The National Institutes of Health (NIH) funds 75 General Clinical Research Centers (GCRC) around the country. In these centers clinical investigators can perform research studies on subjects in a supportive environment. Facilities available to clinical investigators include: inpatient and outpatient beds, a core research laboratory, a computing facility, and a metabolic kitchen. On an annual basis the NIH requires that each center provide a large volume of statistical data which reports the utilization of the facility during the funding period. Due to the large number of inpatients and outpatients seen in the GCRC at the University of Rochester and the reporting requirements of the NIH, management of patient data has become an unwieldy task.

PROBLEM STATEMENT:

During the period from 1986 through 1990, all census data were managed by personal computer (pc) based software. The pc method was an improvement over the previous manual method, but in many cases large reports would require processing times of up to 50 minutes. This was not effective for the staff who utilized the system. In addition, there was no network in place and sharing of data required physical movement on the part of staff to the central pc where data were stored.

It was necessary to find a more efficient system to perform data management and analysis tasks for this application. Major requirements of this system were that the system be accessible by multiple users simultaneously, that it be "user friendly", and that processing time be decreased substantially.

The requirement that the system be "user friendly" posed a problem. The GCRC Computing Facility consists of 3 networked VAXStation 3100's running a variety of SAS® Software components. SAS Software requires a substantial knowledge of programming and staff involved in the utilization of the system had no knowledge of programming. Although SAS software does contain a menu based product, a more automated system was necessary to produce successful user acceptance of the software system. Therefore, it was decided to utilize the VMS DCL language to provide a menu driven front end for pre programmed SAS analyses.

In December of 1990 all data were moved to the GCRC Computing Facility and the SAS software system. Staff personal computers were able to gain access to the GCRC Computing Facility Hardware through University of Rochester telephone communications (ROLM System).

SYSTEM DESCRIPTION:

The GCRC Census System at the University of Rochester is designed with the casual SAS user in mind. When the user logs into the VMS system through the authorized account, a batch file is executed as part of the login command file from VMS. This file begins by providing main menu choices as shown below.

****************************************
* WELCOME TO THE GCRC CENSUS *
* SYSTEM *
****************************************

YOU HAVE THE FOLLOWING OPTIONS:

1. QUIT
2. PROTOCOLS
3. OUTPATIENT CENSUS
4. INPATIENT CENSUS

PLEASE ENTER THE OPTION NUMBER:

Users choose from a list of options on the main menu. The choice leads to another menu of more specific options; to a SAS software application; or
to the automatic production of a report with transfer of the output to a laser printer queue.

If the user depresses the number 1 at this point, an indication is made that work in the census system is complete. Choosing to quit will automatically log the individual off the system and purge all irrelevant files. This keeps disk utilization to a minimum. It is not necessary for the individual to have any real knowledge of VMS or the VAX system since all clean up utilities are performed by the command file.

The remainder of the main menu leads the user to the three main sections which comprise the GCRC Census System.

PROTOCOL SUB-SYSTEM:

The census system is based on the existence of approved protocols. Patients may not be admitted to the GCRC unless a protocol has been submitted and approved by the GCRC Advisory Committee and the Institutional Review Board. A large amount of information is stored about each protocol. These data are generally textual in nature and only one record exists in the SAS data set for each approved protocol.

The Protocol Options menu consists of the ability to enter and/or edit protocol data, produce a variety of protocol lists, or return to the main menu as shown here.

******************************************************
* PROTOCOL OPTIONS *
******************************************************
YOU HAVE THE FOLLOWING OPTIONS:

0. RETURN TO MAIN MENU 1. ENTER/EDIT PROTOCOL DATA
2. PRINT ACTIVE NUMERIC PROTOCOL LIST
3. PRINT ACTIVE ALPHABETIC PROTOCOL LIST
4. PRINT TERMINATED PROTOCOL LIST

PLEASE ENTER THE OPTION NUMBER:

Option 0 will return the user to the main menu.

Option 1 will lead the user to a customized data entry screen created utilizing the SAS/FSP® Software. In the case of protocol data, 2 screens are required to complete the data entry. The standard full screen product commands are available to the user. The user may also invoke the SAS/ASSIST® program while inside the program screen if she/he is familiar with this product.

An example of the protocol data entry screen is provided below.

FSEDIT SASUSER.PROT -------Obs 1 Screen 1
NOTE: This application uses 2 screens.

