Paper P01-04

# Doing More with SAS/GRAPH GMAP: A New Look at an Old Procedure

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## ABSTRACT

One of the roles of a healthcare quality improvement organization (QIO) is to provide tools and support to healthcare organizations and facilities to assist them in their quality improvement efforts. Geographical differences in adherence to clinical guidelines have been demonstrated. The identification of geographical areas of need helps the QIO improve the efficiency of this information delivery. Geographical data analysis and display are used to summarize spatial data, identify variations in performance by regions and providers and show performance trends over time through both static and interactive displays.

The SAS/GRAPH GMAP procedure was designed to produce two- and three-dimensional color maps of data value variations. With the advent of new spatial analysis tools available through SAS/GIS and other geographical information systems, this procedure is sometimes overlooked. Yet the versatility of this procedure, combined with the Output Delivery System (ODS), Java, Active-X, and the new SAS map data sets, allow the GMAP procedure to remain an excellent tool for spatial data display. Examples in this paper will illustrate these capabilities**.**

All output is created using SAS software, version 8.2 on a Windows 2000 platform or version 9 on a Windows XP platform. Abbreviated SAS code for each map is included in the paper.

## INTRODUCTION

The Virginia Health Quality Center (VHQC), winner of the U.S. Senate Productivity and Quality Award for Progress in Performance Excellence, functions as both a health care quality improvement organization and a patient safety organization. The VHQC assists healthcare providers in making successful and meaningful changes in the way care is delivered and in improving outcomes of that care, especially for the Medicare community of Virginia.

Services provided by the VHQC include: 1) health care safety and quality improvement, 2) medical case review, 3) professional credentials verification, 4) health education and 5) analytic services. The VHQC currently collaborates with all acute care and critical access hospitals and invites all physician offices, home health agencies, nursing homes, and other Virginia healthcare organizations to participate in the improvement of health care quality.

In an effort to maximize available resources, geographical analyses using SAS/GRAPH Proc GMAP are used to illustrate: 1) clinical condition prevalence, 2) geographical patterns of compliance with health care standards of care, 3) participation in quality improvement efforts, and 4) non-geographic failure/success rates.

## APPLICATION

Quality improvement focus areas have been identified for by the Centers for Medicare & Medicaid Services (CMS) for quality improvement in inpatient, physician office, nursing home and home health settings. As a Medicare quality improvement organization, the VHQC has the challenge to improve rates on quality indicators in each of these areas. Geographical analyses are used to identify those clinical areas, providers and provider areas most in need of improvement. Several different types of maps are used. The examples that follow detail these applications and the output produced.

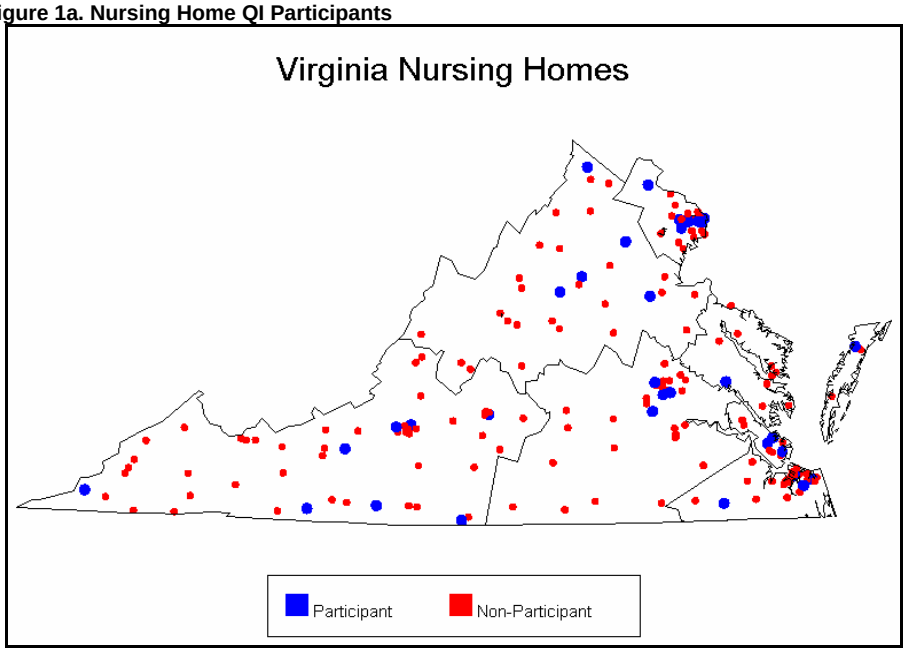
Health care data as depicted in these examples are for illustration only, were generated for the purpose of this paper, and are not intended to depict any actual clinical results.

