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Mixing Tables and Graphics
Suggested Model
References

Clinical Trials Graphical Reporting: A Rescue From Tables

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Statistical Methods in Biopharmacy

Emerging Topics for Statistical Methodology in Clinical Drug Development
Biopharmacie et Sante
Société Française de Statistique SFdS
Paris, France 17 September 2013

Clinical Trial Reporting

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- Miscellaneous interim analyses
- Repeated DMC and final reports
- Reviewers need help
- Make patterns and signals apparent
- Handling multiple dimensions
- Tables often require categorization of continuous variables

What are Tables Good For?

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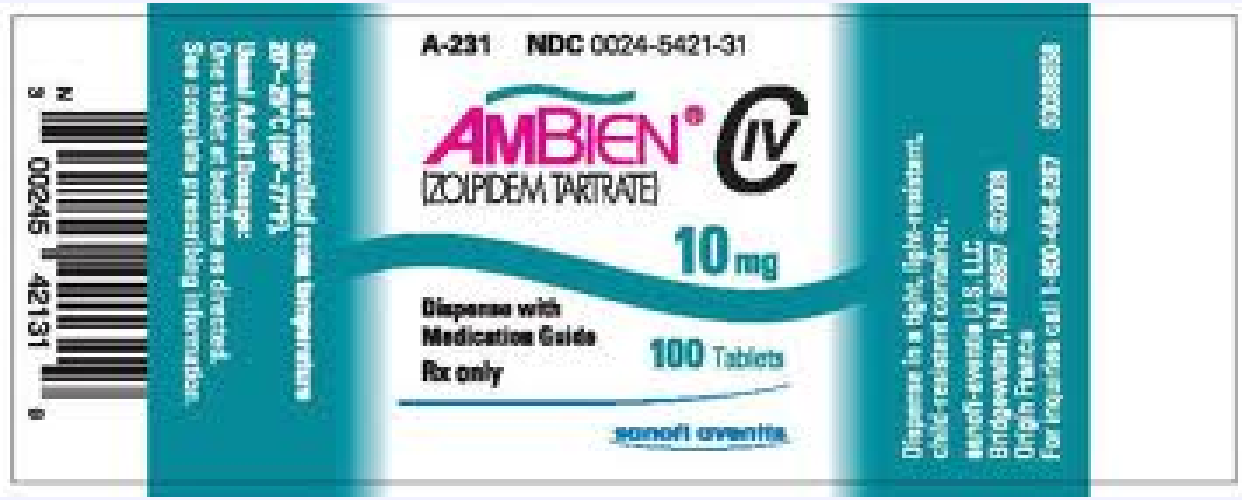
Inducing Sleep!

	Growth (n = 5,218)		Mature (n = 5,226)		Stagnant (n = 5,262)		Full (n = 26,243)	
	MED	SD	MED	SD	MED	SD	MED	SD
R	0.10	1.06	0.33	1.38	0.21	1.40	0.23	1.36
BM	0.57	1.37	0.69	1.47	0.80	1.10	0.75	1.57
BETA	0.72	2.02	1.01	1.06	1.12	1.60	0.89	5.60
SIZE	3.26	2.32	5.07	2.47	5.60	2.25	4.92	2.37
LEV	0.19	0.28	0.17	0.27	0.14	0.19	0.17	0.24
ΔSG	0.06	2.24	0.01	0.24	−0.00	0.08	0.03	1.07
ΔCE	0.05	0.78	0.03	0.82	−0.00	0.18	0.04	1.02
ΔCFO	0.00	0.37	0.03	1.09	−0.00	0.85	0.02	1.51
ΔROS	1.21	30.08	2.20	50.23	−0.57	21.46	1.17	59.47
ΔNI	0.10	1.05	0.33	1.38	−0.00	1.40	0.04	1.03
SG	0.61	4.13	0.26	3.28	−0.07	0.25	0.39	3.38
CAP	0.12	0.31	0.08	0.15	0.02	0.03	0.06	0.21
DIV	0.00	0.25	0.07	0.39	1.21	1.74	0.31	8.03
AGE	16	10.55	39	27.3	74	22.6	45	27.5



What are Tables Good For?

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- Summarizing categorical variables
- Information look-up
- Pretending there is more precision in estimates than actually exists
- Providing denominators (sample sizes)

Paul Murrell's Basic Principles for Good Graphics

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1. Display data values using position or length.
2. Use horizontal lengths in preference to vertical lengths.
3. Watch your data-ink ratio.
4. Think very carefully before using color to represent data values.
5. Do *not* use areas to represent data values.
6. *Please* do not use angles or slopes to represent data values.
7. *Please*, *please* do not use volumes to represent data values.

