USING SAS® SOFTWARE TO DEVELOP ON-LINE PREGNANCY REGISTRY SYSTEM

Jean Fletcher, Burroughs Wellcome Co.

ABSTRACT

Release 6.07 of The SAS System for information delivery has extended its capabilities for data access, data management, data analysis, and data presentation. It also has enriched the environment for SAS application development.

This paper discusses how we integrated several SAS products, SAS/AF®, SAS/FSP®, SAS/BASE®, SAS® Screen Control Language (SCL), and SAS Structured Query Language (SQL) in version 6.07 to develop a user-friendly on-line information system - Pregnancy Registry System (PRS).

INTRODUCTION

The Pregnancy Registry System (PRS) was developed to support the Burroughs Wellcome Co. pregnancy registries. The Acyclovir in Pregnancy and Zidovudine in pregnancy registries are exposure-registration studies designed to collect observational, non-experimental data on drug-specific exposures during pregnancy. Some of the registry activities are entering cases into databases, maintaining case files, monitoring case status, recording pregnancy outcome and subsequent case closure, issuing initial and follow-up letters, performing data analyses, presenting data for periodic reports, and generating mass mailing to several hundred doctors periodically.

DATA MANAGEMENT

At the present time, the Pregnancy Registry System handles two pregnancy registry studies: AZT-Zidovudine and ACV-Acyclovir. Three permanent databases were set up for case management.

ACVPAT - Acyclovir Patient Data Set
AZTPAT - Zidovudine Patient Data Set
DOCTOR - Doctor Data Set

In the doctor data set, there is a field called STUDY. STUDY contains one of three values:

'C' - for the Acyclovir (ACV) study
'Z' - for the Zidovudine (AZT) study
'B' - both studies. Some doctors have patients in both studies.

In the patient data sets, there is a field called ACTDR indicating the active doctor number. ACTDR is obtained from the DRID (doctor id number) in the doctor data set.

SYSTEM OVERVIEW

The Pregnancy Registry System is a menu-driven interactive system which provides the user with up-to-date technology to process information. The main menu of the Pregnancy Registry System (PRS) is shown on Figure 1 (all figures are in Appendix A).

The following are some of the functional capabilities of PRS:

- The use of SAS/FSP and SCL for creating data entry panels for all three permanent SAS data sets
- Entering/modifying/searching both doctor and patient data sets simultaneously
- Performing cross-field and cross-dataset user-input validation.
- The use of SAS/AF, SCL, and SQL for creating an extended table as a telephone screen which allows the user to:
  - Search and display doctor information by WHERE clauses (Figure 2)
  - List all the patients for the selected doctor (Figure 3)
  - Browse a selected patient information from extended table in FSBEGIN session
  - Generate initial/follow-up letter to the selected doctor by pulling data directly from doctor and patient data sets
- The use of the PROC FSLETTER procedure for generating a mass mailing or an individual letter from fifty different kinds of letters stored in the LETTER catalog by retrieving data directly from doctor and patient data sets.
- The use of the PROC FORM procedure for generating mailing labels with special print margins and fonts on IBM 3816 by specifying user defined PAGEDEF and FORMDEF in FORM window.
- Data can be retrieved by either viewing on the screen or outputting to a printer.
- Performing data analysis.
- Generating tables and charts for periodic reports.

DISCUSSION

User Input Validation: Cross-Dataset Validation

For each patient (case) in the study, there must be an active doctor associated with it. When a new patient is registered, the ACTDR (active doctor id) must be entered in the patient data entry panel. The SCL program provides a selection list for all of the doctors in the doctor data set. The ACTDR should match the DRID (doctor id) in the doctor data set. If ACTDR does not match DRID, an error message will be displayed on the screen.
FSEINIT:
/* open doctor data set */
dsid3 = open('afregist.doctor, 'i');
if dsid3 = ° then _msg_ = sysmsgO;
control label;
return ;

INIT:
control always ;
return ;

