

A Quick and Dirty Method for Delivering SAS® Reports Via the World Wide Web

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Abstract

We will describe the development of a system for providing rapid, up-to-date information from a SAS database supporting an ongoing nationwide research study to personnel at participating clinics. Using only one SAS macro (OUT2HTML), a few simple HTML menu pages, and a scheduling program to start the nightly updates, the system was easy and quick to implement, and is almost effortless to maintain. We will discuss our rationale for using the Web, techniques and tools used in the implementation, and remaining issues and future development prospects.

Introduction

We represent the coordinating center for two long-term, nationwide, multi-clinic studies funded by the National Eye Institute, National Institutes of Health. The Ocular Hypertension Treatment Study (OHTS) is a randomized clinical trial evaluating the use of medication in 1637 ocular hypertensive patients. The Collaborative Longitudinal Evaluation of Keratoconus (CLEK) Study is an observational study of 1209 patients, designed to describe the course of this disease and the associations among its various symptoms. Overall, we support over 300 staff members at nearly 40 clinics, and maintain study data on over 2800 patients.

All the data is maintained, managed, and analyzed using SAS. Typical reports provided to clinics include listings of forms received, or those in various stages of central processing, forms with outstanding edit queries awaiting resolution, and indexes to information on file for particular patients.

Our old report system was a Windows based SAS menu system running on active SAS datasets at our coordinating center. It provided our clinics with static reports on demand. However, the process was slow and cumbersome. We wanted to give our clinics more immediate access to current reports. Our solution was to use SAS Web Publishing Tools to convert SAS output to HTML files, and let our clinics access these HTML files via the World Wide Web.

The Old System

Providing our clinics with up-to-date information used to go something like this:

- A clinic calls our office and asks our clinic liaison for one of our many standard reports. Or leaves a message if the liaison isn't at her desk.
- The liaison walks to the research assistant's office and, being lucky enough to find her there, forwards the request.
- Chances are that the research assistant is knee-deep in data entry and will fulfill the request 'as soon as possible.'
- The research assistant gets the report from the printer, walks it to the liaison's office.
- Our liaison then faxes or mails the report to the clinic, hoping that it actually arrives and that the clinic hasn't forgotten the request in the hours since the request.
- Some reports are routinely printed for all clinics and mailed to them on a regular basis – whether or not they want and use them.

In this age of information, we need something faster!

Requirements

Our requirements for a new report system:

- Easy-to-use
- Gives instant access to reports with a click of a mouse
- Accessible to clinics around the U.S.
- Requires very minimal training for end users
- Requires minimal time for programmers to get it up-and-running
- Visually appealing reports
- Able to utilize our pre-existing SAS report code
- Maintain security and confidentiality

Decisions

After attending a SAS Institute workshop on SAS Web Tools, it became obvious that we had found the answer: using the World Wide Web as the report interface:

- Many people are already familiar with the web and how to navigate it.
- Using the internet is easy and people are actually interested in learning it.
- Giving clinics web access is easier than installing SAS on every computer and dealing with licensing issues.
- The World Wide Web is the future of information exchange and in order to be competitive, it must be utilized.
- We have the expertise in our office to guarantee that our data is protected from inquisitive outsiders.

We decided to run the SAS program that generates the HTML reports on our UNIX server instead of using our Windows SAS. This helped us bypass tricky network and scheduling issues.

Our next decision was whether to use the web to generate static or dynamic SAS reports. We chose to keep the reports static:

- Static reports, if they contain up-to-date information, are more than adequate to meet the typical information needs of staff at the clinics. Less frequently requested reports will still be printed on demand.
- Running SAS for dynamic reports is inconvenient in terms of time to access the system and the training involved in teaching end users to operate the system and interpret the results.
- Dynamic reports would require immediate access to our functioning database which undergoes constant daily additions and changes – or would require a snapshot copy be made for access by the Web users.
- Rather than printing individual reports for specific clinics on demand (as is currently done, or could be done by a dynamic Web access system), it is simple to generate all of our standard reports, individually for each clinic, and make them available for access when needed. Despite the large number of reports generated, the space they occupy on our server is negligible.
- Most, if not all, of the ad hoc queries that we receive can be handled by search tools built

into standard Web browsers, as long as we provide tabular listings of appropriate variables to be searched. This allows end users to do limited searches on the data by using the browser's FIND function, which is easy to use.

