Background

The Kid-Care System (not its real name) was devised as a quality assurance and medical education tool for pediatric care given in public hospitals. Each physician newly assigned to the Pediatric Emergency Room is given a set of guideline rules to be used when treating some commonly seen illnesses. Close to 300 items of information listed on the patient’s chart may be entered into a SAS data base. Kid-Care evaluates the doctors’ actions for adherence to the guidelines and identifies each instance when a non-authorized “exception” to the rules has occurred.

The Problem

In practice, when doctors and nurses review the summary reports, they often go back to the original patient chart so they can understand the circumstances surrounding the exceptions. They have complained about the great amount of time spent in retrieving and analyzing patient charts. “Can’t your computer,” they say, “give us the information we need and save us the time it takes to track down the records?”

The Data

The simplest way to meet this request would be to use PROC PRINT to list an individual patient’s record. One problem with this is that for any case, most data elements are normally missing. For example, say there are 20 variables pertaining to laboratory tests. The average patient may have only one or two tests or perhaps none. The rest are missing data, try telling a doctor to look through a PROC PRINT output of 300 data items when 85 to 90% of them contain missing data. Furthermore, the variable names are obscure, the use of variable name labels would add to the clutter, and most values would need to be decoded through the use of PROC FORMAT.

The Solution

All this led to the conclusion that this is a case for a fully-formatted report produced in a DATA _NULL_ step. To make things easy for the doctor, the report should be laid out in sections paralleling the patient’s chart.

The Individual Case Report was designed in just this way to retrieve from the data base as much information as the doctor would look for when reviewing patient records.

What about the previously mentioned missing data problem? If we just label 300 spaces on the report and leave 85% of them blank, we’d be back where we started with PROC PRINT. In practice, our solution was a compromise. A few items of information are so basic that a special place is reserved for them on each report, whether or not they appear for a particular case. Thus, spaces are furnished for patient and physician I.D., diagnosis, date and time of visit, age, temperature, etc. The balance of the information appears in the ‘chart’ format.

The “chart” format - For the information that typically varies from patient to patient, a different technique is used. The page is divided into four columns, each 30 characters wide. Column 1 is reserved for section headings, such as “History”, “Physical Exam”, “RX”, “Follow-Up”, etc. If there is no data for a section, the heading appears in column 1 and the rest of the line remains blank. However, say a patient was given penicillin and dietary advice (i.e., drink hot liquids). “RX” would appear in column 1, “Penicillin” in column 2, and “Diet” in column 3. If 5 tests were done, “Work-Up” appears in column 1: and the five tests with their results appear in columns 2, 3, and 4 of the same line and in column 2 and 3 of the following line (e.g., “Throat Culture=Negative”, “WBC=9900”, etc.)

In this way, the doctor sees all sections found on the chart and at a glance can tell whether there are any entries, and what they are.

Some relatively unimportant information entered into the data base is purposely omitted. Other information is condensed. For example, one or more notations such as “ear bulging”, “fluid in ear”, “discharge from ear”, etc. may all be summarized in the single entry “ear symptoms” produced by the code: IF EARBUR=1 THEN PIEARS=‘EAR SYMPTOMS’.

The resulting Individual Case Report allows the doctor to easily review most of
the important data for a case without having to search for the patient's chart.

Special Features - In order to permit greater flexibility in its use, the following features were built into the program producing the report.

1. Specify selection criteria - MACRO MPICKIT permits specification of selection criteria in a subsetting IF statement. The macro is called in the DATA step that creates the basic data for this report. Thus, all analysis in the DATA step is restricted to the desired data only. This macro is of the form:

```sas
%MACRO MPICKIT;
   IF AGE<2 & TEMP>103;
%MEND MPICKIT;
```

2. Specify sort order for the report - Macro MACSORT enables specification of the sort order for the Individual Case Reports. This macro is called directly before the DATA _NULL_ step that produces the report. An example of this macro is:

```sas
%MACRO MACSORT;
   PROC SORT DATA=SOURCE;
      BY COMPDX MD_ID PA_NUM VIS_DATE;
%MEND MACSORT;
```

3. Specify report title - A LET statement creates the macro variable HEADING which describes the criterion used for selecting cases to appear in the report. This should be a plain English translation of the subsetting IF statement specified in macro MPICKIT.

```sas
%LET HEADING=
   AGE LESS THAN 2 YEARS & TEMPERATURE OVER 103;
```

