

Graphic Displays of Adverse Events

Using the SAS Graph Template Language

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Introduction

- The SAS Graph Template Language, or GTL, is behind every ODS graph, whether from PROC CORR or PROC SGPLOT
- SAS enables you to see the GTL code behind SGPLOT and SGSCATTER graphs – see the extra slides at the end of this deck
- You can also write your own GTL code from scratch to make custom graphs
- This presentation shows how I did that for some AE displays

Presentation Goal

- To show you my custom AE graphs and provide some information about how I produced them with GTL, motivating you to try GTL and make it easier for you to get started

Note: All displays in this presentation are

- from dummy data/values, a hypothetical 2-arm parallel-group study
- assumed to be printable report output (pdf format)

Two-Step Process

1. Use PROC TEMPLATE to define a template for your graph – this is where your real work will take place and what I will illustrate today
2. Use PROC SGRENDER to associate the template with a data set and actually produce a graph, writing it to an ODS destination

Choices

- Type of plot (several can be combined in one graph)
 - Layout
 - Titles and footnotes
 - Axes and legends
-
- And so forth – so the same types of choices as with other graphing tools

AE Display Example - By Treatment Group

- Classic table with count and percent
- Table and proportion plot
- Proportion and risk plot
- Table, proportion and risk plot

Table x. Adverse Events by Preferred Term
Randomized Population

<i>Preferred Term</i>	<i>A</i>	<i>B</i>
	<i>(N=400)</i>	<i>(N=400)</i>
	<i>n (%)</i>	<i>n (%)</i>
Subjects with any AE	200 (50.0)	300 (75.0)
MedDRA Preferred AE Term 1	70 (17.5)	120 (30.0)
MedDRA Preferred AE Term 2	60 (15.0)	102 (25.5)
MedDRA Preferred AE Term 3	56 (14.0)	96 (24.0)
MedDRA Preferred AE Term 4	53 (13.3)	90 (22.5)
MedDRA Preferred AE Term 5	49 (12.3)	84 (21.0)
MedDRA Preferred AE Term 6	46 (11.5)	78 (19.5)
MedDRA Preferred AE Term 7	42 (10.5)	72 (18.0)
MedDRA Preferred AE Term 8	39 (9.8)	66 (16.5)
MedDRA Preferred AE Term 9	35 (8.8)	60 (15.0)
MedDRA Preferred AE Term 10	32 (8.0)	54 (13.5)
MedDRA Preferred AE Term 11	28 (7.0)	48 (12.0)
MedDRA Preferred AE Term 12	25 (6.3)	42 (10.5)
MedDRA Preferred AE Term 13	21 (5.3)	36 (9.0)
MedDRA Preferred AE Term 14	18 (4.5)	30 (7.5)
MedDRA Preferred AE Term 15	14 (3.5)	24 (6.0)
MedDRA Preferred AE Term 16	11 (2.8)	18 (4.5)
MedDRA Preferred AE Term 17	7 (1.8)	12 (3.0)
MedDRA Preferred AE Term 18	6 (1.5)	7 (1.8)
MedDRA Preferred AE Term 19	4 (1.0)	8 (2.0)
MedDRA Preferred AE Term 20	5 (1.3)	7 (1.8)

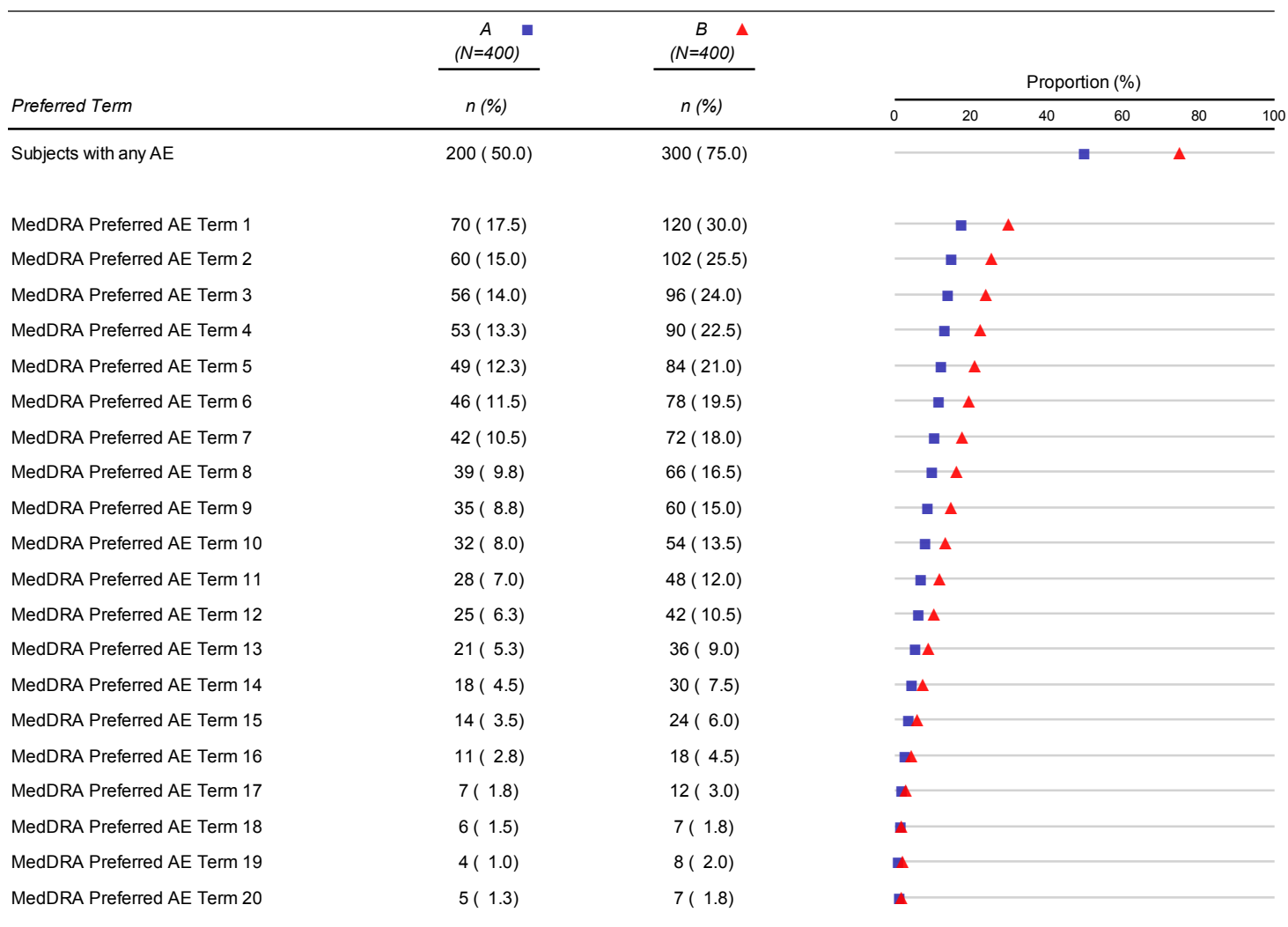
Figure x. Adverse Events by Preferred Term
Randomized Population