- We want the reports to be current to the previous day's closing; thus a report needs to be generated only once per day, not every time it is browsed.
- Because of the confidential nature of our medical data, access to the database is carefully restricted. Our independent oversight committee has been given veto power over what is made available to the clinics via the web. The use of static reports facilitates this control over data access.

Implementing the SAS Part

Converting SAS procedure and datastep output to HTML for use on the Web is the easy part. All you need for each report are two macro invocations and SAS procedures or DATA steps between them. The macro is the HTML output formatter (%OUT2HTM) which is part of the SAS HTML Formatting Tools. You can easily download these tools from SAS Institute's web site.

The following code is all you need to run a SAS job that creates an HTML file named *vitals.htm*:

```
%out2htm (capture=on, runmode=b,
          window=output);

proc print data=patients;
  options nonumber;
  title "Patients' Vital Stats";
  var id sex dob weight;
run;

%out2htm (capture=off, runmode=b,
          window=output,
          openmode=replace,
          htmlfile=/html/dir/vitals.htm);
```

- The first invocation of the OUT2HTM macro starts capturing the output. Three arguments are passed to the macro:

Example: %out2htm (capture=on, runmode=b, window=output);

capture=on: Start capturing the information.

runmode=b: This SAS program will be run in batch mode.

window=output: Capture all information written to the SAS output window.

- The second invocation of OUT2HTM ends the capturing of output. In this example, five arguments are passed:

Example: %out2htm (capture = off,
runmode = b, window = output,
openmode = replace,
htmlfile = /htmlidir/vitals.htm) ;

capture = off: Stop capturing the information.

runmode = b: This SAS program will be run in batch mode.

window = output: Capture all information written to the output window.

openmode = replace: Overwrite contents of the HTML file.

htmlfile = /htmlidir/vitals.htm: Specifies the file /htmlidir/vitals.htm to which the HTML formatted results are written.

Adding Bells and Whistles

There are many other arguments you can use in the second macro invocation to customize your report, such as choosing the color of the background, text, and headings, and the size of text. The SAS Institute's web site describes the options in detail. Below is an example of some of the arguments that we use (the first five arguments have been explained in the previous section):

```
%out2htm (capture = off, runmode = b,  
          window = output,  
          openmode = replace,  
          htmlfile = /htmlidir/vitals.htm  
          bgtype = color, bg = #FFF3CF,  
          hcolor = black, btag = bold, encode = n);
```

bgtype = color: Specifies that we want our background to be a solid color. Another option is image. If color or image is selected, you must also include a bg argument.

bg = #FFF3CF: The color of our background is #FFF3CF. This is an RGB hex triplet that represents a light yellow color. One of the many places on the Web you can go to find a chart of RGB colors is <http://www.phoenix.net/%7Ejacobson/rgb.html>. Other options for specifying the background are using the color name, as in `bg = teal`, and using an image as the background.

hcolor = black: Specifies that headings (as in a PROC PRINT) be black. The color can be an RGB value or a color name. You can change the color of many other output components, including bylines, data lines, titles, and footnotes.

btag = bold: This changes the format of the byline to bold. SAS inserts the HTML tag `<bold>` into the byline code.

encode = n: We use SAS titles that add email links (MAILTO:) to the reports, allowing clinics to contact our center if they have any questions or comments about a report. These email links are HTML commands. In order to use HTML code in our titles, we need the option `encode = n`.

In these SAS titles, we use HTML header tags to change the size and justification of the email link. We also include the email subject in the title statement so that the email recipient knows exactly which report the user was browsing. Note: including the subject works in Netscape but may not work using Internet Explorer.

Example: title1 "<h3 align = right>
<a href = 'mailto: joel@wubios
?subject = vitals-clinic A' >
Questions/Comments? </h3> " ;

<h3 align = right> is an HTML header (H) tag (3 specifies the size of the text), with a right justification option.

<a href = 'mailto: joel@wubios
creates an email window that is configured to send electronic mail to joel@wubios.

?subject = vitals-clinic A' >
makes vitals-clinic A the subject of the email.

Questions/Comments? </h3>";
Questions/Comments? is the text that will appear right justified at the top of the report. It will be an underlined hyperlink to the email window.
 </h3> closes the HTML tags.