### EXAMPLE ONE – CHOROPLETH MAP WITH ANNOTATE

This example provides a traditional use of the GMAP procedure, combined with annotate. The map below shows the location of nursing homes within Virginia, using Virginia healthcare regional boundaries. The SAS provided unprojected county map is used and then projected with the ALBERS projection method using SAS Proc GPROJECT. County boundaries are removed with the GREMOVE procedure. Region replaces county as the geographic ID variable.

Nursing home locations are added with the SAS Annotate facility and are color- and size-coded to identify participants in a quality improvement effort. Participants are represented by blue color and by a larger dot. Non-participants are represented by smaller red dots. The legend is added with a footnote statement. Figure 1a provides the default results.

**Figure 1a. Nursing Home QI Participants**

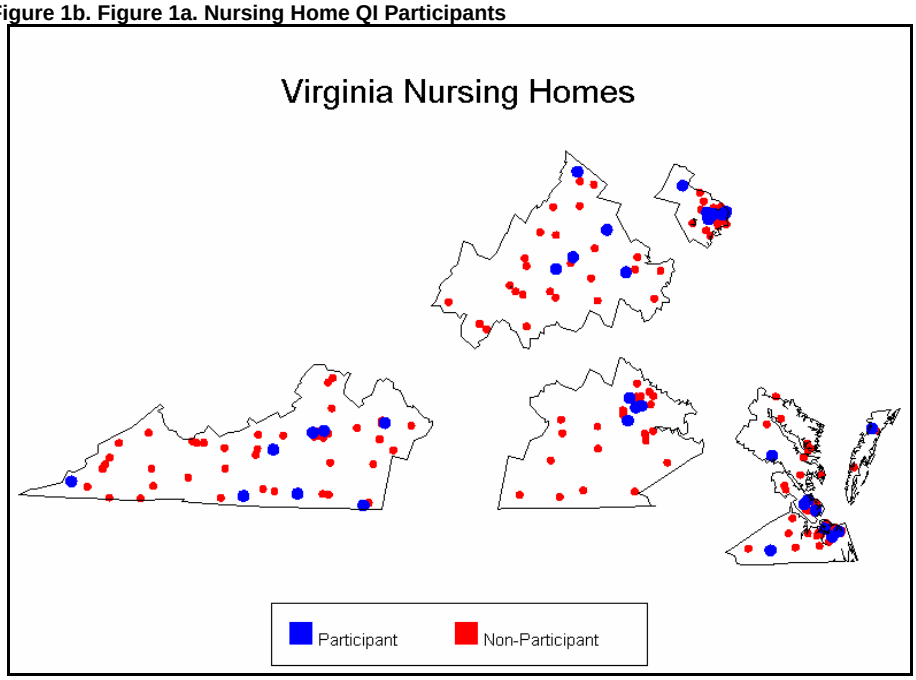



The Proc GREMOVE code use is listed below:

```
proc sql;
   create table vareg as select * from virginiap, regions as r where
   virginiap.state=r.state and virginiap.county=r.county;
proc sort data=vareg; by region; run;
proc gremove data=vareg out=varegion;
   by region; id county;
run;
```

Another way of looking at the same data is to create a map with separation between the regions. This allows an easier visual comparison of the regions and is accomplished by adding a small factor to the X and Y coordinates after projection. The result is illustrated by Figure 1b below.