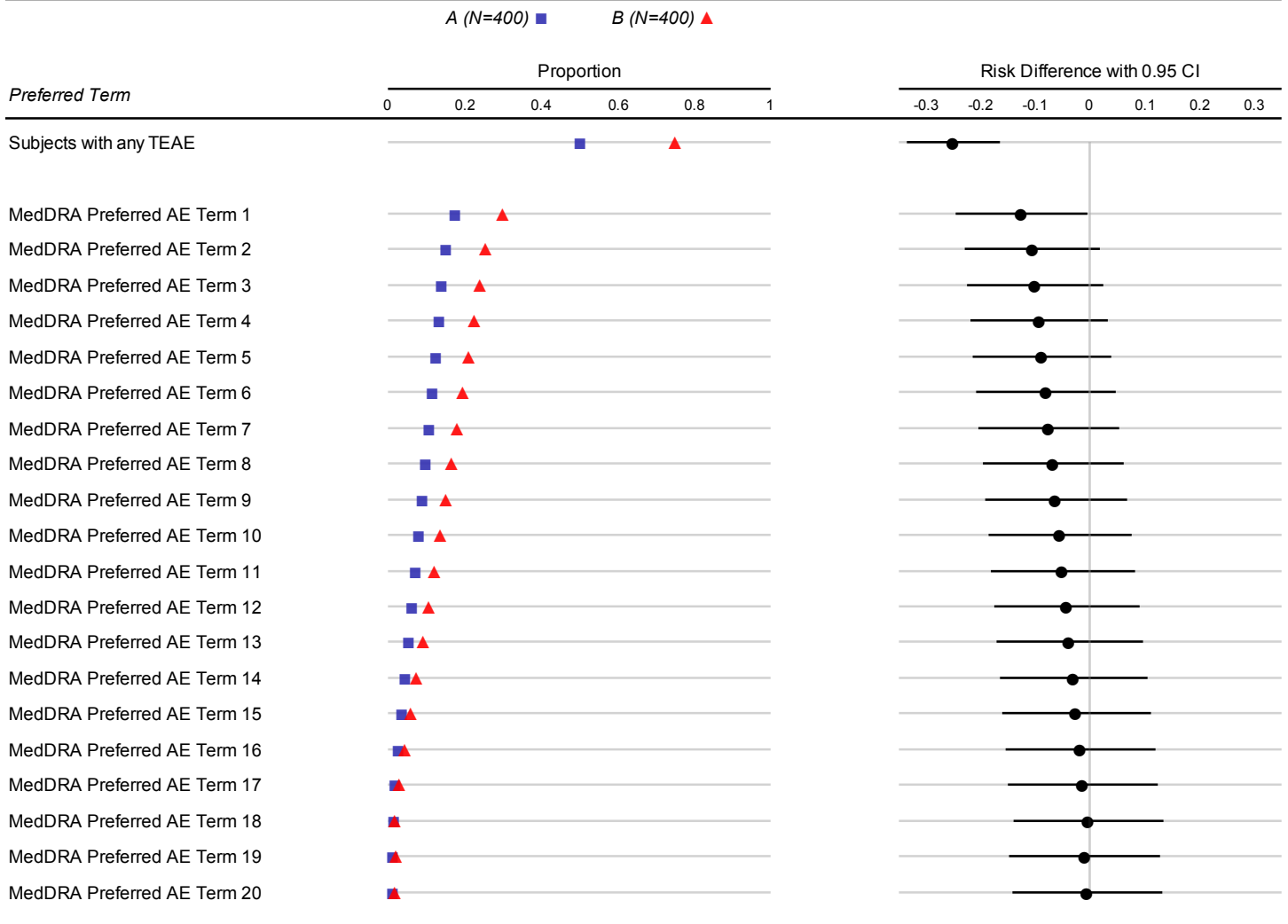
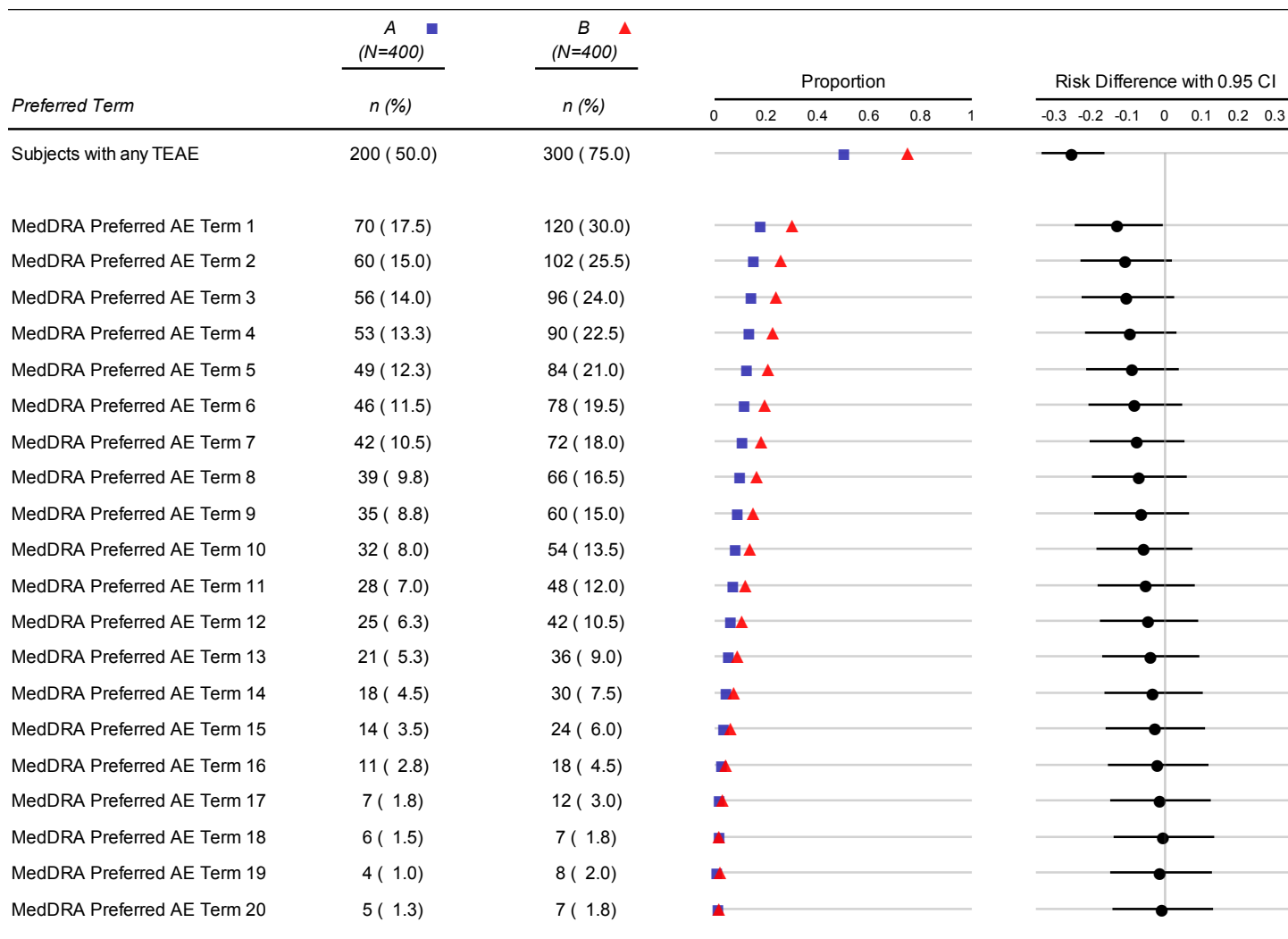
Figure x. Adverse Events by Preferred Term
Randomized Population

