

Using SAS/GRAPH® GMAP to Enhance a Diabetes Wellness Campaign

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ABSTRACT

The role of a quality improvement organization (QIO) is to assist healthcare providers in making successful and meaningful changes in the way care is delivered and in improving outcomes of that care. The ability to identify spatial differences in indicator rates, demographics, medical shortages, and technologies can help improve the efficiency of information delivery to and by healthcare providers. Geographical data analysis and display can be 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. This analysis can also be used to focus culturally sensitive and technologically delivered materials as well as assist in proposed solutions for identified unmet needs.

SAS provides a comprehensive mapping tool through the SAS/GRAPH GMAP procedure for both geographic and non-geographic spatial displays. While this procedure was originally designed to produce two- or three-dimensional color maps, new spatial analysis tools, combined with the Output Delivery System (ODS), Java, Active-X, and the new MAPIMPORT procedure, allow the GMAP procedure to remain an excellent tool for spatial data display. This presentation uses SAS/GRAPH GMAP procedure to develop a series of maps as part of a diabetes wellness campaign for the state of Virginia.

Examples were developed with version 8.2 of SAS executing on a Windows 98 platform or 9.1 of SAS on a Windows XP platform. Examples are not platform specific and can be adapted by both beginning and advanced SAS users.

INTRODUCTION

The Virginia Health Quality Center (VHQC), three-time winner of U.S. Senate Productivity and Quality Award for Virginia, 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 by the Centers for Medicare & Medicaid Services (CMS) for quality improvement in inpatient, physician office, nursing home and home health settings. One of the areas of focus in the physician office setting is diabetes care. Diabetes is a major public health problem and is becoming more prevalent in all age groups. Over 150,000 Americans die each year from diabetes and its complications; these complications include blindness, kidney failure, nerve damage and cardiovascular disease. For most persons with diabetes, many of these complications can be prevented or delayed with appropriate monitoring and treatment; however, studies in both fee-for-service and managed care settings indicate that care is suboptimal. The VHQC diabetes campaign is designed to improve these outcomes by management of risk factors through early detection and disease management.

This initiative includes the following indicators for quality improvement: 1) biennial eye examination 2) biennial lipid profile, and 3) annual hemoglobin A1C. As a Medicare quality improvement organization, the VHQC is evaluated on their ability to improve rates on these quality indicators, both for an identified group of participants and statewide. Geographical analyses are used to identify 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.

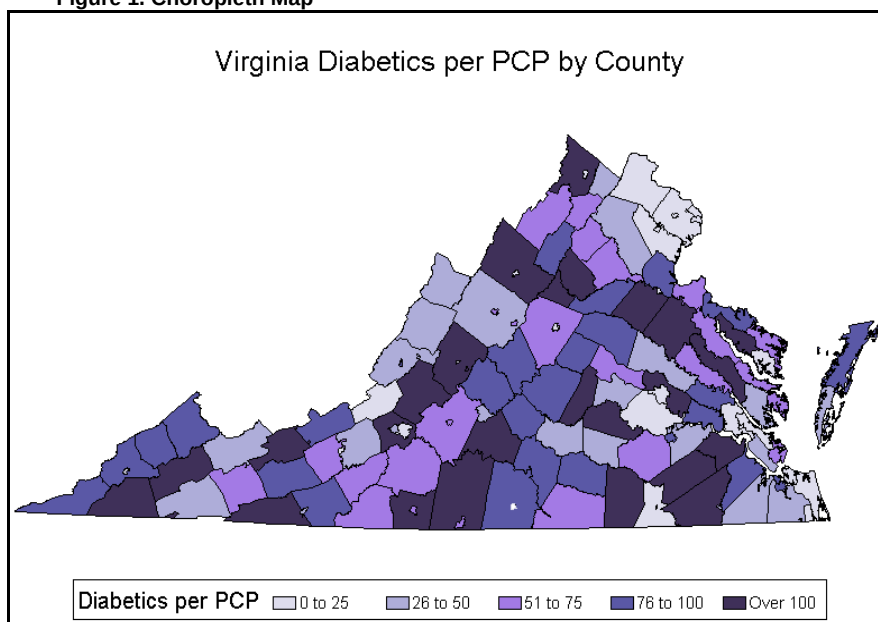
Health care data as depicted in these examples are for illustration only, were generated for the purpose of this paper, and are not intended to depict any actual clinical results.