4. Specify maximum number of observations to appear in the report - A LET statement creates the macro variable NLIMIT which is the maximum number of cases that will be reported. NLIMIT is used in the OBS option for the SET statement in the DATA _NULL_ step that produces the report. This is needed because some selection criteria may be satisfied by hundreds of cases, while all the doctor needs to look at are a few representative ones. An example may be: LET NLIMIT=10; Figure 1 depicts the way that the program permits the above choices to be made.

```sas
%LET NLIMIT=10;
```

5. Count the number of cases meeting the selection criteria - The number of cases selected by the subsetting IF statement can be counted by using a technique taught in the SAS Macro Language course. Set the dataset SOURCE into a DATA _NULL_ step and use the POINT=N and NOBS=COUNT options to count the observations. CALL SYMPUT puts this number into macro variable NSELECT which is later used to report the number of cases meeting the selection criterion.

```sas
DATA _NULL_
   IF 0 THEN SET SOURCE POINT=N NOBS=COUNT;
   CALL SYMPUT ('NSELECT',PUT(COUNT,4.));
STOP; RUN;
```

6. Print note when cases are omitted because the maximum is exceeded - Print a note when the number of cases meeting the selection criterion exceeds the maximum number of cases to appear in the report:

```sas
IF NSELECT > &NLIMIT THEN PUT 260
   "LIMITED TO THE FIRST &NLIMIT OF NSELECT CASES MEETING THE CRITERION";
```

7. Read hospital identity from the data - Kid-care collects data from eleven hospitals. Any reel of data tape is supposed to be limited to the data for only one hospital, for one month's accumulation of patient visits. Thus, reading the hospital designation from any observation should be sufficient to identify all the visits on the tape.

A call to SYMPUT puts the hospital identity into a macro variable for use in the report heading. Thus, the report is "self-documenting" with regard to the hospital identity.

```sas
%LET HOSPITAL=;
```

8. Read report-month from the data - Each data tape is supposed to be limited to patient visits for a single month. However, as you might expect, a small number of dates are incorrectly entered. Hence, if you simply read the month from the first visit date in the dataset, you probably will get the right month (unless you are unlucky enough to encounter one of the problem cases.) However, if you assume that the majority of cases can't be wrong, then you can identify the modal visit month and print that in your header.

```sas
DATA COUNT; SET SOURCE; BY VISMONTH;
   IF FIRST.VISMONTH THEN COUNT = 0;
   COUNT + 1;
   IF LAST.VISMONTH;
PROC SORT DATA=COUNT;
   BY DESCENDING COUNT;
```

```sas
%LET DATE=';
%LET YYYY=;
%LET MM=
```
9. Print information keyed to sections on a patient chart. We now spend some time to produce doctor-friendly text for the report.

If information for a message is not found in two or more places, summarize in one section.

IF HWOM=1 OR HWCRONOM=1 THEN
\* HISTORY OF EAR INFECTION */

Numeric test results can be concatenated to follow identifying text: IF HWABC=1 THEN WBC="WBC=":PUT(WURWABC.G5.); /* HWABC=1 MEANS WHITE BLOOD COUNT ORDERED */ /* PRINTS OUT AS WBC=9000 OR WHATEVER TEST VALUE APPEARED */

Codes can be interpreted through use of PROC FORMAT:

IF WOTHCL=1 THEN THCL="THROAT CULTURE=":PUT(PITHERCL.FCU.I.); /* WOTHCL=1 MEANS THROAT CULTURE WAS ORDERED */ /* FORMAT FCUL = 1='POSITIVE' 2='NEGATIVE' */

For each section of the chart, there is a list of macro calls keyed to all possible messages. The section heading is printed in column 1. All non-blank messages are printed successively in columns 2, 3, and 4. The macro keeps track of the current column, and advances columns and rows as needed:

%MACRO MAC1(VAR);
  IF \$VAR NE " " THEN DO;
  COL + 1;
  IF COL GT 4 THEN COL = 2;
  COLNO = COL + 30 - 29;
  IF 1<=COL<3 THEN PUT @COLNO &VAR \;
  IF COL=4 THEN PUT @COLNO &VAR \;
  END;
  %HELP MAC1;

If a variable needs to be printed with a user-defined format, macro MAC2 does the job:

%MACRO MAC2(VAR,FORMAT);
  IF PUT(&VAR,&FORMAT) NE " " THEN DO;
  COL + 1;
  IF COL GT 4 THEN COL = 2;
  COLNO = COL + 30 - 29;
  IF 1<=COL<3 THEN PUT @COLNO &VAR &FORMAT \;
  IF COL=4 THEN PUT @COLNO &VAR &FORMAT \;
  END;
  %HELP MAC2;

Figure 2 shows sample code including the macro call that produces two sections of the report.