Figure x. Adverse Events by Preferred Term
Randomized Population

AE Display Example – Individual Level

- Classic individual table
- AE start points in study days
- AE start and end points in study days
- AE start and end points in study days (dose)
- AEs with other vital/lab results
- SAE start and end points in study days
- Individual AE by treatment group

GENERATED DUMMY DATA

Listing x. Serious Adverse Events
Randomized Population

Subject Number	Sex/ Race/ Age	System Organ Class/ Preferred Term/ Verbatim Term	AE Start Dt. (study day)/ AE End Dt. (study day) Or Ongoing	Ser- ious TEAE	Pattern	Relation to Study Drug	Action Taken ^a	Out- come ^b	Severity	Con- comitant therapy intro- duced	Trt/ Start Dt./ End Dt.
01-0001	Male/ White/ 20	MedDRA system organ class 1/ MedDRA preferred term 1/ Verbatim string 1	2015-MM-DD (10)/ 2015-MM-DD (20)	Yes	Single Event	Not Related	1	1	Moderate	Yes	2015-MM-DD / 2015-MM-DD
02-0002	Female/ Black/ 30	MedDRA system organ class 2/ MedDRA preferred term 2/ Verbatim string 2	2015-MM-DD (20)/ 2015-MM-DD (30)	Yes	Intermittent	Unlikely Related	2	2	Severe	No	2015-MM-DD / 2015-MM-DD
03-0003	Male/ White/ 40	MedDRA system organ class 3/ MedDRA preferred term 3/ Verbatim string 3	2015-MM-DD (30)/ 2015-MM-DD (40)	Yes	Continuous	Probably Related	3	3	Moderate	Yes	2015-MM-DD / 2015-MM-DD
04-0004	Female/ White/ 50	MedDRA system organ class 4/ MedDRA preferred term 4/ Verbatim string 4	2015-MM-DD (40)/ 2015-MM-DD (50)	Yes	Single Event	Possibly Related	4	4	Severe	No	2015-MM-DD / 2015-MM-DD
05-0005	Male/ White/ 60	MedDRA system organ class 5/ MedDRA preferred term 5/ Verbatim string 5	2015-MM-DD (50)/ 2015-MM-DD (60)	Yes	Intermittent	Related	5	5	Moderate	Yes	2015-MM-DD / 2015-MM-DD
06-0006	Female/ White/ 20	MedDRA system organ class 6/ MedDRA preferred term 6/ Verbatim string 6	2015-MM-DD (60)/ 2015-MM-DD (70)	Yes	Continuous	Not Related	1	6	Severe	No	2015-MM-DD / 2015-MM-DD
07-0007	Male/ Asian/ 30	MedDRA system organ class 7/ MedDRA preferred term 7/ Verbatim string 7	2015-MM-DD (70)/ 2015-MM-DD (80)	Yes	Single Event	Unlikely Related	2	1	Moderate	Yes	2015-MM-DD / 2015-MM-DD
08-0008	Female/ Black/ 40	MedDRA system organ class 8/ MedDRA preferred term 8/ Verbatim string 8	2015-MM-DD (80)/ 2015-MM-DD (90)	Yes	Intermittent	Probably Related	3	2	Severe	No	2015-MM-DD / 2015-MM-DD

Note: Adverse events were classified into system organ class and preferred term using MedDRA version 15.

^a Action Taken: 1 = Dose Not Changed, 2 = Dose Reduced, 3 = Drug Interrupted, 4 = Drug Withdrawn and 5 = Not Applicable.

^b Outcome: 1 = Not Recovered / Not Resolved, 2 = Recovered / Resolved, 3 = Recovered / Resolved with Sequelae, 4 = Recovering / Resolving, 5 = Fatal and 6 = Unknown.