EXAMPLE ONE – CHOROPLETH MAP

In order to assist with improving quality of care for diabetics, it is important to know where they are located in the state versus the location of primary care providers so that interventions can focus on the areas of most need. In the

following map, a rate is calculated by dividing the number of primary care providers (PCPs) by the number of diabetics for each county of the state. Primary care providers include general practice, family practice, internal medicine and general pediatrics. The SAS provided unprojected county map is used and then projected with the ALBERS projection method using SAS Proc GPROJECT. Colors selected for this map were selected because they show difference both in color and in grayscale. The colors used are as follows: BWH, VPAB VLIPB LIB MOPB.

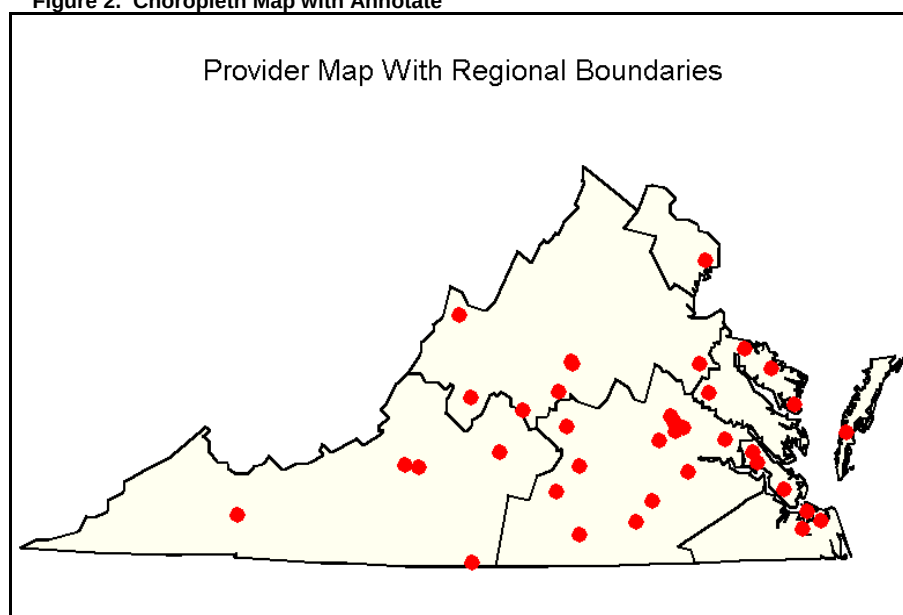
Figure 1. Choropleth Map



EXAMPLE TWO – CHOROPLETH MAP WITH ANNOTATE

This example provides a traditional use of the GMAP procedure, combined with two annotate data sets. The map below shows the location of physician office groups within Virginia that are part of the identified participant group, working with VHQC to improve their rates for the diabetes quality indicators listed above. Locations are shown within state regions, 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. Proc GREDUCE is used to change the overall map density. County boundaries are enhanced with an annotate data set to increase the line thickness to a width of 3. Internal county boundaries within each region are then removed with the GREMOVE procedure. Region replaces county as the geographic ID variable. The physician office locations are added with the second annotate data set. Because statewide data is reported by region, this allows a comparison with regional interventions.