Murrell [2013]

Guidelines for High Information Graphics

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- Exclude unneeded dimensions and chartjunk
- Graphics don't need to be "dumbed down" or "sexy"
- Keep continuous variables continuous
- Use graphical perception research
  - Emphasize position along a common scale
- Don't choose a graphic requiring an arbitrary choice
  - E.g., rotation of pie chart
- Avoid bar charts
- Choose *descriptive* descriptive statistics
- *Show* differences
- Use real estate to show useful information, not Table 1

Cleveland, Tufte, Bertin, . . .

Classic Books

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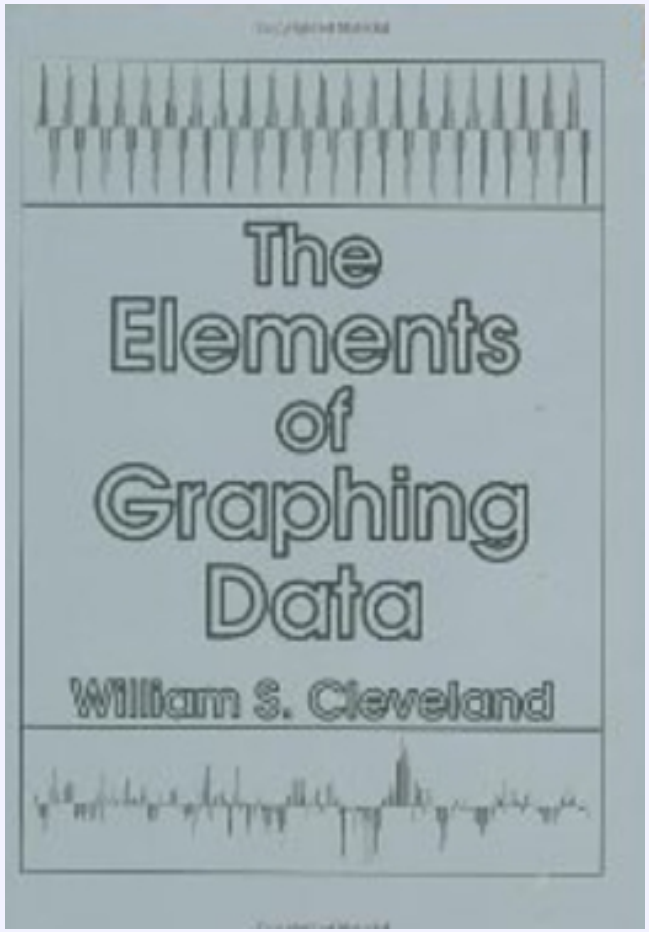