PROTOCOL: ______ PRININV: ______
PI DEPT: _________________________
OTHER INVEST: _________________________
OTHER DEPTS: _________________________
TITLE: _________________________

AXIS I: _______ AXIS II: _______
CRC APR DATE: (MMDDYY)
SCIENCE: _______ NEED FOR CRC: _______
HUMAN INVEST APPROVAL DATE: _______

Options 2 through 4 produce standardized reports which consist of protocol lists in a variety of formats. Selection criteria are used to limit the protocols which will be included in a report. A menu choice begins a SAS application and creates the usual log and list files. The list file is automatically sent to the laser printer queue on the VAX system. Extensive use of PROC SORT and the PUT statement is used in this portion of the SAS programs.

OUTPATIENT SUB-SYSTEM:

The second component of the GCRC Census System is the Outpatient census. In this section, all outpatients seen on the CRC are recorded according to NIH guidelines. The management of actual patient data in both the inpatient and outpatient categories is the main focus of the census system. Here, more complex statistical reporting procedures can be found. The menu for the system is shown next.
OUTPATIENT OPTIONS

YOU HAVE THE FOLLOWING OPTIONS:

0. RETURN TO MAIN MENU
1. ENTER/EDIT OUTPATIENT DATA
2. PRINT MONTHLY OUTPATIENT LIST
3. PRINT OUTPATIENT PROTOCOL REPORT
4. PRINT TOTAL OUTPATIENT REPORT
5. PRINT OUTPATIENT CHARGE DATA
6. PRINT MONTHLY PROTOCOL SUMMARY

PLEASE ENTER THE OPTION NUMBER:

As in the previous sub-system, option 0 returns the user to the main menu and option 1 invokes the FSP product and calls up a customized outpatient screen for data entry. The outpatient data entry process consists of one screen and includes all information regarding the patient admission. Major points of interest in the data entry screen include the patient name, date of service, hospital unit number, protocol number, and information regarding research category and visit category for each patient. Additional information which is added to the data entry form is patient ancillary charge data. Ancillary charges are separated into various categories such as laboratory, pharmacy, radiology and others. A negotiated percentage is applied to the base charge resulting in an appropriate charge to the center for services.

Option number 2 provides a list of patients seen in the department as outpatients for a specified month. The user is given another menu of options to specify the desired month or the entire grant year at this point.

Additional options are available on this menu which provide the capability to move between the outpatient options and the main menu. Accessing the outpatient month options by choosing option 2 places the user down three levels in the menu system. The capability of moving to the main menu from this level saves a step for the user.

The outpatient month options menu is displayed below. Options 1 through 12 allow the user to produce reports for specific months. Option 13 provides the entire outpatient census for the grant year. You will note that these options begin with the month of December because the funding period for the University of Rochester GCRC runs from December through November.

OUTPATIENT MONTH OPTIONS

YOU HAVE THE FOLLOWING OPTIONS:

M. RETURN TO MAIN MENU
0. RETURN TO OUTPATIENT MENU
1. DECEMBER CENSUS
2. JANUARY CENSUS
3. FEBRUARY CENSUS
4. MARCH CENSUS
5. APRIL CENSUS
6. MAY CENSUS
7. JUNE CENSUS
8. JULY CENSUS
9. AUGUST CENSUS
10. SEPTEMBER CENSUS
11. OCTOBER CENSUS
12. NOVEMBER CENSUS
13. COMPLETE CENSUS

PLEASE ENTER THE OPTION NUMBER:

Option 3 on the main outpatient menu provides the user with admission data by protocol including summary statistics and ancillary charge data.

Option 4 produces a 2 page summary report of patient admissions by patient category and by duration of visit. PROC TABULATE and PROC FORMAT are utilized to produce this output. Typical processing time for this report is about 3 minutes. In the previous system, a minimum of 45 minutes was required to complete the report.

Selections number 4 and 5 on the outpatient options menu are simple reports which summarize and tally patient charge data and handle monthly statistics for each protocol. These two are mainly used as interim reporting mechanisms for the center.
INPATIENT SUB-SYSTEM:

The most complex portion of the GCRC Census system is the inpatient data management system. On the exterior it is quite similar to the outpatient tracking system because it simply records the patient's admission data. However, part of the recorded information includes admission and discharge date. It is necessary to look at length of stay statistics and look at patient days over each month to provide utilization figures to the NIH. The analysis would be quite simple if patients were always admitted and discharged in the same month, but this is often not the case. In many instances the patient crosses several months and an algorithm was devised to handle these calculations. The inpatient options menu is shown below.