Figure x. Adverse Events per Each Subject
Randomized Population

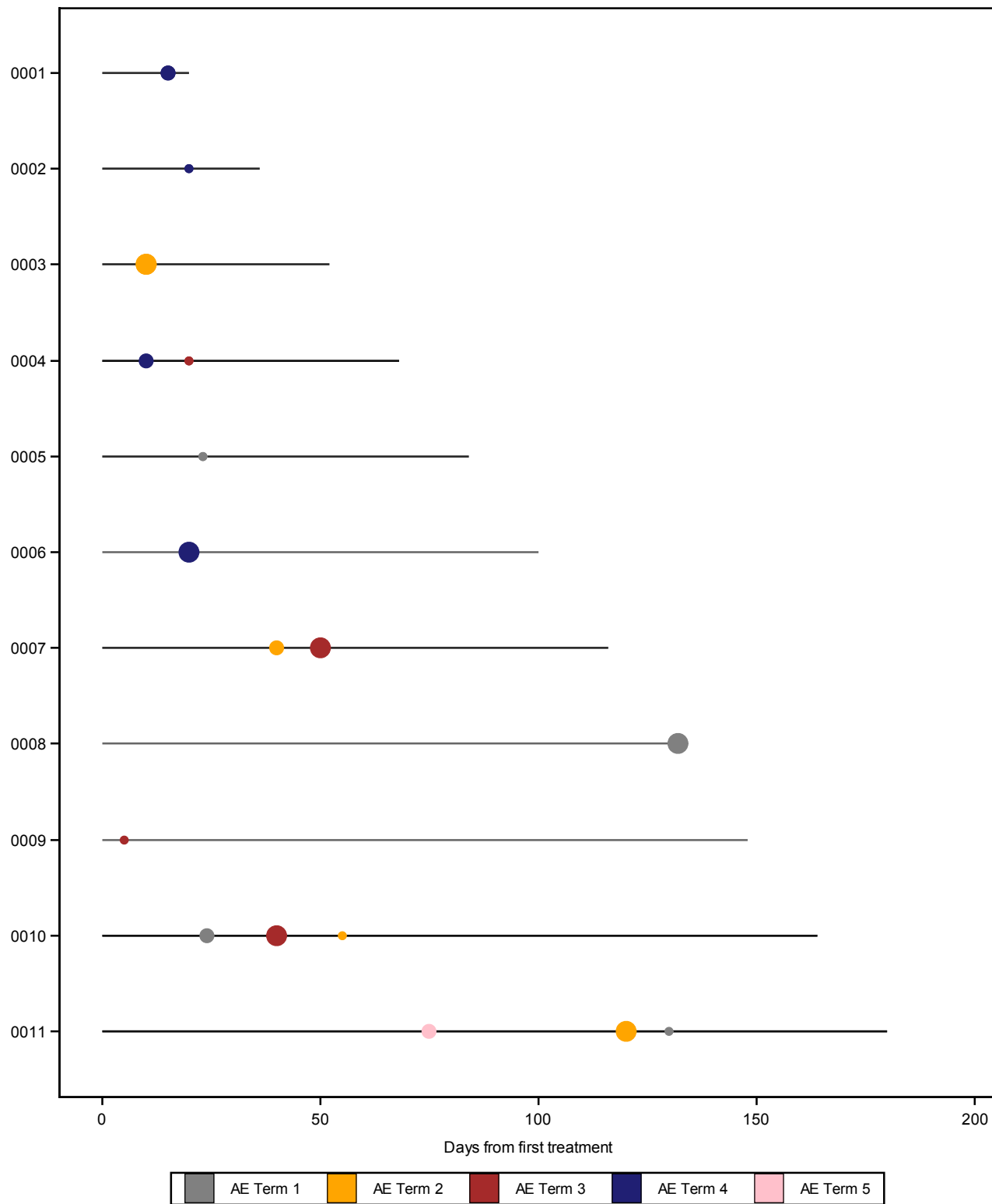


Figure x. Adverse Events per Each Subject
Randomized Population

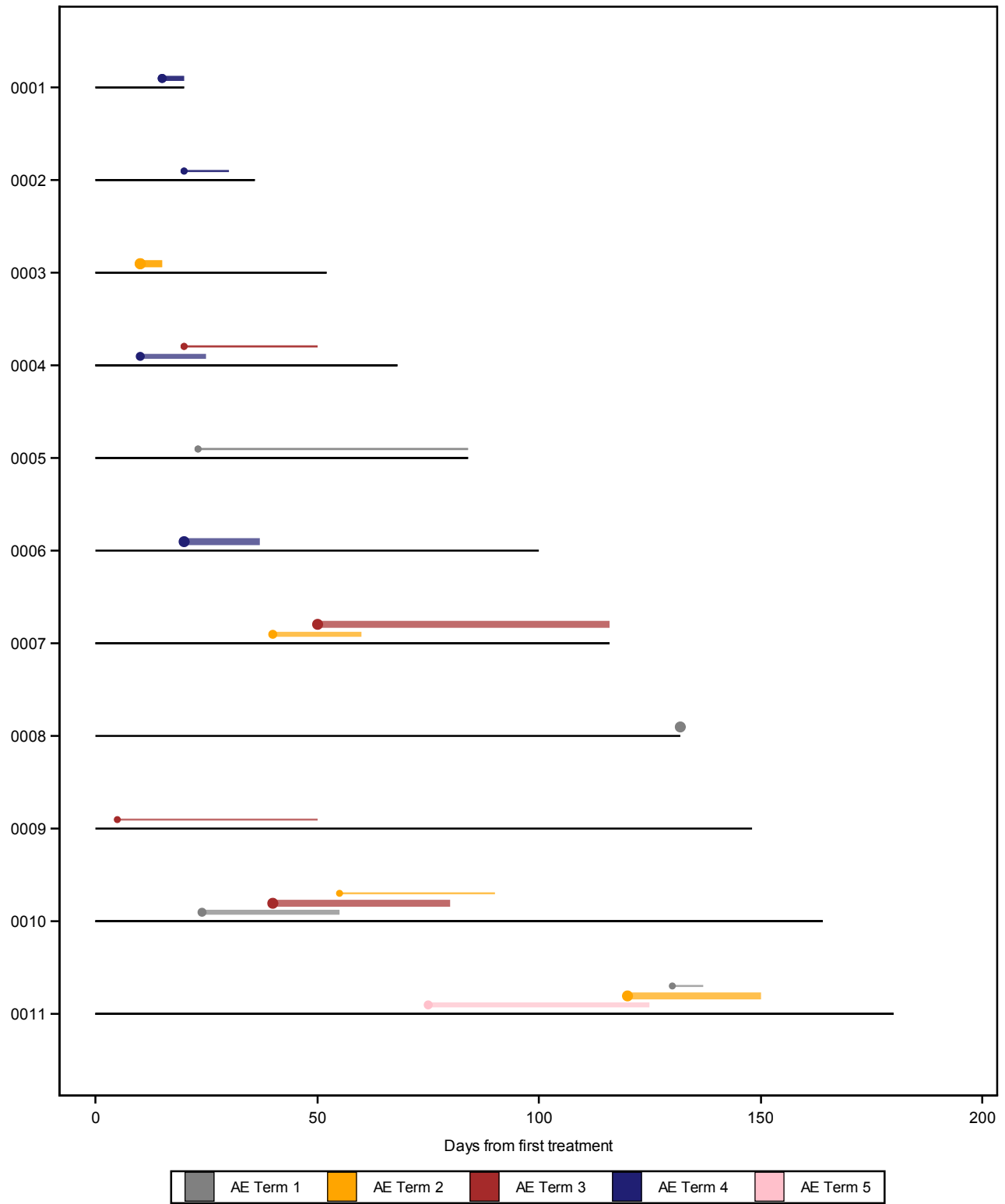


Figure x. Adverse Events per Each Subject
Randomized Population

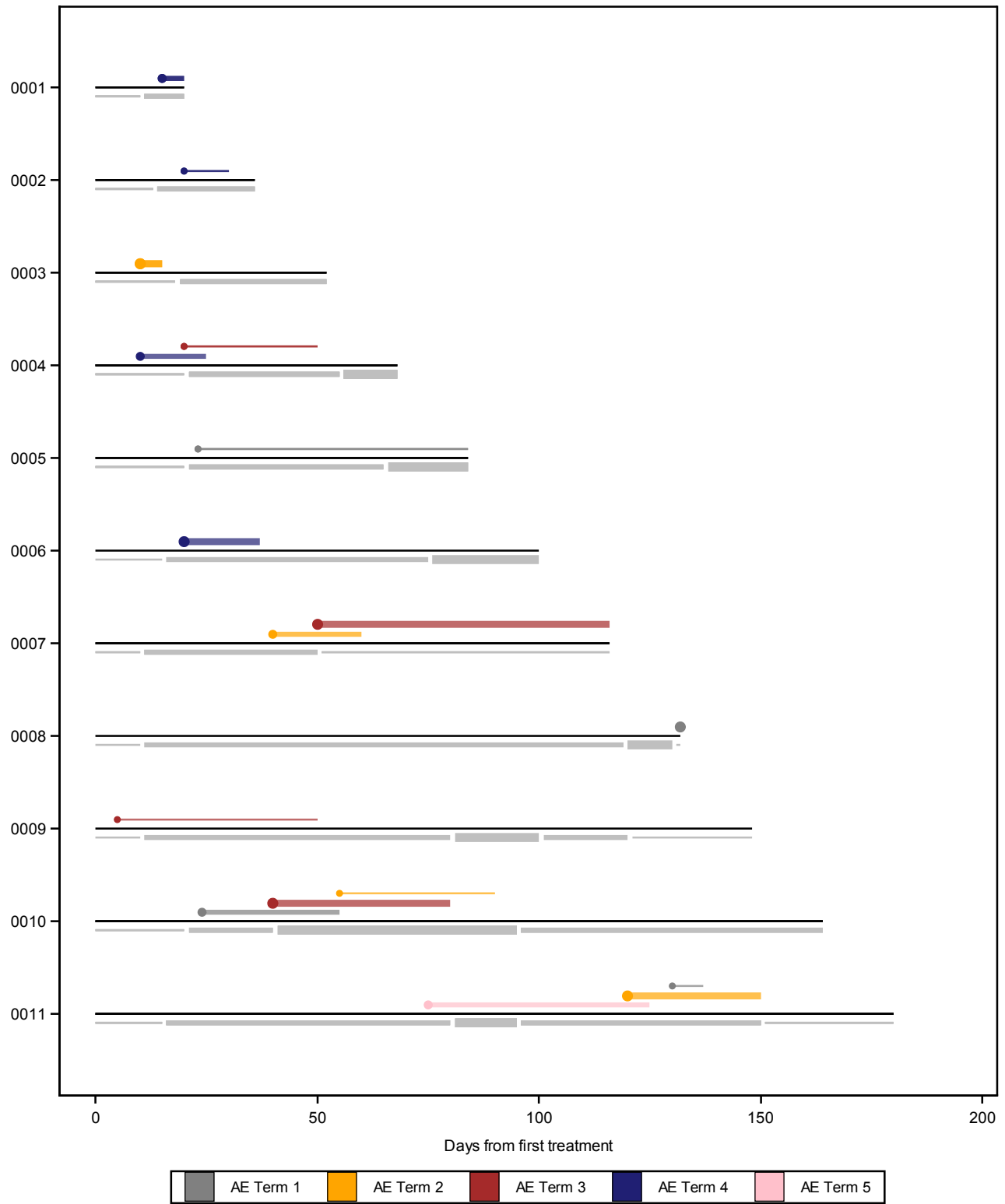


Figure x. Serious Adverse Events per Each Subject
Randomized Population

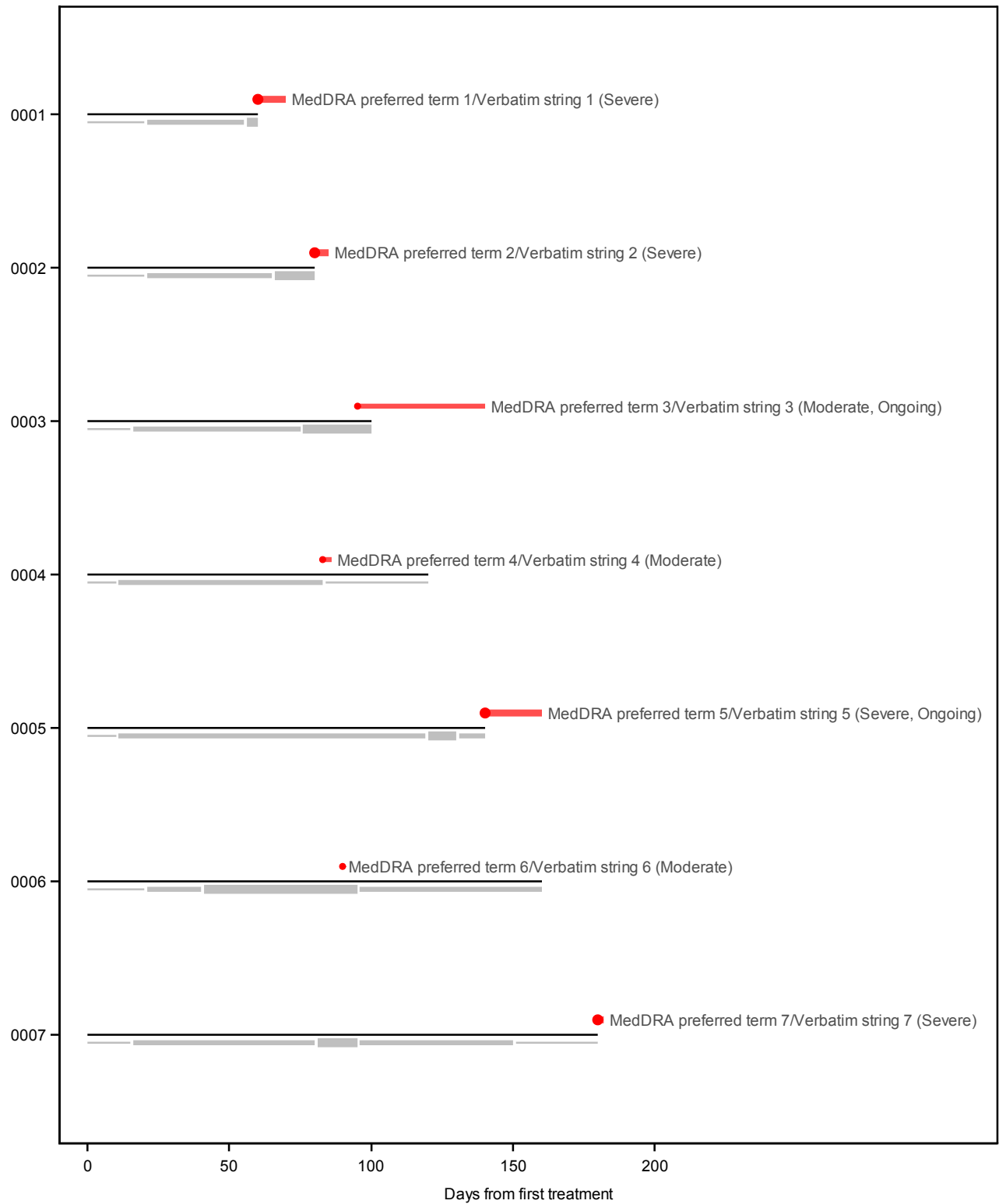


Figure x. Adverse Events per Each Subject
Randomized Population

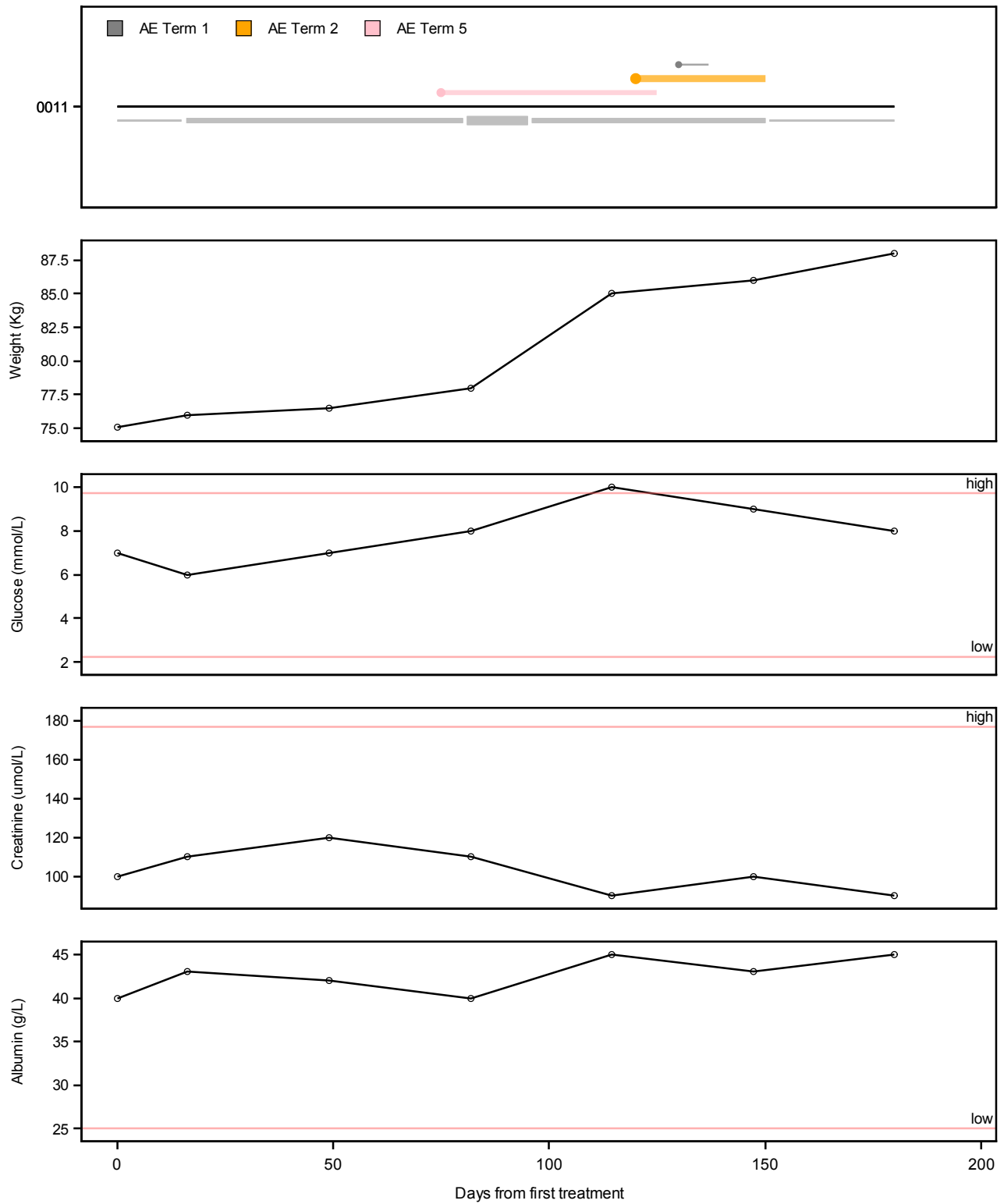
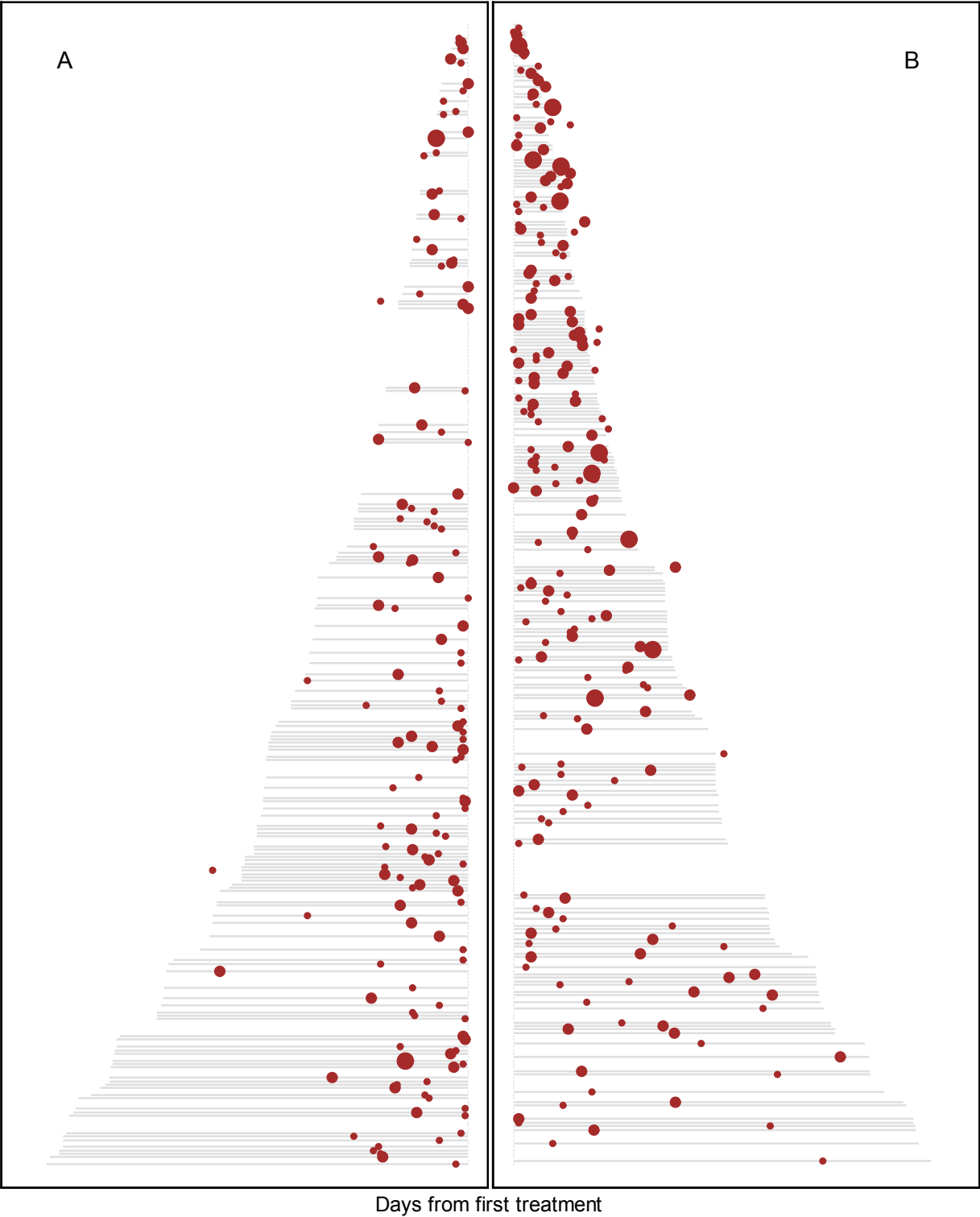


Figure x. Adverse Events per Each Subject
Randomized Population

AE Term 1



Coding Scheme

