

Chasing MRSA in the Nineteenseventies

In 1978 I was working at the Hoffmann-LaRoche Clinical Pharmacology Unit at Newark Beth Israel Medical Center. Dr. Jerry Murillo, a pediatrician and infectious disease specialist at the 'Beth' told me about infection control in the neonatal care unit. Looking at the 'antibiograms,' i.e. lab characteristics of the germs isolated it occurred to me that the results should be entered into a Fortran program. We were looking for changes in antibiotic resistance. The program would allow us to immediately recognize new, resistant strains of bacteria.

Interestingly, we transferred our data to the mainframe computer and back at 110 bauds, i.e. 110 symbols per second. Today's cell phones operate at 5 gigabits.

In retrospect, we were hunting for methicillin resistant staphylococcus aureus which has now become known and feared as MRSA. The program worked. Dr. Murillo told me that on several occasions it triggered vigorous infection control action in the neonatal care unit.

We presented our approach at a computer conference.

An On-Line Computer Program for the Surveillance of Nosocomial Infections

J. L. Murillo, H. P. Blumenthal and J. A. Titelbaum

Abstract, Ninth Annual Conference, Society for Computer Medicine

Society of Computer Medicine, Arlington, Va., 1979

Detection of a Staphylococcus Aureus Outbreak Using a Computer Assisted Antibigram Surveillance

J. L. Murillo, H. P. Blumenthal and J. A. Titelbaum

Abstract, 1982 Annual Meeting, Association for the Advancement of Medical Instrumentation

AN ON-LINE COMPUTER PROGRAM FOR THE SURVEILLANCE
OF NOSOCOMIAL INFECTIONS

Jeremias L. Murillo, M.D.
Hospital Epidemiologist
Newark Beth Israel Medical Center
Newark, New Jersey

Peter Blumenthal MD
Clinical Pharmacologist
Newark Beth Israel Medical Center
Newark, New Jersey

Jules A. Titelbaum, M.D.
Director of Pediatrics
Newark Beth Israel Medical Center
Newark, New Jersey

Mailing Address:

Jeremias L. Murillo, M.D.
Infection Control Service
Newark Beth Israel Medical Center
201 Lyons Avenue
Newark, New Jersey 07112

SESSION IC: MEDICAL RECORDS FOR THE PRACTITIONER

AN ON-LINE COMPUTER PROGRAM FOR THE SURVEILLANCE OF NOSOCOMIAL INFECTIONS

Thursday

Jeremias L. Murillo, M.D., P. Blumenthal, and J.A. Titelbaum
Newark Beth Israel Medical Center, Newark, New Jersey

In recent years, there has been a steady increase in the use of computers for patient care. Various types of computers have been used in recordkeeping, laboratory test reporting, and automated medical histories, as well as in monitoring the clinical status of patients. Computer technology has also found a role in the field of hospital infection control. Computers have been used in surveillance activities because they can organize huge amounts of information and facilitate the preparation of reports. Currently available computer programs for the surveillance of nosocomial infections have utilized batch-type processing which, in general, has a lag period of two to four weeks between data collection and report availability. Although this method is useful in the analysis of trend data, there are limitations to its usefulness in specific outbreak detection and intervention. We would like to report on a novel on-line computer program which uses timesharing facilities and can process data on a day-to-day basis.

Data on nosocomial infections are collected on a daily basis through case-finding activities performed by the infection control nurse using both the daily microbiology reports and infection reports from the nursing units as sources of information. Each nosocomial infection is reviewed and confirmed by the hospital epidemiologist using established criteria. The data are then entered daily into the computer and processed during the same session.

The computer program is written in FORTRAN and consists of three parts: (1) procedure for entering new data; (2) procedure for editing old or new data; and (3) procedure for sorting old and new data. The procedure for entering new data is performed using a question and answer method. Old or new data can be edited through either a purge or a change/update mode. Both old and new data can be sorted according to date of culture, organism, antimicrobial sensitivity, source of specimen, location in the hospital, and attending physician. Additional data available for each patient include the hospital I.D. number, age, sex, diagnosis, and factors predisposing the patient to the nosocomial infection.

