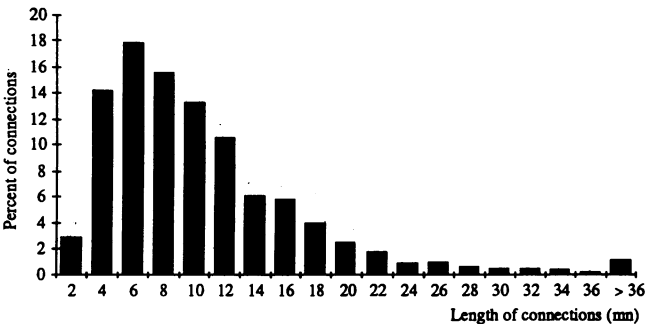


FIGURE 2—Distributions of the Lengths of the Connection Times of SGPs with Host Computer (data correspond to the period November 1, 1984 to March 1, 1985 during which a device was implemented to record these data)

1985 Influenza Epidemic

The epidemic of influenza occurred during the week of January 7–13, 1985. This began to be reflected on the terminals of the network no more than five days later (Friday, January 18). The complete time course of the surveillance data is shown in Figure 3. The maps displayed on the terminals showed the geographical distribution of the disease (Figure 4).

If we assume that the SGPs are representative of their 49,775 colleagues,¹⁰ the extrapolation of the data would indicate that there were roughly 4,500,000 cases of influenza syndrome seen by GPs during this epidemic between weeks #2 and #14, with a large majority (85 per cent) occurring in the working age groups (see below). Assuming that the mean duration of the absence from work is five days, this epidemic may have accounted for 20,000,000 work days lost. This

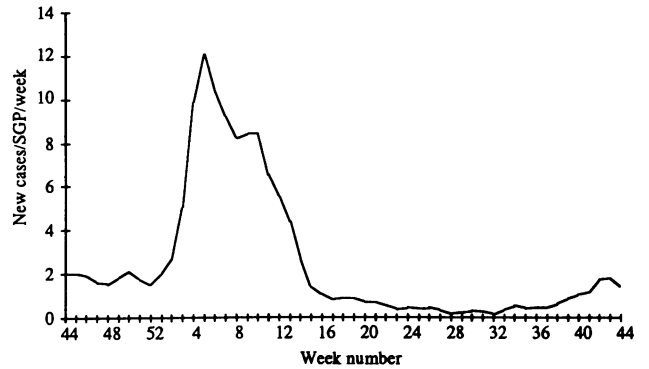


FIGURE 3—Weekly Number of New Cases of Influenza (or like) per General Practitioner during the Period November 1, 1984 to November 1, 1985 (the epidemic began on week 2 of 1985, ended on week 14)

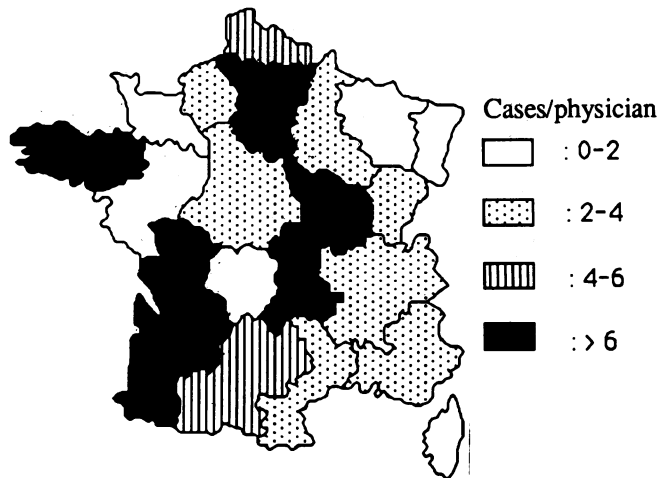


FIGURE 4—Regional Distribution of Reported Cases of Influenza, January 14–20, 1985, as Shown on the Network on Friday, January 25, 1985

represents roughly the work of the whole French active population during one day, or, since there are roughly 200 working days per year, a loss of total productivity of 0.5 per cent.

Other Surveillance Results

The average incidence of cases observed by SGPs has been computed over the reference period. There are .05 new cases of presumed viral hepatitis per week per SGP, which extrapolates to an annual incidence of 130,000 in France (total population 55 million). There are 0.1 new cases of measles per week and per SGP, which extrapolates to a total of 260,000 in France, roughly a third of the number of newborns. There are 0.17 new cases of male urethritis per week and per SGP, which extrapolates to an annual incidence of 440,000 in France. There are 0.09 new cases of mumps per week, which extrapolates to an annual incidence of 230,000 in France.