Figure 2. Choropleth Map with Annotate



The Proc GREMOVE code (remove boundaries) is listed below, followed by the annotate code used to darken the boundary lines:

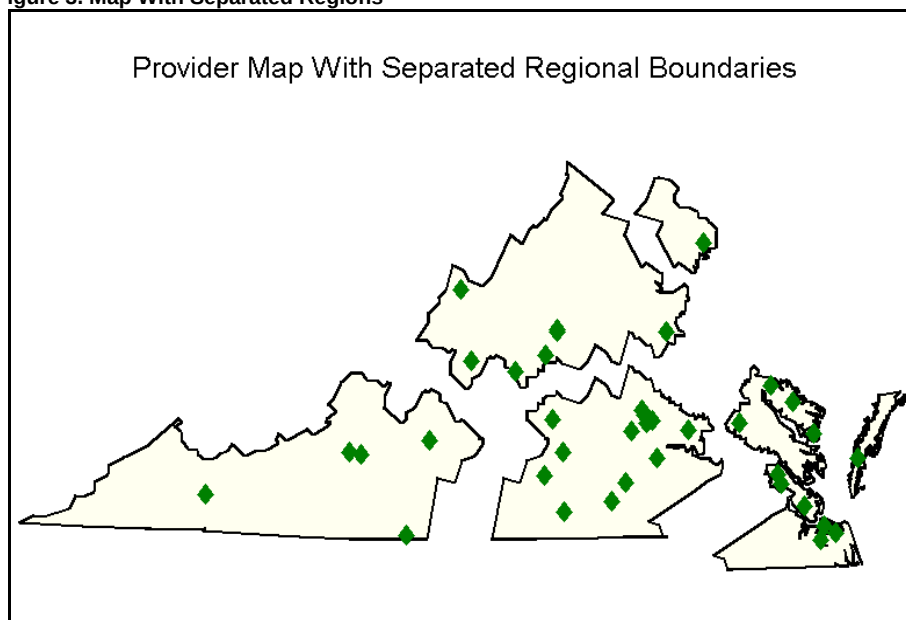
```
proc sql;
  create table vareg as select * from virginia, regions as r where
    virginia.state=r.state and virginia.county=r.county;
proc sort data=vareg; by region; run;
proc gremove data=vareg out=varegion;
  by region; id county;
run;

data annoreg;
  set varegion;
  by region segment;
  retain size 3 color 'black'
    xsys '2' ysys '2' when 'a';
  if first.segment or (lag(x)=. and lag(y)=.)
    then function='POLY';
  else function='POLYCONT';
  if x and y then output;
run;
```

EXAMPLE THREE – EXPLODED MAP

One way of looking at regional 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 of both the map boundary data set and the response data set. The example below uses this technique with the data in the previous example, potential physician offices quality improvement partners. The factor must be added after the map is projected. A distribution such as the sample one below suggests greater recruitment is needed in the northern and western parts of the state. The result is illustrated in Figure 3 below.

Figure 3. Map With Separated Regions



Listed below is the code used to create the separation between regions for the regional boundaries.

```
data vareg3; set varegion;
  if region='Eastern' then do;
    x=x+.01;
    y=y-.005;
  end;
  if region='Northern' then do;
    x=x+.005;
    y=y+.005;
  end;
```

```

if region='Southwest' then do;
  x=x-.01;
end;
if region='Northwest' then do;
  y=y+.005;
end;
run;

```

EXAMPLE FOUR – ZIP CODE MAP

Many statewide interventions are enacted at the zip code level, in areas of most need. Beginning with SAS version 9, SAS/GRAPH provides a new experimental procedure (MAPIMPORT) for importing ESRI shape files into SAS data sets. SAS does not include zip code boundary files as part of the SAS/GRAPH product., but 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. These can be converted into SAS map data sets. Listed below is the Proc MAPIMPORT code used to create a zip code boundary data set file for the state of 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;

```

While version 9 of SAS is necessary for creating the SAS data set from the shape file, once a SAS data set is created it can be used with earlier versions of SAS.

Map by zip code is especially useful when mapping small geographic areas, but can also be used to illustrate gradational patterns, a technique often used in geologic mapping. 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, county and zip code 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, although color names are restricted to those defined by SAS). The pattern statements defining these colors are listed below.

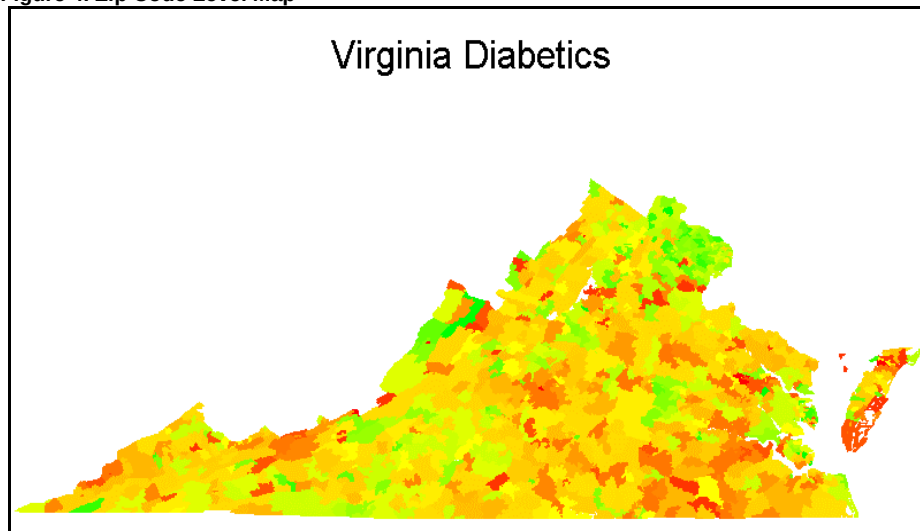
```