INTRODUCTION

In recent years, there has been a steady increase in the use of computers for patient care. Various types of computers have been used in record keeping, laboratory test reporting, automated medical histories as well as in monitoring the clinical status of patients.¹ Computer technology has also found a practical application in the field of hospital infection control.² Computers have been used in surveillance activities because of their ability to organize huge amounts of information and facilitate the preparation of reports. Currently available computer programs for the surveillance of nosocomial infections have utilized batch data processing which in general require a lag period of two to four weeks between data collection and report availability. Although this method is useful in the analysis of trend data, there are limitations to their usefulness in specific outbreak detection and intervention.

Because of the rapid advances in the development of computer technology, hardware costs appear to be declining while software costs continue to soar. This has caused a tremendous need for low-cost, ready-made software packages developed for a specific purpose. We would like to report on a unique on-line computer program developed specifically for the surveillance of nosocomial infections. The computer program uses a time-sharing service and can process data on a day to day basis.

DESCRIPTION OF THE SYSTEM

A. Data Collection

The first important step in the entire process is the collection of data on nosocomial infections. The Infection Control nurse (IC nurse) performs daily ward rounds and is responsible for the collection of accurate data. The IC nurse generally utilizes three sources of information during case-finding activities, namely: a) the Initial Report of Infection (Fig. 1) which is generated from the individual nursing units, b) verbal reports from either the nursing supervisor or the head nurse of a particular nursing unit and c) the Daily Microbiology Report which is distributed by the Microbiology laboratory and contains a listing of patients with positive cultures identified during the previous 24 hours. The listing also includes the patient's room number, the micro-organism isolated, the date the culture was obtained and the source of the specimen. The IC nurse also performs chart reviews of cases highly suspected to have a nosocomial infection. A preliminary list of patients with suspected nosocomial infection is made by the IC nurse and the list is then reviewed with the hospital epidemiologist. Using established criteria, a final list of patients with confirmed nosocomial infection is then drawn and entered into a line-listing form (Fig. 2). The line-listing contains all the essential information required by the computer. After the line-listing is completed, the computer session can then be initiated.

B. Hardware

The system uses a Texas Instrument Model 725 700[®] Electronic Data Terminal which is a keyboard send/receive (KSR) input/output unit with a self-contained electronic page printer and an internal acoustic coupler. Data is transmitted and received through a standard telephone handset to a computer facility that maintains a Time Sharing Service.

C. Software

The computer program is written in FORTRAN and allows an on-line interaction between the user and the computer. "On-line" is a computer terminology used to describe a computer operation where data entered by a user at an input terminal is sent immediately to the computer and the subsequent action by the computer is made available immediately to the user. This interactive FORTRAN program allows the user to create and update the data base and permits instant review.

The program is divided into three parts. The first part consists of a procedure for entering new data. This occurs in the form of a dialogue between the user and the computer. Before the session begins, the number of old cases stored in the data base is automatically displayed and the computer asks for the number of new cases (Fig. 3). After the appropriate response is given, the computer is ready to receive new data. Fifteen attributes from each patient with a nosocomial infection are obtained through a series of pre-determined questions (Fig. 4). The antibiogram is abbreviated in the same sequence as the antibiotics

shown in the microbiology laboratory slips (Fig. 5) and the sensitivity is coded as follows: 1 (sensitive), 0 (resistant).

After the data from the last patient is entered, the computer prints a summary of all the new cases to provide a hard-copy for that particular session and to allow the user to double-check for errors in entering the data.

The second part of the program allows the user to update the data base when additional information becomes available or purge the data when it becomes useless. When an update is required, the name of the patient is requested by the computer (Fig. 6). After the name of the patient is given, the update process is initiated. The update process uses the question and answer dialogue, shown in the new data entry process.