**Figure 1b. Figure 1a. Nursing Home QI Participants**



This separation is accomplished by selecting a central point and moving the other entities from that point. For the Virginia map, regions were moved from the central region. Code used to offset the other regions is listed below:

```
data varegion; set varegion;
  if region='Eastern' then do;
      x=x+.015;y=y-.01;
  end;
  else if region='Northern' then do;
      x=x+.01;y=y+.01;
  end;
  else if region='Southwest' then do;
      x=x-.02;
  end;
  else if region='Northwest' then do;
      y=y+.01;
  end;
run;
```

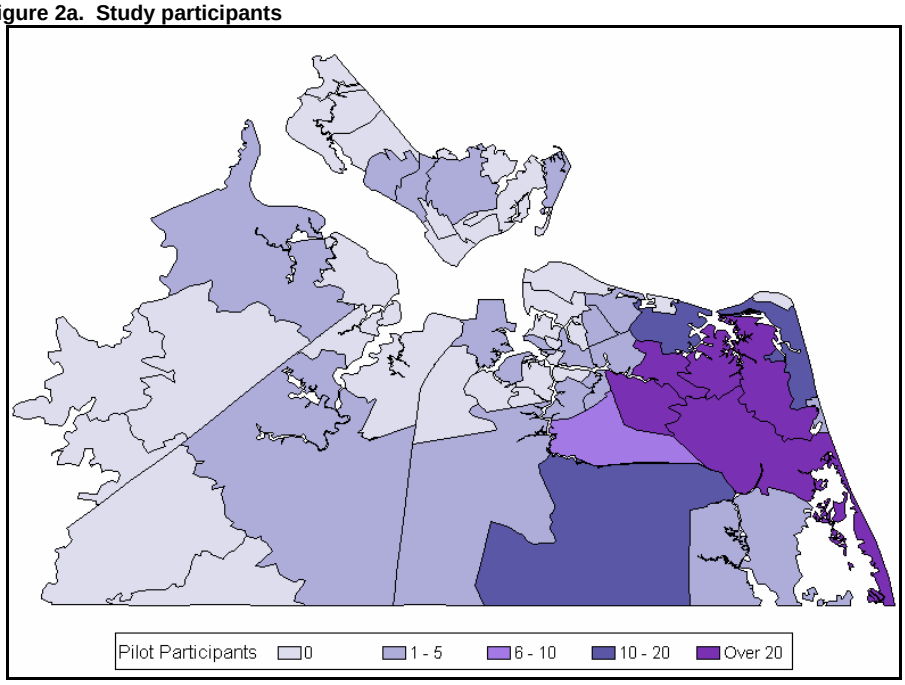
**EXAMPLE TWO – ZIP CODE MAP**

Beginning with SAS version 9, SAS/GRAPH provides a new experimental procedure (MAPIMPORT) for importing ESRI shape files into SAS data sets. The U.S. Census Bureau provides zip code (five digit zip code tabulation area) boundary files in ESRI shape file format (.shp) by state for free download. Listed below is the Proc MAPIMPORT code used to create a zip code data set file for Virginia using the downloaded census shape file.

```
libname c 'c:\myfiles\zt51_d00_shp';run;
proc mapimport out=c.zip datafile='C:\myfiles\zt51_d00_shp\zt51_d00.shp';
run;
```

Map by zip code is especially useful when mapping small geographic areas. The example below (Figure 2a) shows prevalence of participants in a pilot study in the Hampton Roads (Eastern Virginia) area by zip code. Degrees of a single color are used to display results, with the darker colors identifying the highest rates. The specific color pattern was selected because differentiation between colors remains when printed or copied in grayscale.