RACTDR:
if _status_ ne 'C' and ractdr ne. then do;
rc=locaten(dsid3,vamum(dsid3,'drid'),ractdr,' ','a') ;
if rc <= 0 or ractdr eq 0 then do ;
cursor ractdr ;
raetdr=datalistn(dsid3, 'drid driirst driast drizip',
'Choose an active Doctor ID:','y');
end;
patid=patid ;
/* assign patid to patid for index */
drid = ractdr ;
/* assign a new doctor id */
study='Z';
end ;

Displaying Information from Multiple Data Sets

SAS/AF is an extremely powerful tool which gives application programmers the ability to develop "user friendly" systems to perform a variety of different tasks. Creating a dynamic extended table using Screen Control Language (SCL) in SAS/AF has opened a brand new world for information display.

An extended table is a structure that allows repeated rows of data to be displayed on the terminal. Within SAS/AF, the programmer creates a model row of what to display in that row. When executed, the linked data set will fill the screen as a selection list. A user can then scroll through each page of data and make selections. The extended table is a dynamic data structure, i.e., there is no limit to the number of rows that can be retrieved.

- Searching and displaying doctor information in the extended table by using WHERE clause: (Figure 2)

... more ...
The GETROW and PUTROW sections in the SASIAF PROGRAM source code must be included to display and process the table. The GETROW section reads and displays each observation which meets search criteria from the doctor data set. If the user issues the UP or DOWN command, previous or subsequent observations will be read and displayed on the screen. The PUTROW section will call two other programs: PHONVIEW.PROGRAM and DRTELE.PROGRAM.

PHONVIEW.PROGRAM creates a SAS data view called AFREGIST.PHONVIEW using the SQL procedure.

- Displays information from three different SAS data sets (ACVPT, AZTPT, and DOCTOR) in the extended table (Figure 3).

The top part of the screen (Figure 3) displays the doctor's mailing address which is stored in a SAS data view created from SQL procedure (see code below). The bottom part comes from two patient data sets. The field STUDY indicates which data set a patient belongs to (AZTPT or ACVPT). PROC SQL is the vehicle used for gathering and joining the selected observations and variables into a data set for subsequent processing. This data set is linked to this extended table within Screen Control Language (SCL) so that all the information appears in a table. The user can scroll and select a patient by placing the cursor on a patient and pressing the enter key. This selection will take the user to the FSBROWSE subset session for detailed information about the selected patient.

DRTELE.PROGRAM
- displays the information accessed by the view PHONVIEW.

The SAS data view PHONVIEW is opened and is subsetted according to the doctor's full-name and city using the WHERE = data set option. The FETCH and SET functions link the data set values with SCL screen variables and display them on the top part of screen (Figure 3).

Here is a source code sample for the top part of Figure 3:

```sas
* Program : DRTELE.PROGRAM (called by phonlet.pgm) */
* - Display doctor's information by accessing */
* phoneview data view */
* - Displays a list of patients for the user to choose */
* from, or allows selection of a patient during telephone/ */
* conversations with doctor. */
***********************************************************************/
entry
drid 5
dfirst $10
dlast $20
dcity $25
dstate $2
dstudy $1:
init:
length dsname $15 ;
control label ;
dsid=opan(' afregist.phonview(where=(drfirst=""||drfirst||"" and */
dlast=""||dlast||"" and */
dcity=""||dcity||""),"")) ;
call set(dsid) ;
rc=fetch(dsid) ;
rc=close(dsid) ;
... continued ...
```

DRTELE.PROGRAM also creates a new extended table (the bottom part of Figure 3) and displays all the patients who belong to the selected doctor. This extended table will be used as a new selection list for further displaying a patient information in the FSBROSE session.

The SAS SQL interface is used to extract a subset of patient data set(s) by using the doctor-patient index in the AFREGIST.REGDRPT data set and simultaneously obtain the number of rows (NROWS) in the extended table. Once the SAS SQL data set is created and the number of rows is determined, SAS SCl sets up the framework and the available options of the table with the SETROW statement.