When no update is necessary, the program proceeds to the third part which consists of the review process. The data base can be reviewed according to the organism, attending physician, site or source of the culture specimen, date the culture was obtained, name of the patient and location or room number of the patient in the hospital. When a particular organism is reviewed, e.g. E. Coli (Fig. 7) information on every patient is arranged into 2 lines. The first line includes the patient's name and the source of the specimen while the second line contains the date the culture was obtained, the diagnosis, room number and type of infection (hospital-acquired versus community-acquired). But the most important information is the sensitivity pattern of each isolate arranged in columns. This particular

format facilitates the identification of resistant strains that deviate from the usual patterns of sensitivity and enables the user to detect early outbreaks caused by presumptively the same strain of organisms based on similarities of their antibiograms. The individual antibiotics are abbreviated and read downwards. When a particular attending physician is selected for review, a list of patients with nosocomial infections under his care is given. The list also includes the patient's room number, the organism isolated and the antibiogram (Fig. 8). When the data base is reviewed according to the site or source of infection e.g. blood, (Fig. 9) a list of patients with positive blood cultures with their corresponding room number, organism isolated and antibiogram is given. A review according to the date the culture was obtained can also be performed. A time period is provided by the user, and the computer lists all the patients who had their cultures obtained during that time period. The list is given in chronological order. In this manner, the nosocomial infections can be classified on either a weekly or monthly basis (Fig. 10). Nosocomial infection data can also be reviewed on each patient. When the patient's name is given, all the 15 attributes are displayed for review (Fig. 11). Finally the data base can be reviewed according to the nursing unit where the patient acquired his infection (fig. 12). The list includes the patient's name, his room number, the organism isolated and the antibiogram.

DISCUSSION

There are distinct advantages that are quite obvious when an on-line computer program is used to monitor hospital-acquired infections. Not only does it provide a rapid review of the current data on nosocomial infections but it also allows the epidemiologist to detect outbreaks earlier and enable him to plan an intervention program in order to prevent the deterioration of an epidemiologic problem while the problem is still actively in progress. This is a major improvement from the batch data processing that is currently available. Although batch data processing is extremely useful in evaluating trends and in long-term planning, it has not been helpful in dealing with specific outbreaks. The data is usually available when the epidemiologic problem has resolved and the investigation is most often conducted in a retrospective fashion.

The computer program presented in this paper has, in addition to the advantages of the on-line system, certain innovative features that are geared towards epidemiologic investigation. The most prominent and perhaps the most important feature of this computer program is the display of the antibiogram. A major *Staphylococcus aureus* outbreak in the intensive care nursery was aborted when a routine review of the data by organism and by location showed the emergence of several Staphylococcal isolates with the same antibiogram. An investigation was immediately organized and subsequent phage typing confirmed a common source. Corrective measures were undertaken before the specific problem

was given an opportunity to explode into a catastrophe. When specific organisms are reviewed either by source or by location, important shifts in antibiotic sensitivities are clearly delineated. This becomes clinically useful in the selection of antibiotics for the therapy of hospital-acquired infections.

The computer program can be expanded to include other uses such as antibiotic utilization and cost analysis. With modification and improvement, the system has great potential and eventually will become a necessity in hospital epidemiology.

Newark
Beth Israel
Medical
Center

INITIAL REPORT OF INFECTION
EPIDEMIOLOGY
SECTION

ICDA _____

HAI _____

ADMITTING DIAGNOSIS _____

Was the patient admitted with frank infection? Yes No
Did an infection develop after admission? Yes No If Yes, When? _____ DATE

SITE OF INFECTION: Urinary Tract Respiratory Tract Septicemia
 POSTOPERATIVE WOUND Phlebotomy Site
Other (specify) _____

CULTURE OBTAINED Yes No Date obtained _____

Is the Patient on antibiotic treatment? Yes No

Name of antibiotics 1. _____ 3. _____
2. _____ 4. _____

(TO BE COMPLETED BY THE INFECTION CONTROL NURSE)