*********************************************************
* INPATIENT OPTIONS                                      *
*********************************************************
YOU HAVE THE FOLLOWING OPTIONS:
0. RETURN TO MAIN MENU
1. ENTER/EDIT INPATIENT DATA
2. PRINT MONTHLY INPATIENT LIST
3. PRINT INPATIENT PROTOCOL REPORT
4. PRINT TOTAL INPATIENT REPORT
5. PRINT INPATIENT CHARGE DATA
6. PRINT MONTHLY PROTOCOL SUMMARY
7. PRINT "C" PATIENT LIST
8. PRINT BILLING LETTERS

PLEASE ENTER THE OPTION NUMBER:

The inpatient sub-system menus resemble the outpatient menus with a few options added to the list of choices.

Option 0 returns the user to the main menu. Choosing number 1 takes the user to another custom screen where data entry for each patient admission will be performed. This screen is very similar to the one used for outpatients. The format of this screen and the outpatient data entry screen includes a list of SAS/FSP Software commands in a small box at the top of the form. This provides an online reference for users.

Additional user help is provided through on screen lists of possible values next to a field. This limits the amount of time required for the user to look up field requirement information. The fields MD and DX are only required for patients whose type is "C". This is denoted by the information in the brackets adjacent to these fields.

FSEDIT SASUSER.INPT ____________NEW COMMAND ===>

| GCRC INPATIENT CENSUS DATA ENTRY |
| FORM                              |
| RETURN - Next Field ADD - new record |
| ENTER - Add Record DEL - Delete rec |
| FORW - Next Record END - Leave scrn |
| BACW - Go Back 1 Record           |
| Last Name:_____ First Name:_____  |
| Unit #:_____ Prot #:_____ Ins Code:_____  |
| Admit Dt:_____ Discharge Date:_____ mmddyy |
| Type:_____ {A,B} Pt Age:_____ Age Type:_____  |
| MD:_____ DX:_____ {"C" type} |
| LAB:_____ EEG:_____ CAT SCAN:_____ OP:_____ |
| EKG:_____ INH:_____ IV THER:_____ CPL:_____ |
| PHARM:_____ RADIOL:_____ OTHER:_____ |

Inpatient option number 2 is similar to the outpatient report because it produces a list of inpatient admissions sorted by admission date. The report also contains a length of stay calculation which is derived by subtracting the discharge date from the admission date. Extensive use is made of PROC SORT and PROC PRINT. It is important to note that the submenu of Inpatient Month Options is also available so that users may choose to print the report for the entire grant year or a specified month. Total length of stay is derived by summing the length of stay field and summary calculations are made for days by patient type.

Production of the inpatient protocol report (option 3), inpatient charge data report (option 5) and inpatient monthly protocol summary (option 6) are the same as in the outpatient category except for the inclusion of the length of stay calculations.

Option 7 "Print C Patient List" is a new report which is only necessary for the inpatient category. From time to time it is necessary to admit patients to the research floor who are not research patients.
but require hospitalization for medical reasons. These patients are listed as type “C” and must be reported separately to the NIH. This report includes information about the patient’s length of stay, admitting physician and diagnosis code.

Option 8 on the Inpatient Options menu is also specific to this group of patients. Each time a patient is admitted and discharged from the GCRC a letter is sent to the Hospital Accounting Department including information regarding accounts to be charged for the admission. The SAS/FSP software component PROC FSLETTER is used to produce these standardized letters.

The most complex report produced by the GCRC Census System is option 4 on the Inpatient Options menu. The Total Inpatient report initially required 50 to 60 minutes of processing time on a personal computer. The scope of this report is so large and requires so many calculations by multiple categories, that it was much too large to be handled by a pc. Current processing time on the SAS Software system is approximately 4 minutes.

The protocol number in both inpatient and outpatient records is a link field to the protocol data set discussed previously. Information regarding protocol title and principal investigator are merged with records in these data bases to produce the Monthly Inpatient and Outpatient lists (option 2 on both menus). The entire protocol record is merged with admission records to produce the Inpatient and Outpatient protocol reports (option 3 on both menus).

CONCLUSION:

Movement of the GCRC Census management system to a VAX based computer system has made a major contribution to productivity at the University of Rochester. Processing time has decreased dramatically as shown above. This has increased staff productivity.

The ability to provide a multiuser environment on the VAX system for shared data has eliminated the need for purchase, installation and management of a pc based network. The pc based networks can increase costs drastically and require a certain amount of computer expertise for daily management.

The standard policy of the GCRC Computing Facility at the University of Rochester is to provide daily incremental and weekly full back up of all user data. Previous back up schedules for the pc were inconsistent and in many cases were not performed for several weeks. A system failure at any time would have meant excessive loss of valuable census data. The GCRC VAX computing environment provides a secure password based environment with a standard backup schedule.

The DCL language available on the VAX computer is a flexible tool which interacts effectively with the SAS Software System. The overall concept of this project can be applied to other data management and analysis projects where standardized reporting is required.

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