- SAS Graph Template Language (GTL)

```
proc template;
  define statgraph aetab;
    begingraph/drawspace=graphpercent;
      layout overlay;
```

```
    drawline x1=0 y1=100 x2=100 y2=100 / lineattrs=(thickness=1);
```

```
    /*Table column header*/
    drawtext textattrs=(style=italic size=7.5pt) "Preferred Term" / anchor=left x=0 y=92 width=20 ;
```

```
    ...
    drawtext textattrs=(size=8pt color=bib) {unicode '25a0'x} / anchor=center x=%sysevalf(&x_A + 3) y=98.5 width=1 transparency=0.1;
    drawtext textattrs=(size=7pt color=red) {unicode '25b2'x} / anchor=center x=%sysevalf(&x_B + 3) y=98.5 width=1 transparency=0.1;
```

```
    /*Plot column header*/
    drawtext textattrs=(size=7.5pt) "Proportion (%)" / anchor=center x=%sysevalf( (&x_plotst +100)/2 ) y=94 width=20 ;
    drawline x1=&x_plotst y1=92.5 x2=100 y2=92.5 / lineattrs=(thickness=1);
    drawtext textattrs=(size=6pt) "0" / anchor=center x=&x_plotst y=91 width=3 ;
    drawtext textattrs=(size=6pt) "20" / anchor=center x=%sysevalf( &x_plotst + ((100 - &x_plotst)*20)/&plotpctmax ) y=91 width=3 ;
    ...
```

```
    /* macro setting to repeat each row*/
    ...
```

```
    *** AE column ***;
    drawtext textattrs=(size=7.5pt) "&col" / anchor=left x=0 y=&y width=50 ;
```

```
    *** n(%) value ***;
    drawtext textattrs=(size=7.5pt) "&npa" / anchor=center x=&x_A y=&y width=50 ;
    ...
```