The GETROW section will read and display each observation from the SAS SQL data set. The SQL data set will be a joined subset of AFREGIST.ACVPAT and AFREGIST.AZTPAT data sets. If the selected doctor has patients in both studies.
/* to create a new extended table to display all the patients for this selected doctor (shown at top part of Figure 3) from both studies */
/* initialize the dynamic table */
call setrow(0,1,'n','y') ;
control asis ;
submit continue;
options sortpgm=sas ;
data acvdrpt(keep=patid drid study) ;
set afregist.acvpat ;
r rename ractdr=drid ;
length sludy $ 1. ;
if ractdr ne . then do ;
study='C' ;
output ;
end ;
run ;
data aztdrpt(keep=patid drid study) ;
set afregist.aztpat ;
r rename ractdr=drid ;
length study $ 1. ;
if ractdr ne . then do ;
study='Z' ;
output ;
end ;
run ;
data comb; set acvdrpt aztdrpt ;
run;
proc sort data=comb out=afregist.regdrpt ; by drid patid ;
run;
/*/ submit SCL code to get patient information by drid */
/*/ from index dataset afregist.regdrpt */
/*/ use two proc sql's */
proc sql ;
create table pt1 as
select patid, study
from afregist.regdrpt
where (a.patid=d.patid) and (a.study=d.study) ;
quit ;
run;
endsubmit;
end;
end;
end ;
end;
open patient datasets by drstudy */
if drstudy = 'C' then do ;
/* open acvpat data set in input mode */
dsname='afregist.acvpat' ;
link sqltbl ;
end ;
else do ;
if dstudy='Z' then do ;
dsname='afregist.ztpat' ;
call set(dsid) ;
control asis ;
submit continue ;
proc sql ;
create table pt1 as
select f.patid, f.patinil, f.rtype, f.rclose, f.patedd, f.rdate,
from a, afregist.acvpat as f
where (a.patid=f.patid) and (a.study=f.study) ;
quit ;
run ;
data pts : set pt1 pt2 ;
run ;
endsubmit ;
end ;
end:
/*/ associate all data set variables and SCL */
ptidrc=open(plS,'I') ;
if ptidrc=0 then return ; /* no patients for that doctor id */
call set(ptidrc) ;
ptobs = attm(ptidrc,'nobs') ;
call setrow(ptobs,1,'n','y') ;
return ;
main: return ;
term: rc=close(dsid) ;
rc=close(ptidrc) ;
rc=delete(work.letsef) ;
return ;
GETROW: if fetchobs(ptidrc,_curROW)=-1 then
call endtable0 ;
return ;
... continued ...

The PUT ROW section will branch to FSBRCGWSE session for the selected patient from the extended table.
The PUTROW and PUTROW sections provide an efficient method to display dataset observations that the user can easily select.

Generating Letters and Corresponding Mailing Labels

The PROC FSLETTER procedure in SAS/FSP software provides an interactive environment for composing, formatting, editing, storing, copying, moving, and printing all kinds of text. You can compose and print a simple letter for one person or personalized versions of a letter for many different recipients. Pregnancy Registry System has used the following features of PROC FSLETTER:

- Preparing a letter for one person
- Preparing letters for more than one person
- Printing letters using information from multiple SAS data sets
- Enhancing letter output by using specially defined forms

The information collected from figure 2 to 3 (selected the doctor and the corresponding patient) are stored in a temporary SAS data set called WORK.LETTER. Fields defined in the individual letter in the letter catalog will be filled in automatically with values from the data set WORK.LETTER in the FSLETTER SEND window.

Special forms are defined and stored along with letters in the AFREGIST.LETTER catalog. These forms contain specifications for formatting text and printing a document. CMS Print File Parameters in FORM window (screen #3) provides a new selection SELECT IBM 3800 Print File Parameters which is a new FORM window in the version 6.07 Base SAS software. User defined PAGEDEF and FORMDEF (ESP2), including the special print margin, font, and printer designation, are specified in IBM 3800 Print File Parameters window. The ESP2 also directs a document to be printed on the second bin of the printer which can be pre-loaded with letter-head paper.