Discussion

As a communication medium, the network is not just a substitute for the telephone or the ordinary mail. Electronic mail has the advantages of the telephone (because it arrives instantaneously to the correspondent) and of the ordinary mail (because it is a written message that the sender can easily copy for his own files and circulate to the recipients of a

mailing list), but it has other advantages as well: the message arrives instantly, whether the recipient is there, or not, there is never a "busy" line, the sender can send his message at any time without concern for the presence of the recipient, and conversely the recipient can read his "mailbox" whenever and wherever he happens to be (provided he has a terminal). The mailbox is not attached to a physical address (which is of particular interest for field work). The compliance of the SGPs and the quality of their work are facilitated by these characteristics, and the system enhances the quality of a relationship with health departments, and of reporting.¹³ The quick return of the information to the SGPs stimulates their participation.^{5,14,15} Finally, the system has all the characteristics of an "active surveillance" system, which has been shown to be more efficient than a passive one.^{13,16,17}

There are two limitations to our initial efforts. The first one is the possible lack of representativeness of the SGPs. The SGPs are volunteers rather than a random sample. The alternative solution, which would be to select a randomized sample of SGPs, would not necessarily be better because there would be a partial dropout and no reason to consider those remaining as "representative". This possible lack of representativeness of the SGPs may affect the extrapolations made to the whole country, but does not limit the value of the surveillance system as a tool to detect epidemics inasmuch as it is always the same set of SGPs which reports throughout the year. The second limitation deals with the current lack of laboratory validation of the reported cases of diseases. A viral hepatitis project is currently under development at the National Department of Health and, in the future, sera from patients so diagnosed by SGPs will be collected and tested in a single national laboratory.

Our immediate goal is to increase the number of participants in the network, especially that of SGPs who are expected to number around 600 in the next few months. This will allow a more efficient reporting even of rare, but serious situations.

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REFERENCES

1. Langmuir AD: William Farr: Founder of modern concepts of surveillance. *Int J Epidemiol* 1976; 5:13-18.
2. Doll R: Surveillance and monitoring. *Int J Epidemiol* 1974; 3:305-314.
3. Thacker SB, Choi K, Brachman PS: The surveillance of infectious diseases. *JAMA* 1983; 249:1181-1185.
4. Bouvet E: Surveillance des maladies transmissibles, une nouvelle conception? *Weekly Epidemiol Res* 1985; 60:355-357.
5. Valleron A-J: Projet pour le développement de la recherche et de l'information sur les maladies transmissibles, Rapport a la Direction Generale de la Sante, Paris, 1984.
6. Menares J-C, Reyes E, Martin-Bouyer G: Surveillance de la grippe par les médecins correspondants. France: septembre 1980-juin 1981. *Rev Fr de Santé Publique* 1982; 19:77-87.
7. World Health Organization: Surveillance of acute viral respiratory infections in Europe—A report of WHO symposium, Madrid 1980, June 2-6. Copenhagen: WHO Regional office for Europe, 1981.
8. Centers for Disease Control: Measles United States First 39 weeks. *MMWR* 1984; 33:673-676.
9. American Public Health Association: Mumps. In: Benenson AS (ed): *Control of Communicable diseases in Man*, 14th Ed. Washington, DC: APHA, 1985.
10. Le secteur Libéral des professions de Santé en 1984, Carnets Statistiques, Caisse Nationale des Assurances Maladie et Travailleurs Salariés, 1984, Paris.
11. Spécifications Techniques d'Utilisation du Minitel. Ministère des Postes et Télécommunications, Direction Générale des Télécommunications, September 1984, Paris.
12. Tizes R, Pravda D: Proposed toll-free telephone reporting of notifiable diseases. *Health Serv Rep* 1972; 87:633-637.
13. Schaffner W, Scott HD, Rosenstein BJ, Byrne EB: Innovative communicable disease reporting. Washington, DC: Health Services and Mental Health Administration, 1971; 86:431-436.
14. Kononitz PM, Petrossian GA, Rose DN: The underreporting of disease and physicians' knowledge of reporting requirements. *Public Health Rep* 1984; 99:31-35.
15. Kimball AM, Thacker SB, Levy ME: Shigella surveillance in a large metropolitan area: assessment of a passive reporting system. *Am J Public Health* 1980; 70:164-166.
16. Brachott D, Mosley JW: Viral hepatitis in Israel: the effect of canvassing physicians on notifications and the apparent epidemiological pattern. *Bull WHO* 1972; 46:457-466.
17. Vogt RL, Larue D, Klaucke DN, Jillson DA: Comparison of an active and passive surveillance system of primary care providers for hepatitis, measles, rubella, and salmonellosis in Vermont. *Am J Public Health* 1983; 73:795-797.