/*Green*/
pattern1 v=s c=cx00ff00; 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;
/*Yellow*/
pattern10 v=s c=cxffff00; 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;
/*Red*/
pattern25 v=s c=cxff0000;

```

In this example, a map is created that identifies rates of diabetics in the state by zip code. The rate for each zip code area is calculated by dividing the total population of the zip code by the number of diabetics in that zip code (diabetics/total population). This allows identification of areas where a higher proportion of the population is diabetic, rather than identifying total numbers of diabetics in each area --- a number that generally corresponds to overall population numbers. The map is shown in Figure 4.

Figure 4. Zip Code Level Map

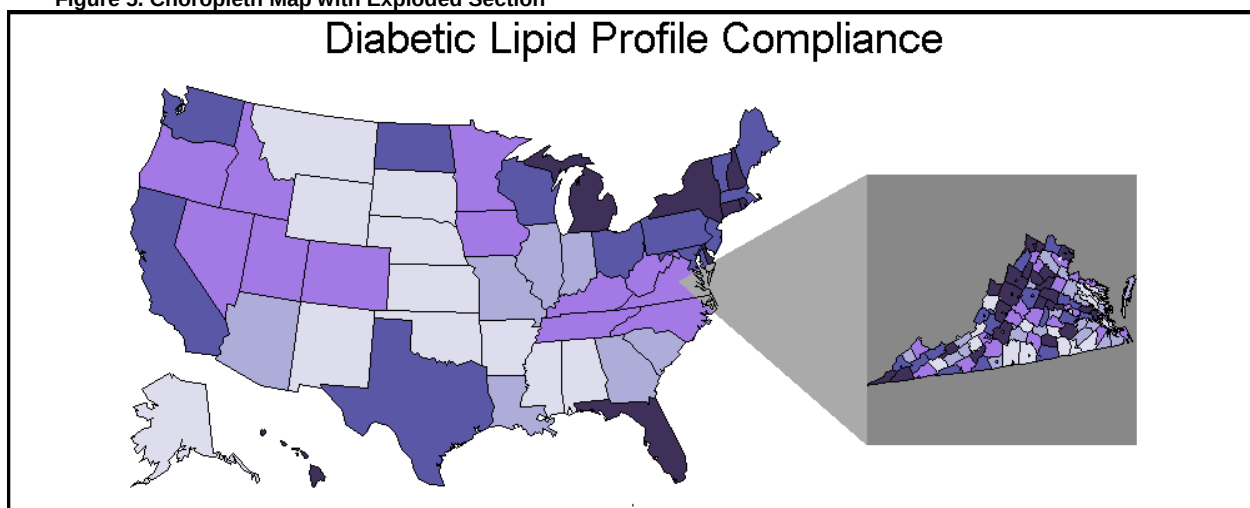


EXAMPLE FIVE – EXPLODED SECTION MAP

Sometimes it is important to simultaneously look at data from two different levels of detail. This can be accomplished in SAS by exploding a section of a map and providing additional detail for the exploded section. While SAS does not provide a procedure or option for this presentation type, it can be accomplished by adding the following steps to the production of a choropleth map (Figure 5 below):

- ☐ Add a variable to the map data sets to set as id for exploded area.
- ☐ Subset exploded area and combine with detailed data set (merge state with county).
- ☐ Set the height and width of exploded area.
- ☐ Move the exploded area to the right of the map.
- ☐ Add coordinates to force a larger graphic area.
- ☐ Create the path to exploded area (triangle to rectangle).