The resulting Individual Case Report is close enough to the original chart to save the doctors a significant amount of time they would otherwise spend searching for patient records. A typical Individual Case Report appears in Figure 3. *SAS is a registered trademark of SAS Institute, Inc., Cary, NC, USA.

For additional information contact Ira A. Baker, NYC Health & Hospitals Corp., 220 W. 41 St., New York, NY 10036, (212) 391-6281.
**INDIVIDUAL CASE REPORT**

**SET UP REPORT USING %LET STATEMENTS & MACRO MPICKIT**

**MACRO MPICKIT - CRITERION FOR SELECTION**

```sas
%MACE MPICKIT;
IF AGE<2 & TEMP>103;
%MEND MPICKIT;
```

**HEADING DESCRIBES SELECTION CRITERION**

```sas
%LET HEADING=AGE UNDER 2 YEARS & TEMPERATURE OVER 103;
```

**SET MAXIMUM NUMBER OF OBSERVATIONS TO APPEAR IN REPORT**

```sas
%LET NLIMIT=10;
```

**MACRO MACSORT - SPECIFY SORT ORDER FOR REPORT**

```sas
%MACRO MACSORT;
PROC SORT DATA=SOURCE;
BY PA NUM VIS_DATE;
%MEND MACSORT;
```

---

**MEDICATION SECTION**

```sas
PUT // 31 "RX \n";
Y.MAC2CPIONANTI,FONANTI;
Y.MACZ(PIOHREX,FONRX);
Y.MACZ(HXRXALG,FRXALG);
Y.MAC2RXANTIBIFANTIBI;
Y.MACZ(RXSULFA,FSULFA);
Y.MACZ(RXBRONCH,FBRONCH);
Y.MACZ(RXSTROID,FSTROID);
Y.MAC2CRXDIET,FDIET;
RX => OVERPRINT, 3; COL=1;
```

**X-RAYS, BLOOD WORK, URINE, & OTHER WORK-UP INFO**

```sas
PUT // 31 "X-RAYS, BLOOD WORK, URINE, & OTHER WORK-UP INFO \n";
Y.MACHWBC;
Y.MACH N EUTS 1;
Y.MACHBANDS;
Y.MACHURINAL;
Y.MACHBUN;
Y.MACHTHCUL T;
Y.MACHURCUl T;
Y.MACHSTCUl T;
Y.MACHWUOTH;
```

---

**Figure 1. %LET statements and macros that facilitate report set-up.**

**Figure 2. Sample SAS code, including macro calls, that produces two sections of the report.**
## KID CARE SYSTEM

**COUNTY GENERAL HOSPITAL - APRIL, 1987**

**PATIENT: 777777 - COMPUTER DIAGNOSIS: PNEUMONIA**

**CRITERION:** AGE UNDER 2 YEARS & TEMPERATURE OVER 103

**LIMITED TO THE FIRST 10 OF 44 CASES MEETING THE CRITERION**

---

<table>
<thead>
<tr>
<th>MD I.D.</th>
<th>5555</th>
<th>AGE</th>
<th>1.7</th>
<th>TEMP.</th>
<th>103.9</th>
<th>WEIGHT</th>
<th>PNEUMONIA</th>
</tr>
</thead>
</table>

**APPEARANCE:** -

**VISIT DATE:** SAT 04APR87

**TRIAGE TIME:** 16:07

**DISCHARGE TIME:** 23:45

**DISPOSITION:** DISCHARGED

---

**DX BY M.D.***

**DX BY COMPUTER***

**PRESENT ILLNESS***

**HISTORY***

**PHYSICAL EXAMINATION***

**RX***

**WORK-UP***

**FOLLOW-UP***

---

**Note:** This report is a summary of patient data and does not present all the information on the data base.

---

**Exception Summary**

<table>
<thead>
<tr>
<th>DIAGNOSIS</th>
<th>WORK-UP</th>
<th>RX</th>
<th>FOLLOW-UP</th>
</tr>
</thead>
</table>

---

**Figure 3. Typical Individual Case Report (fictitious identifying information.)**