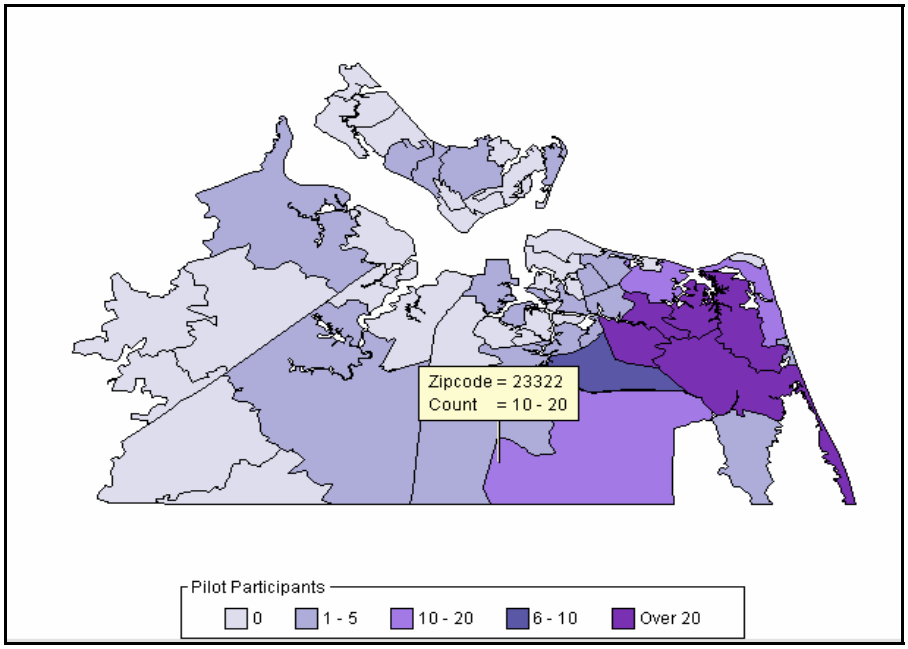
**Figure 2a. Study participants**




The above example works well in a written, hard-copy report, but reports that are delivered electronically can incorporate interactive informational features. The example below (Figure 2b) uses the java driver and ODS to create

the same map with pop-up information when the mouse is placed on a zip code. The Active-X driver will produce similar results.

**Figure 2b. Study participants with Java pop-up**




The ODS and GOPTIONS statements used to create this map are listed below:

```
ods html file="c:\working sas\java\hrhc.html"
  ATTRIBUTES=("CODEBASE"="s:\bbo\applets")
  parameters=("DRILLDOWNMODE"="LOCAL" );

goptions reset=global lfactor=2 gunit=pct colors=(bwh vpab vlipb lib biv )
    noborder cback=white ftext="Arial" device=java; run;
```

**EXAMPLE THREE – GRADATIONAL MAP**

Geological maps often do not include state and county boundary lines and represent graduated values, mapping values of elevation, soil, weather, temperature, pollution, or other characteristics. SAS can be used to create this type of map and it can be adapted for use in the health care quality improvement arena. A choropleth map is created, a multi-value color scale is created, state and county boundary lines are removed with a coutline statement (coutline=same) and data values used are at the smallest geographic division available. By setting a number of levels (levels=25), SAS automatically divides the values into 25 groups.

The color pattern statements used for color graduation in these examples use a 25-color scale are adapted from Massengill's "SAS Mapping: Technologies, Techniques, Tips, and Tricks" (see references). Color values are given in hexadecimal rgb, ranging from green to red. (SAS will also accept color values as HLS (hue, lightness, saturation) and SAS color names). The pattern statements defining these colors are listed below.

```
pattern1  v=s c=cx00ff00;  /*Green*/
pattern2  v=s c=cx35ff00;
pattern3  v=s c=cx65ff00;
pattern4  v=s c=cx88ff00;
pattern5  v=s c=cx9aff00;
pattern6  v=s c=cxbaff00;
pattern7  v=s c=cxccff00;
pattern8  v=s c=cxd0ff00;
pattern9  v=s c=cxe0ff00;
pattern10 v=s c=cxffff00;  /*Yellow*/
pattern11 v=s c=cxffee00;
pattern12 v=s c=cxffe000;
```

```
pattern13 v=s c=cxffdd00;
pattern14 v=s c=cxffdc00;
pattern15 v=s c=cxffd800;
pattern16 v=s c=cxffd100;
pattern17 v=s c=cxffcd00;
pattern18 v=s c=cxffc000;
pattern19 v=s c=cxffb700;
pattern20 v=s c=cxff9a00;
pattern21 v=s c=cxff8700;
pattern22 v=s c=cxff7700;
pattern23 v=s c=cxff5400;
pattern24 v=s c=cxff3400;
pattern25 v=s c=cxff0000; /*Red*/
```

In Figure 3a below, the map shows geographic areas by rates of compliance with mammography clinical guidelines as part of a breast cancer prevention project. Darker colors represent a higher rate of missed opportunities. The data set used was generated for illustration purposes only and does not depict actual rates.