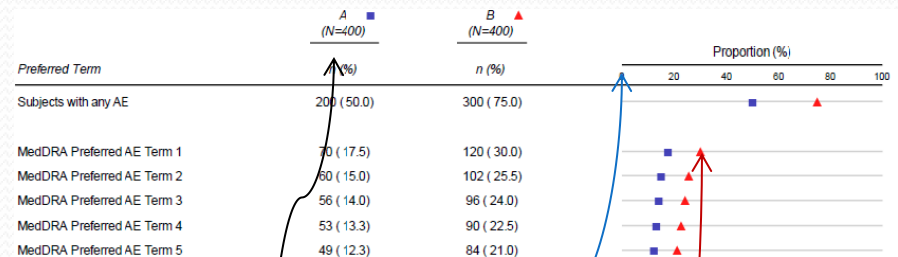
```
    *** plot ***;
    drawline x1=&x_plotst y1=&y x2=100 y2=&y / lineattrs=(thickness=1 pattern=1 color=ligr) transparency=0.3;
    drawtext textattrs=(size=8pt color=bib) {unicode '25a0'x} / anchor=center x=&x_A y=&y width=1 transparency=0.1;
    ...
```

```
    /* end of macro setting to repeat each row*/
```

```
    drawline x1=0 y1=%sysevalf(&y_last -3) x2=100 y2=%sysevalf(&y_last -3) / lineattrs=(thickness=1);
```

```
  endlayout;
endgraph;
```

```
end;
run;
```



Coding Scheme

- SAS Graph Template Language (GTL)

```
proc template;
  define statgraph aedisplay3;
    beginngraph;

      discreteattrmap name="symbols" / ignorecase=true trimleading=true;
        value "Headache" / lineattrs=(color=GRAY);
        ...
      enddiscreteattrmap;

      discreteattrvar attrvar=lineae&i var=ae&i attrmap="symbols";
      ...

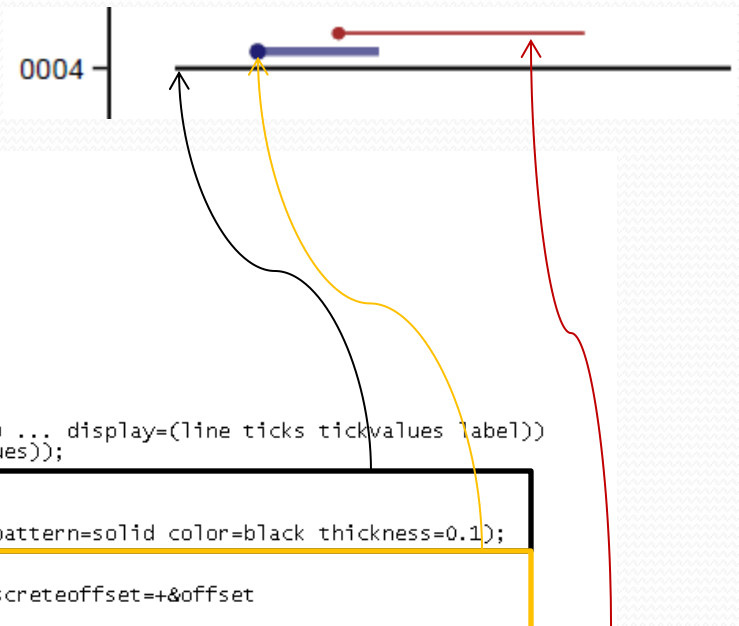
      layout overlay /
        xaxisopts=(label='Days from first treatment' labelattrs=(size=7pt) ... display=(line ticks tickvalues label))
        yaxisopts=( tickvalueattrs=(size=7pt) display=(line ticks tickvalues));

        /*Baseline: Treatment days*/
        highlowplot y=SUBJID high=studydays low=zero /
          group=SUBJID outlineattrs=(pattern=solid) type=line lineattrs=(pattern=solid color=black thickness=0.1);

        /*AE start point*/
        scatterplot x=sd&i y=SUBJID / groupdisplay=cluster group=mae&i discreteoffset=+&offset
          MARKERSIZERESPONSE=AESEVN MARKERSIZEMIN=4 MARKERSIZEMAX=7;

        /*AE start to end : line*/
        highlowplot y=SUBJID low=sd&i high=ed&i /
          group=lineae1 type=line lineattrs=(pattern=solid thickness=&thick) datatransparency=0.3 discreteoffset=+&offset;

        ...|
      endlayout;
    endgraph;
  end;
run;
```



Coding Scheme

- SAS Graph Template Language (GTL)

```
proc template;
  define statgraph aedisplay4;
    begingraph;
```

```
    ...
    layout lattice / rows=5 rowweights=(0.19 0.19 0.19 0.19 0.24) ... rowgutter=10;
```

```
    /*AE per ID on the top box*/
    layout overlay /
```

```
      xaxisopts=(label='Days from first treatment' labelattrs=(size=7pt) ... display=(line ticks tickvalues label))
      yaxisopts=( tickvalueattrs=(size=7pt) display=(line ticks tickvalues));
```

```
    /*Baseline: Treatment days*/
    highlowplot y=SUBJID high=studydays low=zero / group=SUBJID ... ;
```

```
    ...
```

```
    discretelegend "aelegend1" "aelegend2" "aelegend5" / ... location=inside border=false autoalign=(topleft);
```

```
  endlayout;
```

```
    /*weight by study days*/
    layout overlay /
```

```
      xaxisopts=(label=' ' labelattrs=(size=7pt) ... display=(line))
      yaxisopts=( label='weight (kg)' ... display=(line ticks tickvalues label));
```

```
      seriesplot X=LBDY Y=weight / group=SUBJID primary=true display=(markers) NAME="VLINE";
```

```
  endlayout;
```

```
    ...
```

```
  endlayout;
```

```
endgraph;
```

```
end;
```

```
run;
```

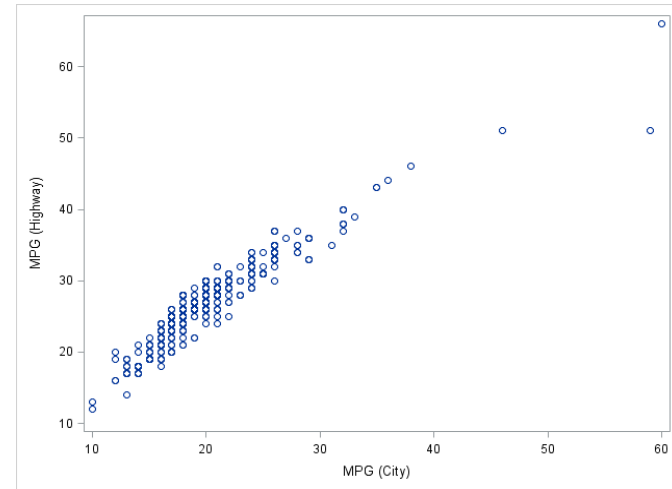


Suggestion?