- ☐ Combine the two maps to be created simultaneously.
- ☐ Create the exploded section map.

Figure 5. Choropleth Map with Exploded Section

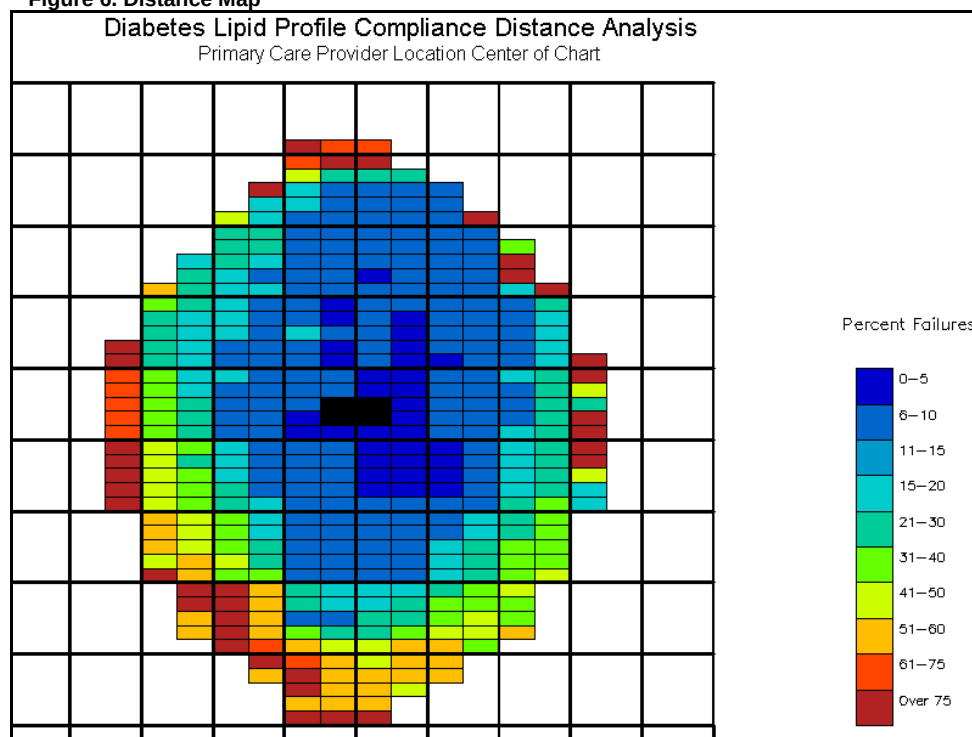


The map above shows national rate of compliance with biennial lipid profiling for diabetics while simultaneously displaying the same rates by county for the state of concern, Virginia. The display provides graphical representation of both how the state overall ranks among other states, and which areas of Virginia are in most need of improvement.

EXAMPLE SIX – 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 increased distance from the location of the primary care provider. For quality improvement work, this suggests greater and significantly different efforts are needed in areas with fewer primary care providers. Figure 4 illustrates this non-geographical map.

Figure 6. 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 quality improvement applications using SAS/GRAPH GMAP as part of statewide and identified participant diabetes wellness initiatives. Through these and other applications, healthcare and social marketing campaigns can focus on the areas of greatest need within the state, allowing for the most efficient use of quality improvement dollars. Geographic data display also aids in the identification of issues such as patient access, provider shortage, and distance to provider, all of which impact quality of care received.

The built-in flexibility SAS/GRAPH GMAP, combined with SAS Annotate, and ODS 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.

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