CONCLUSION

The use of the SAS System has proven to be an effective tool for managing multiple databases and improving the quality and accessibility of information. In addition, Pregnancy Registry System demonstrates the power of the SAS System to integrate several products and interfaces into a user-friendly system which enables the user to enter, update, remove, construct queries, produce reports, generate letters, and create subdatasets for further analysis without having to write a single line of SAS code.
APPENDIX A:

Pregnancy Registry Main Menu
Select Option ==> 

Pregnancy Registry Main Menu
1) Access Doctor Information
2) Access ACV Patient Information
3) Access AZT Patient Information
4) Search/Telephone/Letter Panel
5) Letter Panel
6) Generate Doctor's Mailing Address
7) Print Doctor/Patient data set
8) Data Analysis
9) Search Patient(s) or Doctor(s) Infor Panel
10) Summary/Display/Statistics data set

Enter the number of your choice on the Command line or Press <F10> to Exit.

Doctor Information Search Panel
Command ==> 

NOTE: Where clause has been replaced.

Choose a variable name based on the DOCTOR Data Set
(Note: Value is assumed to be character)

Enter Variable Name: drcity (Enter ? for list)
Enter Search Value: New York

Move the cursor to the selected row and press enter:

<table>
<thead>
<tr>
<th>ID</th>
<th>First Name</th>
<th>Last Name</th>
<th>City</th>
<th>State</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>81</td>
<td>Paul</td>
<td>Temple</td>
<td>New York</td>
<td>NY</td>
<td>C</td>
</tr>
<tr>
<td>86</td>
<td>Sherly</td>
<td>Toze</td>
<td>New York</td>
<td>NY</td>
<td>C</td>
</tr>
<tr>
<td>88</td>
<td>Robert</td>
<td>Scott</td>
<td>New York</td>
<td>NY</td>
<td>Z</td>
</tr>
<tr>
<td>91</td>
<td>Tina</td>
<td>Arbeielt</td>
<td>New York</td>
<td>NY</td>
<td>C</td>
</tr>
<tr>
<td>203</td>
<td>Harold</td>
<td>Philips</td>
<td>New York</td>
<td>NY</td>
<td>Z</td>
</tr>
<tr>
<td>204</td>
<td>Rhoda</td>
<td>Spencer</td>
<td>New York</td>
<td>NY</td>
<td>B</td>
</tr>
</tbody>
</table>

TELEPHONE SCREEN
Command ==> 

Dr. Name: Rhoda Spencer M.D. ID #: 204
Address : OB/GYN-ID
Mount Oliver Medical Center
One Gustave L. Dive Place
Box 1173
New York , NY 23333
Phone #: 9190009999 Ext/Beep #: 8888 Study : B

Move the cursor to the selected row and press enter:

<table>
<thead>
<tr>
<th>ID</th>
<th>Initial</th>
<th>Type</th>
<th>Status</th>
<th>Date Delivery</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>E</td>
<td>G</td>
<td>C</td>
<td>06/05/91</td>
<td>Z</td>
</tr>
<tr>
<td>13</td>
<td>EBB</td>
<td>P</td>
<td>C</td>
<td>05/22/90</td>
<td>01/06/90</td>
</tr>
<tr>
<td>22</td>
<td>P</td>
<td>X</td>
<td>05/25/92</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>M</td>
<td>C</td>
<td>T</td>
<td>07/03/90</td>
<td>10/29/89</td>
</tr>
<tr>
<td>57</td>
<td>C</td>
<td>M</td>
<td>T</td>
<td>07/03/90</td>
<td>04/11/90</td>
</tr>
<tr>
<td>58</td>
<td>B</td>
<td>C</td>
<td>T</td>
<td>07/03/90</td>
<td>04/28/90</td>
</tr>
</tbody>
</table>

References

TRADEMARKS
SAS, SAS/AF, and SAS/FSP are registered trademarks or trademarks of SAS Institute Inc. in the USA and other countries © USA registration