

A MEDICAL RESEARCH MANAGEMENT SYSTEM USING SAS/ASSIST AND SAS/FSP

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INTRODUCTION

The Mayo Clinic is a private group practice of medicine whose team approach to medicine dates back to the turn of the century. The Mayo Clinic is the largest medical complex in the world and provides patients with virtually every kind of medical expertise, treatment and diagnostic tool. Mayo's patient care activities are intertwined with and supported by extensive programs in medical education and research. The large amount of clinical information available at the Mayo Clinic permits a rich environment for research. Patients numbering over 289,000 in 1990 and over 4.3 million since 1907 give researchers many opportunities for studies on a great variety of retrospective and prospective research projects.¹

At the Mayo Clinic the storage of patient information is a combination of paper, computerized test and clinical information, and patient indexing systems. The blood culture testing area, of the microbiology department, wanted to store information about their tests in a computerized form in addition to its reports in the medical history. This would allow the researchers to identify positive cultures (those in which bacteria were found) and analyze the data without the arduous task of calling the medical history each time that a study was designed.

In 1977, a SAS® based system was designed for microbiology blood cultures with technicians hand coding the information on data entry forms. Editing was done in a batch SAS® edit update program. The microbiology department moved to a computerized laboratory information

system in 1984. Clinical and laboratory functions determined the sizing of the laboratory information system, therefore the need to have the computer information transferred to the research computer for analysis still existed. The volume of data available for research use continues to grow. The numbers of cultures available on the active files are represented in Appendix I.

Changes were occurring in the microbiology department that made it imperative to take a new look at the research system. Microbiology information was already in electronic form on the clinical computer. The paper based data entry system was to be changed to add additional pediatric information. Additional terminals were being purchased. Physicians were requesting the ability to do queries on the patient population.

PROJECT DEFINITION

Joint application development (JAD)^{2,3,4} sessions were held to review the old system, determine information needs, information sources, and user requirements. From the JAD sessions the requirements emerged: transfer of the data electronically from the microbiology laboratory system, reduce technician time of paper coding everything to online coding only additional information not stored on the laboratory system, low development and maintenance costs, increase the quality of data, and give the user access to retrieval capabilities in an effort to lower programming costs and reduce lag time for research requests. Successive JADs were used to develop a prototype and gain user acceptance. The final

JADs developed a conversion plan and data transfer plan.

METHODS OVERVIEW

The goal was to define an online database system that incorporates a method of data transfer that will prefill a majority of the data entry points for the user and provide error checking capabilities for data correction. The process of transferring data from the microbiology system, error reports at the time of data transfer, and error checks at the time of data entry were defined. Along with the issues of data transfer, on-line retrieval and user access to reporting and statistical procedures were also needed.

The resulting system uses user controlled data verification tables to prefill those data entry points at the time of data transfer, and do cross-table validation during data transfer and data entry. The system uses Base SAS Version 6.06 as the data transfer tool, SAS/FSP® as the data entry tool, SAS/SCL® as the error checking tool, SAS/ASSIST® as the retrieval and statistical analysis tool, and SAS/EIS® was used to create the system with point and click menus.

ENVIRONMENT

The data that is transferred comes from a VAX/VMS system and is uploaded to the SAS® environment on an IBM 3090 mainframe under MVS/ESA.

THE DEVELOPMENT OF THE ON-LINE MICROBIOLOGY SYSTEM

The first step that needed to be taken was the defining of the tables that needed to be developed. The end result was one main table for data entry and three normalized data-verification tables. One normalized table is the organism table. An organism is a bacteria and this table consists of one observation for each unique bacteria used in the microbiology area. A media is a substance that is used to grow bacteria. The media table is a second such table that also has one observation for every medium

used. The third data-verification table is the detection systems table. This table identifies all unique sets of media used for detection of bacteria for a blood sample. Furthermore, because a conversion needed to be done between the old and new systems for organisms, an entry point was added in the organism table for the user to enter those conversion codes.

After the tables were defined, the next step was building the screens for all of these tables using SAS/FSP® so the users could start building the verification tables and do the organism conversion. SAS/SCL® code was then added to flag the data entry errors and do the cross-table validation that was defined in the JAD sessions. To make the system (user friendly) a block menu front end using SAS/EIS® was built. And finally, the last step was to convert the old data, load it into the system, and set up the procedures to do monthly updates to add the new data.

On the data entry table there are a possible 46 data entry points that need to be filled in. When the old system was in place the user would read the culture report and transcribe the information onto a 26 entry point coding sheet that would be sent to keypunch and then uploaded. The new system is comprised of a procedure to electronically download the needed information from the VAX/VMS system onto a diskette. That diskette gets uploaded electronically into the SAS® system and 31 entry points are prefilled. At that time, error reports are also printed for invalid detection systems, organisms, and patients. These reports are given to the users to correct on-line.

USER OPERATION OF THE SYSTEM

Patient demographic data is prefilled from the Mayo registration files and the other data fields are taken care of by the validation tables. The users now only need to enter a possible 14 results of the media and check to see if four of the 31 entry points have been prefilled correctly. When the user completes data entry, the SAS/SCL® code is run to catch any other typing errors that could have occurred. These checks consist of making sure required entry points are

filled, if one point is filled, then an answer is required in a second field, cross-validation between data fields, and cross-table validation. When these errors occur the entry person has to fix them before he/she moves on to the next patient. This greatly decreases the data error rate.

EXPERIENCE AND LESSONS LEARNED FROM THE SYSTEM

Our users were given the ability to enter data into the validation tables before the SAS/EIS® front-end was developed. SAS/ASSIST® was adequate and our users could follow the steps needed to get to the wanted file, but after experiencing the point and click, front-end block menu they would never go back to the old way. Our users do not care what the names of files are and do not want to have to remember those names. The block menu gave them the ability to bypass the unwanted computer names and reference a file with a term that is more useful to them. Block menu selection also speeds up productivity and reduces user error.

The system was developed without any prior knowledge or experience in SAS Version 6.06. Accessing SAS/FSP® through SAS/ASSIST® was very easy to learn. The SAS Screen Control Language manual was very easy to use and made the learning curve very short. Because there are so many functions and ways to write SAS/SCL® code; finding the most efficient way became a challenge. The SAS/EIS® product was a little more difficult to understand and use. A previous SUGI paper, "SAS/ASSIST® Software under Release 6.06,"® explained the process of developing a front-end. Additional projects using SAS/EIS® now take minimal time due to the ease of the product.

SUCCESS AND FUTURE DIRECTIONS

With the system that was developed our user requirements were satisfied. Data transfer was done using Base SAS® which then lead to minimal data entry using SAS/ASSIST® and SAS/FSP®. Better quality data was also a result of electronically transferring data and

incorporating SAS/SCL® for extensive online checking. Development time was minimal due to the use of SAS/EIS® and SAS/ASSIST®. When using the old system it took our users about six hours to transcribe data onto coding sheets each month. Even though our users are novice computer users and we are capturing 20 more data entry points, it took under five hours to enter the positivity results. Along with the benefits of better quality data, as our users become more experienced, time savings will grow. Future directions will include more training in using SAS/ASSIST® to do statistical analysis and report writing.

APPENDIX I

Cultures on Active Data Base

	Blood Cultures Received	Blood Cultures Positive
1980	26,321	2,466
1981	27,455	2,504
1982	27,634	3,027
1983	31,955	4,995
1984	29,453	4,693
1985	30,515	3,927
1986	33,359	4,087
1987	34,656	3,316
1988	35,913	3,387
1989	34,846	2,800
1990	37,362	2,750

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