- More ideas on display of AEs ?
- More thoughts : What could be display options in platforms other than printable (or printed) format? - Depends on DSMB meeting setting

Extra slides for your later review to
help you get started with GTL

What is behind an SGPLOT?



Use TMPLOUT to save the GTL

```
proc sgplot data=sashelp.cars
    tmpout="P:\PhUSE\gtl_cars_scatter1.gtl";

    scatter x=mpg_city y=mpg_highway;
run;
```

TMPLOUT works with SGPLOT and SGSCATTER but not with SGPANEL

The generated GTL for this plot

```
proc template;  
  define statgraph sgplot;  
    begingraph /;  
      layout overlay;  
        ScatterPlot X=MPG_City Y=MPG_Highway /  
          primary=true LegendLabel="MPG (Highway)" NAME="SCATTER";  
      endlayout;  
    endgraph;  
  end;  
run;
```

What if I want to reuse this code to produce exactly the same graph? If I simply submit the PROC TEMPLATE code, I don't get a graph – all I get is this in the log:

```
7   proc template;  
8   define statgraph sgplot;  
9   begingraph /;  
10  layout overlay;  
11      ScatterPlot X=MPG_City Y=MPG_Highway / primary=true LegendLabel="MPG (Highway)"  
11 ! NAME="SCATTER";  
12  endlayout;  
13  endgraph;  
14  end;  
NOTE: STATGRAPH 'Sgplot' has been saved to: SASUSER.TEMPLAT  
15  run;  
NOTE: PROCEDURE TEMPLATE used (Total process time):  
      real time          0.07 seconds  
      cpu time           0.00 seconds
```

Rather than this code producing a graph, it simply saved a new template named SGPLOT. To actually use that template, you need to call PROC SGRENDER, supplying the template name and a suitable data set. Since the PROC TEMPLATE code contains hardcoded variable names, the supplied data set must contain those variables. Either of the following would work, with the first reproducing the original plot and the second showing only the subset of European cars.

```
proc sgrender data=sashelp.cars template=sgplot;  
run;
```

```
proc sgrender data=sashelp.cars(where=(origin='Europe')) template=sgplot;  
run;
```

One possible modification of this template would be to make it more flexible so that it could produce a scatter plot of any two variables in a data set, not just variables named MPG_City and MPG_Highway.

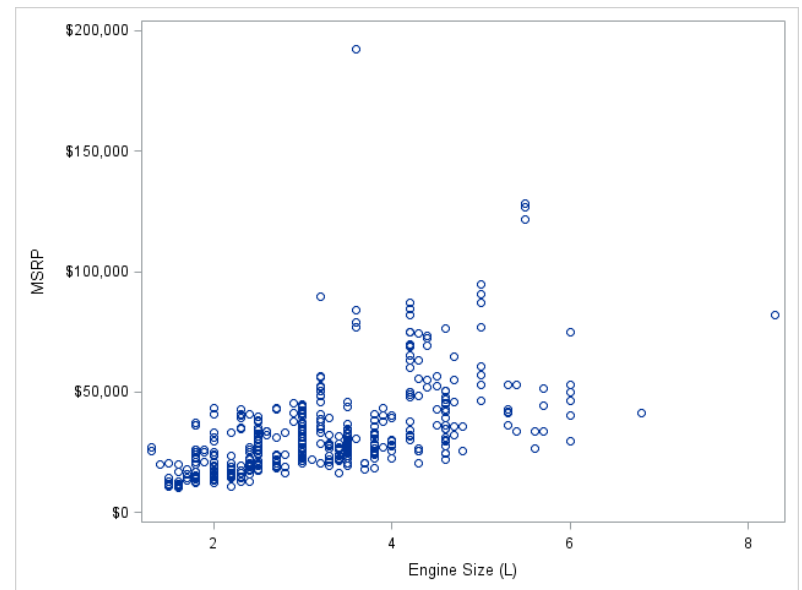
We simply re-define the template to use DYNAMIC VARIABLES, and then we specify values for those dynamic variables when we call SGRENDER.

```

proc template;
  define statgraph sgplotdyn;
    begingraph /;
      dynamic _xvar _yvar;
      layout overlay;
        ScatterPlot X=_xvar Y=_yvar /
          primary=true NAME="SCATTER";
      endlayout;
    endgraph;
  end;
run;

proc sgrender data=sashelp.cars template=sgplotdyn;
  dynamic _xvar='EngineSize' _yvar='MSRP';
run;

```

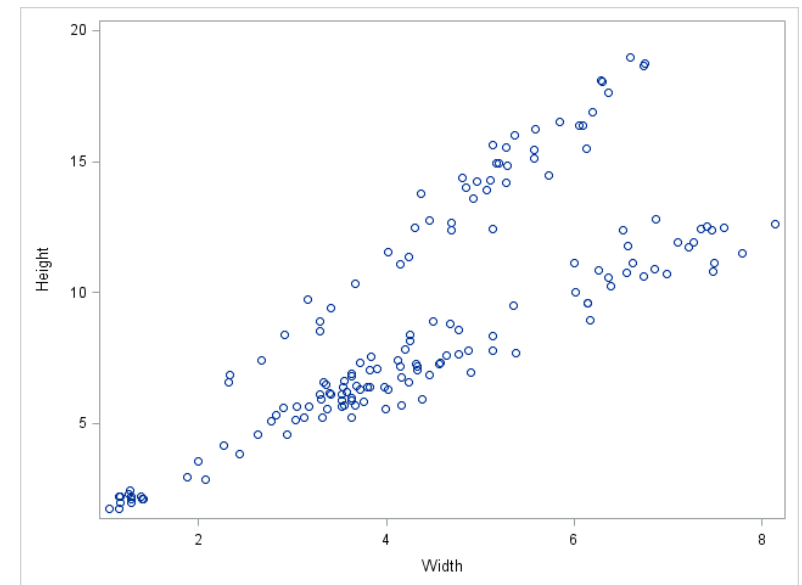


```

title 'Fish dimensions in sashelp.fish';
proc sgrender data=sashelp.fish
  template=sgplotdyn;
  dynamic _xvar='Width'
    _yvar='Height';
run;

```

Fish dimensions in sashelp.fish



Of course, this is only the beginning, because so far we haven't done anything that couldn't be more easily done with a simple PROC SGPLOT call!

But at least you have seen the process of using GTL to define a template and then calling PROC SGRENDER to actually apply that template to produce a graph.

References

Sanjay Matange – Getting Started with the Graph Template Language in SAS®

Warren Kuhfeld – Statistical Graphics in SAS®

SAS 9.4 GTL documentation:

<http://support.sas.com/documentation/cdl/en/grstatgraph/67280/HTML/default/viewer.htm#titlepage.htm>