TYPE OF INFECTION: COMMUNITY-ACQUIRED NOSOCOMIAL

PREDISPOSING FACTORS: (ENCIRCLE POSITIVE FINDINGS)

<u>HOST</u>	<u>IV THERAPY</u>	<u>URINARY TRACT</u>	<u>SURGERY</u>
PULM	CVP LINE	FOLEY	CLASS I
GI	ARTERIAL	STR CATH	CLASS II
NEURO	CUTDOWN	SUPRAPUBIC	CLASS III
RENAL	TPN	INSTRUMENT	
CANCER	ANGIOCATH		
DIABETES		<u>OTHER</u>	<u>REMARKS:</u>
VASC DIS	<u>RESPIRATORY</u>	CHEMOTHERAPY	_____
WBC <1500	O ₂ MASK	H DIALYSIS	_____
OTHER _____	IPPB	P DIALYSIS	_____
	ENDOTRACH	RADIATION	_____
	TRACH	STEROID	_____
		PROSTHESIS	_____

RESULT OF CULTURE:

SENSITIVITY
(R-RESISTANT
S-SENSITIVE)

A	C	C	C	C	E	F	G	K	L	M	N	N	N	P	P	S	S	S	T	T

Fig. 1 The Initial Report of Infection


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EPIDEMIOLOGIC SURVEY, INFECTIONS AT THE NBIMC

36 CASES WERE ON FILE

INDICATE NUMBER OF NEW PATIENTS
=0

INDICATE (0) NO UPDATE, (1) UPDATE, OR (2) PURGE
=0

NO MORE UPDATES
```

Fig. 3 The initial interaction between the user and the computer. The second line shows the number of cases on file. The third line asks for the number of new patients and the fifth line asks whether an update is necessary.

```
INDICATE NUMBER OF NEW PATIENTS
=1

-GIVE PATIENTS LAST AND FIRST NAME, AGE AND SEX (M/F)
=DGE JOHN 12 M
-HOSPITAL NUMBER ?
=123456
-ROOM NUMBER ?
=0501
-DOCTOR'S NAME AND SERVICE CODE ?
=TITELBAUM 50
-DIAGNOSIS ?
=HEAD TRAUMA
-PREDISPOSITION ?
=POLEY
-ENTER TWO DATES AS MONTH, DAY AND YEAR :
-DATE OF ADMISSION AND DATE OF CULTURE
=7 15 79 3 10 79
-TYPE OF INFECTION: HOS/ROOM ACQUIRED ?
=HOS
-SITE/SAMPLE ?
=URINE
-ORGANISM ?
=ENTEROCOCCUS
-ABCDEFGHIJKLMNAPQRSTT
=1 01 1 0000 0 0 00

ANTIBIOGRAM?