Adding these enhancements to the program gives us the following:

```
%out2htm (capture = on, runmode = b,  
          window = output);  
  
title1 "<h3 align = right>  
      <a href = 'mailto: joel@wubios  
      ?subject = vitals-clinic A' >  
      Questions/Comments? </a> </h3> " ;  
  
proc print data = patients;  
  options nonumber;  
  title "Patients' Vital Stats";  
  var id sex dob weight;  
run;  
  
%out2htm (capture = off, runmode = b,  
          window = output,  
          openmode = replace,
```

```
htmlfile=/html/dir/vitals.htm
bgtype=color, bg=#FFF3CF,
hcolor=black, btag=bold, encode=n);
```

Adding a Report to the System

Adding a report to the system is a simple, three step process:

- Write or include existing SAS code.
- Put the two macro invocations around the SAS code.
- Paste a link to the new report in every applicable menu (we paste the code in 38 clinic menus).

Security and Confidentiality

The nature of our medical research requires not only that we guarantee the confidentiality of patient information, but that we control what parts of the dataset can be viewed by study staff.

Staff members in participating clinics are required to complete a request for Web access, that includes a confidentiality agreement, and requires signoff by the principal investigator of their clinic and final approval at our coordinating center.

Once a request form is received and approved, the individual is assigned a unique user ID and password (which the user can change). At the same time, the user ID is associated with one or more groups, which determines the directories of files and reports accessible to that person.

For example, individuals at Clinic A are in group A, which gives access to information about patients seen at that clinic (and not other patients), and also in group ANY, which gives access to summary reports that can be viewed by any study personnel.

To enhance security, individuals are encouraged to change their password on a regular basis, and are given an option on our Web menu which allows them to make this change on-line. Administrative utilities are available to coordinating center staff to add and delete users, change the group memberships, and monitor access to the system.

User Front-end Menu Access

We added several simple Web pages, written in HTML, to facilitate access into the system, to validate user authorizations, and to provide customized clinic menus. The first page to appear asks the user to identify the study of which she is a part. If she selects OHTS, as in the examples which follow, the OHTS main menu (figure 1) appears.

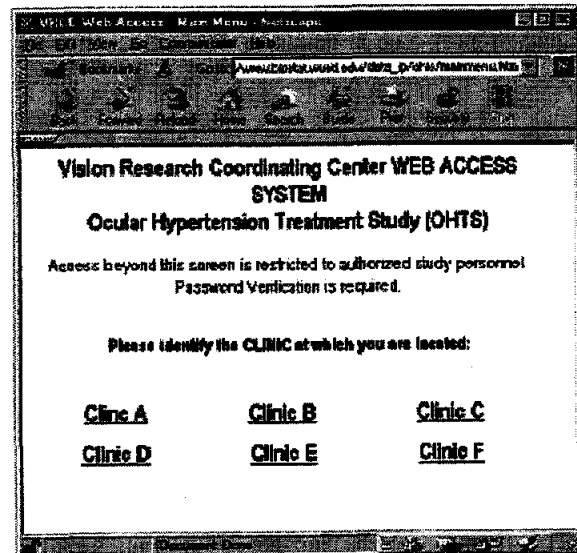


Figure 1: Main Menu

Once the user clicks on the name of their clinic, the operating system displays the following pop-up window (figure 2) to request the user's userid and password. Only if an authorized userid and password is given will the user be authorized to proceed to the clinic report menu.