**Figure 3a. Mammography Missed Opportunities**

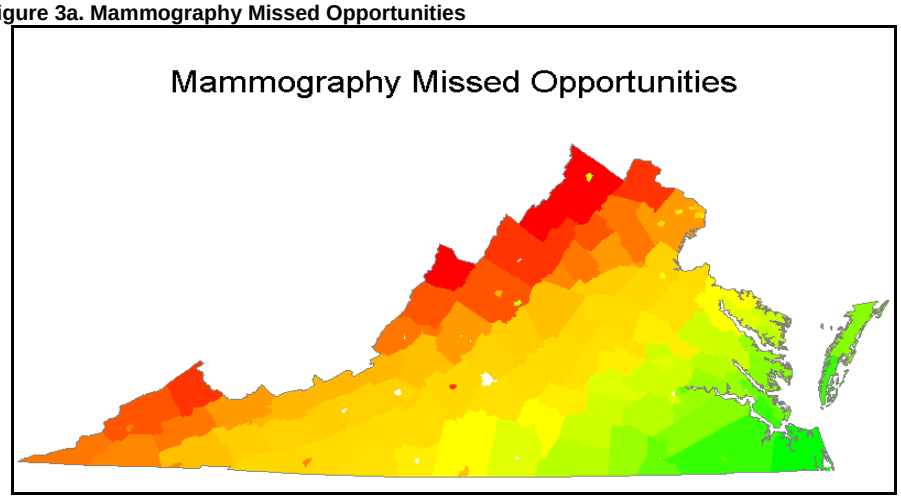
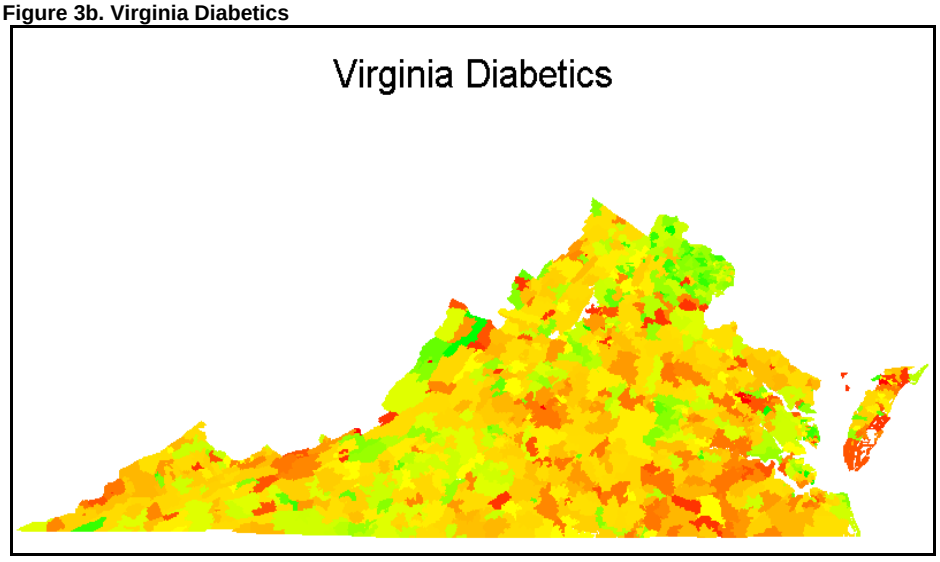



Figure 3b takes the same methodology and creates a map identifying rates of diabetics in the state (diabetics/total population). Because data values are available at the zip code level, mapping uses zip code rather than the county values used in the first map and a zip code base boundary file is used. Again, state, county, and zip code boundary lines are removed. The data set used is for illustration only and does not depict actual rates of diabetics.