Patient's name
Doctor's name
```

AGE	JOHN	ENTEROCOCCUS	URINE	HOS
7 15 79	12 M	TITELBAUM	123456	50
3 10 79	HEAD TRAUMA	POLEY	1 01 1 0000	0 0 00

Fig. 4 The new data entry procedure. The last three lines summarize the data that has been entered and allows a review for errors as well as provide a hard copy for permanent file.

LABORATORY REPORT - CHART COPY

LABORATORIES OF
NEWARK DEBETH ISRAEL MEDICAL CENTER

REQUESTED BY	DATE OF SPECIMEN																																																																																																																																																																																																																																																																																																																																																																																																																																				
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Fig. 5 The microbiology culture report. The antibiotic sequence in the computer display follows the same order as shown in the laboratory slip.

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INDICATE (0) NO UPDATE, (1) UPDATE, OR (3) PURGE
=1
GIVE LAST AND FIRST NAME OF THE PATIENT IN QUESTION
=DOE JOHN

DOE          JOHN          ENTEROCOCCUS  URINE  HOS
 7 13 79    12 M  0501    TITELBAUM  123456  50
 8 10 79    HEAD TRAUMA  FOLEY      1 01 1 0000  0 0 00

-GIVE PATIENTS LAST AND FIRST NAME, A L AND SEX (M/F)
=DOE JOHN 12 M
-HOSPITAL NUMBER ?
=123456
-ROOM NUMBER ?
=0501
-DOCTOR'S NAME AND SERVICE CODE ?
=TITELBAUM 50
-DIAGNOSIS ?
=HEAD TRAUMA
-PREDISPOSITION ?
=FOLEY
-ENTER TWO DATES AS MONTH, DAY AND YEAR :
-DATE OF ADMISSION AND DATE OF CULTURE
=7 13 79 8 13 79
-TYPE OF INFECTION: HOS/ROOM ACQUIRED ?
=HOS
-SITE/SAMPLE ?
=URINE
-ORGANISM ?
=ENTEROCOCCUS
-ABCDEFGHIJKLMNPPSSSTT          ANTIBIOGRAM?
=1 01 1 0000  0 0 00

DOE          JOHN          ENTEROCOCCUS  URINE  HOS
 7 13 79    12 M  0501    TITELBAUM  123456  50
 8 10 79    HEAD TRAUMA  FOLEY      1 01 1 0000  0 0 00
DATA OF DOE          JOHN          HAVE BEEN CORRECTED/PURGED
  
```

Fig. 6 The data update. The original patient data is displayed first followed by the corrective dialogue. The last four lines display the corrected data. Note the encircled dates representing the error and the correction.

REVIEW BY (1) ORGANISM, (2) PHYSICIAN, (3) SITE, (4) DATES, (5) NAME,
(6) LOCATION OR (0) NO FURTHER REVIEW
=1

INDICATE THE ORGANISM
=E COLI

SENSITIVITY OF E COLI

SENSITIVITY OF E COLI		ABCDEFGHIJKLMNPPRSTT				
XXXXXXXX	LYXXXXXXXX	URINE	1111	111	1	11 11
8 9 79	CHF	A622 HOS				
XXXXXXXX	EMXXXX	URINE	1111	111	1	11 11
8 13 79	TOP	D322 HOS				
XXXXXXXX	XXXXXXXX	URINE	1111	111	1	11 11
8 20 79	MYOCARD DEGEN	B404 HHOS				
XXXXXXXX	XXXXXXXX	URINE	1111	111	1	11 11
8 20 79	METASTATIC CA	A407 HOS				
XXXX	LXXXX	URINE	1111	111	1	11 11
8 27 79	PERITON HERNIA	B415 HOS				
XXXXXX	XXXX	BLOOD	0011	10		1 0 01
8 28 79	CRF	F435 HOS				

Fig. 7 The organism review. The antibiotic names are abbreviated and read downwards. 1 indicates sensitivity while 0 denotes resistance. Patients' names are masked to preserve confidentiality.

REVIEW BY (1) ORGANISM, (2) PHYSICIAN, (3) SITE, (4) DATES, (5) NAME,
(6) LOCATION OR (0) NO FURTHER REVIEW
=2

INDICATE THE ATTENDING PHYSICIAN
=BRFC

REVIEW OF ALL OF DR. BRFC		VS PATIENTS				
XXXXXXXX	8408	BETA STREP S	1 11 1	0011		1 0 00
XXXXXXXX	8717	K PNEUMONIAE	0011	111 1		11 11
XXXXXX	8709	P MIRABILIS	1110	11		0 1 01
XXXXXXXX	8710	ENTEROCOCCUS	1101	100 0		300 00

Fig. 8 Review of patients according to the attending physician responsible for their care.