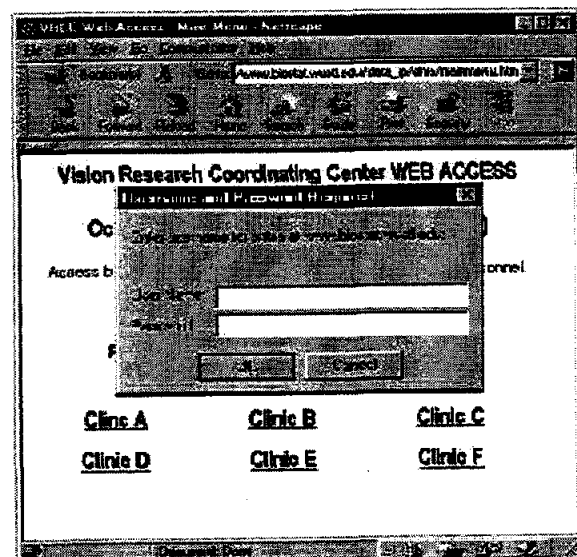


Figure 2: Password Screen

For each clinic, a menu links to the reports (figure 3). Below is the code for clinic A's menu. All other clinics' menus look nearly identical to clinic A's. The only difference is the clinic name in lines three and six.

```

<html>
<head>
  <title>Reports Page: Clinic A</title>
</head>
<body bgcolor="white">
  <h3 align="center"> Clinic A's Report Page
  </h3>
  <h2 align="center">Click on the report you
  would like to view</h2>
  <center>
    <a href="vitals.htm"> Patients' Stats
    </a> <br> <br>
    <a href="received.htm"> Forms
    Received </a>
  </center>
</body>
</html>

```

The resultant menu looks like:

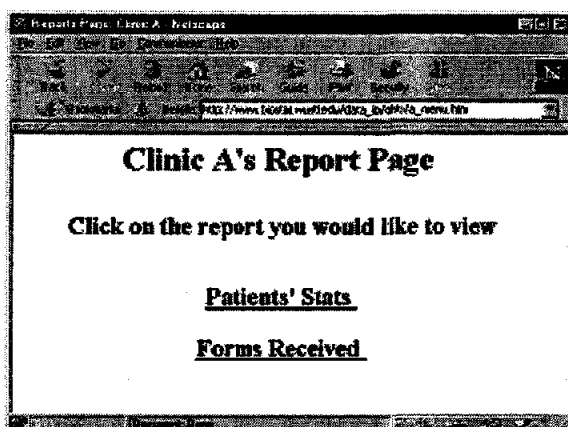


Figure 3: Clinic A's Menu

Clicking on "Patients' Stats" will take you to the HTML report *vitals.htm*:

ID#	ID	SEX	DOB	WEIGHT
1	DVD	M	04/01/1950	120
2	OFL	M	10/21/1962	215
3	JOC	M	12/25/1918	250
4	KAC	F	03/24/1946	140
5	SHB	F	11/01/1956	120

Figure 4: HTML Report *vitals.htm*

With little effort, we have created a menu for clinic A and a report that can be accessed by a click of the mouse.

Other Essential Components

- Scheduling the SAS program to run daily. In our case we set up a UNIX CRON job to run the program every day at 6:00 am. This is a one line command in a CRONTAB file that looks like:

```
00 06 * * * cd /htmlidir/; sas /htmlidir/report.sas
```

- Help files have been added to all administrative menus. By just clicking on the highlighted HTML link the user is shown a screen of helpful hints for using that menu.

Future Considerations

- Convert the reports to PDF files to make printouts of the reports professional looking. At this point, our reports have titles only once on the page, at the top of every report. This is fine if the report is only one page long but if longer, we would like titles on each page of the report.
- Create a procedure for inserting a block of code into each of the 38 clinic's HTML menus.
- Add quality control graphs (produced by GPLOT and GCHART) to the list of available reports available for viewing.
- Investigate the usefulness of the SAS HTML Data Set Formatter and the SAS HTML Tabulate Formatter.

Conclusions

At this time, our new system is in the testing phase. Our oversight committee has excitedly encouraged and approved our implementation of this system. We are awaiting final approval of specific content (reports) to be made available. It is now used solely in-house by the clinic liaisons and research assistants; however, by January 1, 1999 we expect it to be widely used by the clinics. Testing at three clinics is to be started shortly. We will introduce the system to study personnel as a demo at our annual national meeting in November. We think that the demo will garner much interest for this system.

We believe we have created a hands-on tool that gives clinics fast access to reports, which we expect will increase enthusiasm for our studies. At the same time, this system controls the dissemination of study data and protects it from access by outsiders. The system is easy to use and the programming and upkeep is trivial. The majority of the system was built using only basic SAS code and

procedures, and one SAS-supplied macro. The only aspects of the system which required more sophisticated expertise were the layout of a directory structure and setting access permissions, and the creation of scripts for creating user IDs and managing group memberships and passwords.

References

SAS Institute Web Tools – Formatting Tools,
www.sas.com/rnd/web/format/

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