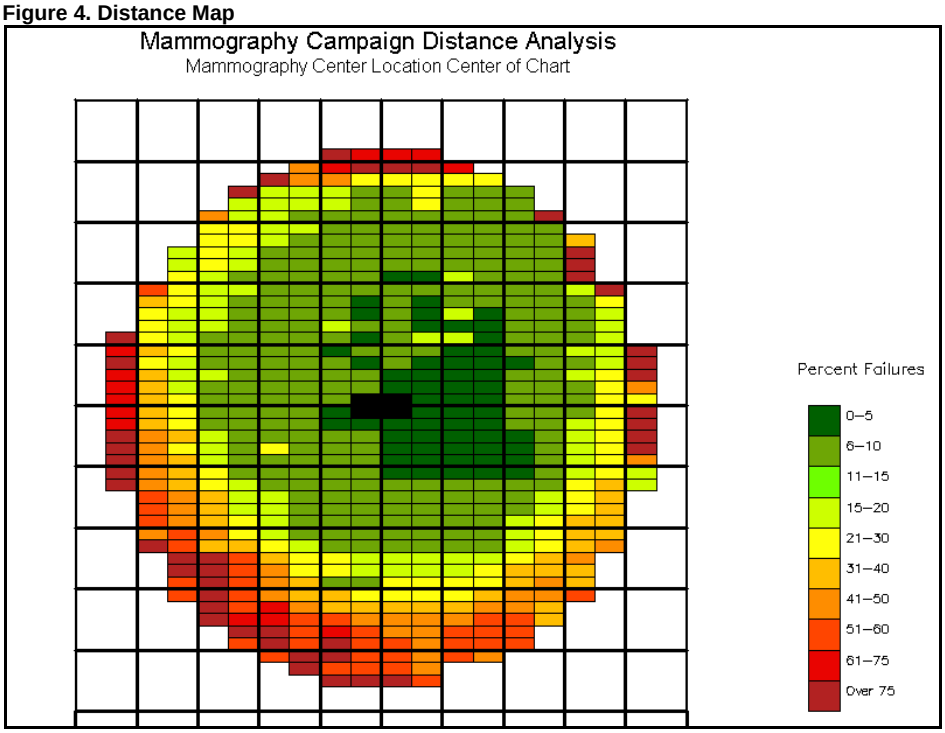
**Figure 3b. Virginia Diabetics**



**EXAMPLE FOUR – NON-GEOGRAPHICAL MAP**

Distance maps are often thought of in geographic terms, depicting distances between two places. In this example, SAS Proc GMAP is used to create a distance map without reference to a specific geographic place, showing decreasing compliance with annual mammogram screening with increased distance from a mammography center. Figure 4 illustrates this non-geographical map.

**Figure 4. Distance Map**




The code below was used to create the grid that encloses the distance map.

```
/* Create grid squares*/
data grid;
   length function color $ 8 text $ 60;
   xsys='2'; ysys='2'; hsys='3'; when='a';
   size=3; /* set thickness */
   color='black';
do grid_y=1 to 10;
   do grid_x=1 to 10;
     function='poly';
     x=(grid_x*10)-10; y=(grid_y*10)-10; output;
     function='polycont';
     x=x+10; output;  y=y+10; output; x=x-10; output;
     y=y-10; output;
   end;
end;
```

## CONCLUSION

This paper illustrates several different healthcare quality improvement applications using SAS/GRAPH GMAP. Through these applications, healthcare and social marketing campaigns can focus on the areas of greatest need, allowing for the most efficient use of quality improvement dollars. Additionally, the built-in flexibility SAS/GRAPH GMAP, combined with SAS Annotate, ODS, Java and ActiveX can be used to demonstrate geographical differences and to provide a foundation for further analyses to identify additional relationships and critical factors to enhance the quality improvement process.

## REFERENCES

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## ACKNOWLEDGEMENTS

Data sets used were generated used SAS/STAT Proc SURVEYSAMPLE.



The analyses upon which this publication is based were performed under contract no. 500-02-VA-03, titled “Utilization and Quality Control Peer Review Organization for the Commonwealth of Virginia,” sponsored by the Centers for Medicare & Medicaid Services (CMS), Department of Health and Human Services (DHHS). The content of this publication does not necessarily reflect the view or policies of the DHHS, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government. The Virginia Health Quality Center (VHQC) assumes full responsibility for the accuracy and completeness of the ideas presented. This publication is a direct result of the Health Care Quality Improvement Program initiated by CMS, which has encouraged identification of quality improvement projects derived from analysis of patterns of care and therefore required no special funding on the part of VHQC. Ideas and contributions to the VHQC concerning experience in engaging with the issues presented are welcomed.

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