REVIEW BY (1) ORGANISM, (2) PHYSICIAN, (3) SITE, (4) DATES, (5) NAME,
(6) LOCATION OR (0) NO FURTHER REVIEW
#3

INDICATE SITE/SOURCE OF INFECTION
#BLOOD

REVIEW OF ALL BLOOD CULTURES							
XXXXXXXX	F307	STAPH AUREUS	1111	1	1111	1	1 11
XXXXXXXX	D994	PSEUDOMONAS FLU0100	010			1	0 01
XXXXXX	2401	STAPH AUREUS	1	11	1 1111	1	1 11
XXXXXXXX	C603	MICROCOCCUS	0	11	0 1010	0	0 01
XXXXXX	F436	E COLI	0011		10	1	0 01

Fig. 9 Review according to the site of infection. The list above represents patients with nosocomial sepsis identified during a specified time period.

REVIEW BY (1) ORGANISM, (2) PHYSICIAN, (3) SITE, (4) DATES, (5) NAME,
(6) LOCATION OR (0) NO FURTHER REVIEW
#1

FOR A SEQUENCED REVIEW OF CASES ORDERED BY DATE OF CULTURE
INDICATE FIRST AND LAST DATE OF SEARCH AS MONTH, DAY AND YEAR
#8 1 79 3 7 79

REVIEW OF ALL CASES BETWEEN		8 1 79 AND	3 7 79				
XXXXXXXX	XXXXXXXX	P MIRABILIS	VAGINAL	HQS			
	15 F D334	XXXXXXXX	121190	44			
3 1 79	TOP	SURGERY	1111	11		0	1 01
XXXXXXXX	XXXXXXXX	S AUREUS	WOUND	HQS			
	-1 F D993	XXXXXXXX	142357	49			
3 3 79	PREMATURITY	SURGERY	9 11 1	0011		0	1 10
XXXXXXXX	XXXXXXXX	BETA STREP B	URINE	HQS			
	35 F 2608	BRFC	150926	44			
3 3 79	0UB	FOLEY	1 11 1	0011		1	0 00
XXXXXXXX	XXXXXX	E CLOACAE	WOUND	HQS			
	55 M 9607	DHT	152130	61			
3 3 79	CAD	SURGERY	0101	01		1	1 11
XXXXXX	XXXXXXXX	E AEROGENES	URINE	HQS			
	32 M 8616	XXXXXXXX	152576	60			
3 6 79	ESOPH VARIX	FOLEY	0101	011		1	11 11
XXXXXX	XXXXXX	BETA STREP B	LOCHIA	HQS			
	17 F A703	XXXXXXXX	106758	40			
3 7 79	PREGNANCY	SURGERY	1 11 1	0011		1	0 00

Fig. 10 Review according to a specified time period. Patients' and doctors' names are masked to preserve confidentiality.

```
REVIEW BY (1) ORGANISM, (2) PHYSICIAN, (3) SITE, (4) DATES, (5) NAME,
(6) LOCATION OR (0) NO FURTHER REVIEW
=#
GIVE PATIENTS LAST AND FIRST NAME
=#002 JOHN
002      JOHN      ENTEROCOCCUS  URINE      HOS
  7 15 79  12 M  0501  TITELBAUM  123456     50
  8 15 79  HEAD TRAUMA  FOLEY      1 01 1 0000  0 0 00
```

Fig. 11 Review or search for individual patient data.

```
REVIEW BY (1) ORGANISM, (2) PHYSICIAN, (3) SITE, (4) DATES, (5) NAME,
(6) LOCATION OR (0) NO FURTHER REVIEW
=#
INDICATE WING AND FLOOR AS A LETTER/NUMBER COMBINATION (E.G. "03")
=#03
REVIEW OF ALL CASES IN LOCATION #3
F3052  F307  STAPH AUREUS  1111 1 1111  1 1 11
J30522  F305  S EPIDERMIDIS  0 11 0 1110  0 1 01
```

Fig. 12 Review by location in the hospital.

REFERENCES

1. Barnett GO: Computers in patient care. N Engl J Med 279: 1321-1327, 1968.
2. Good, A and Greenhalgh, P: Effective infection surveillance using a computer. J Clin Computing 4:298-310, 1975.