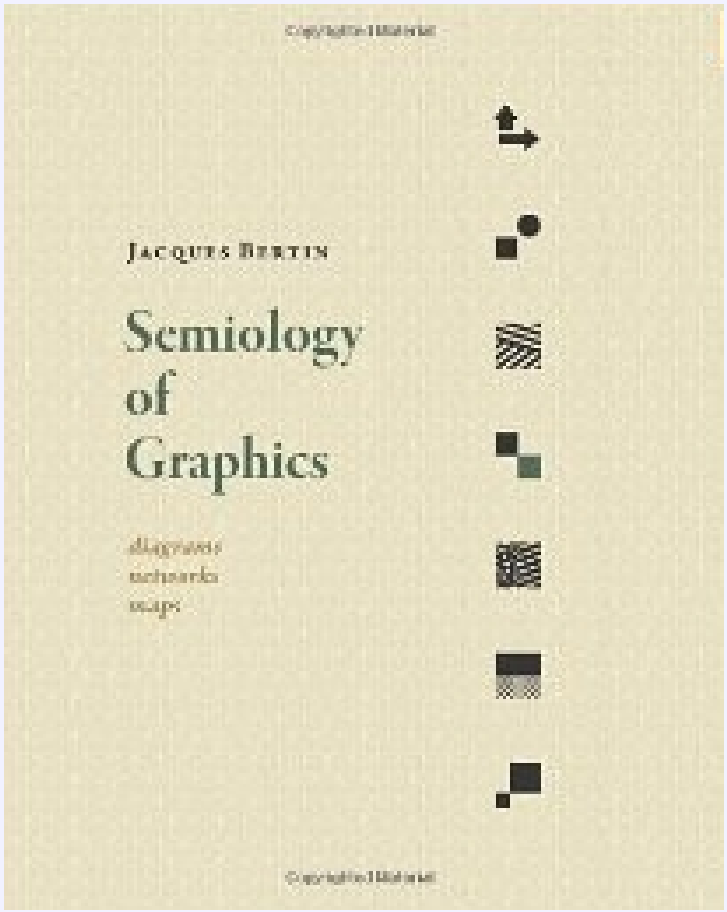

Showing the Difference

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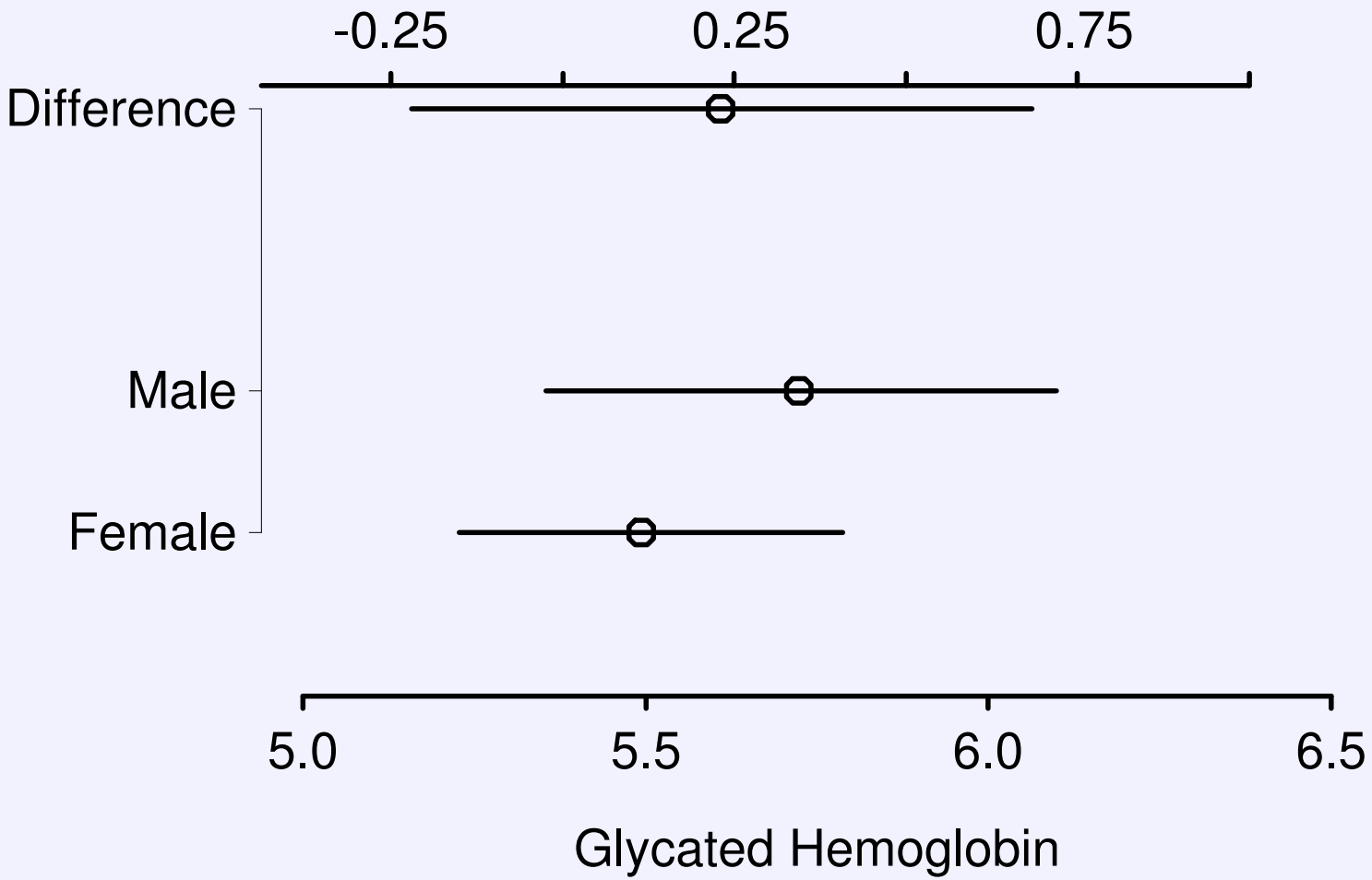

Not This

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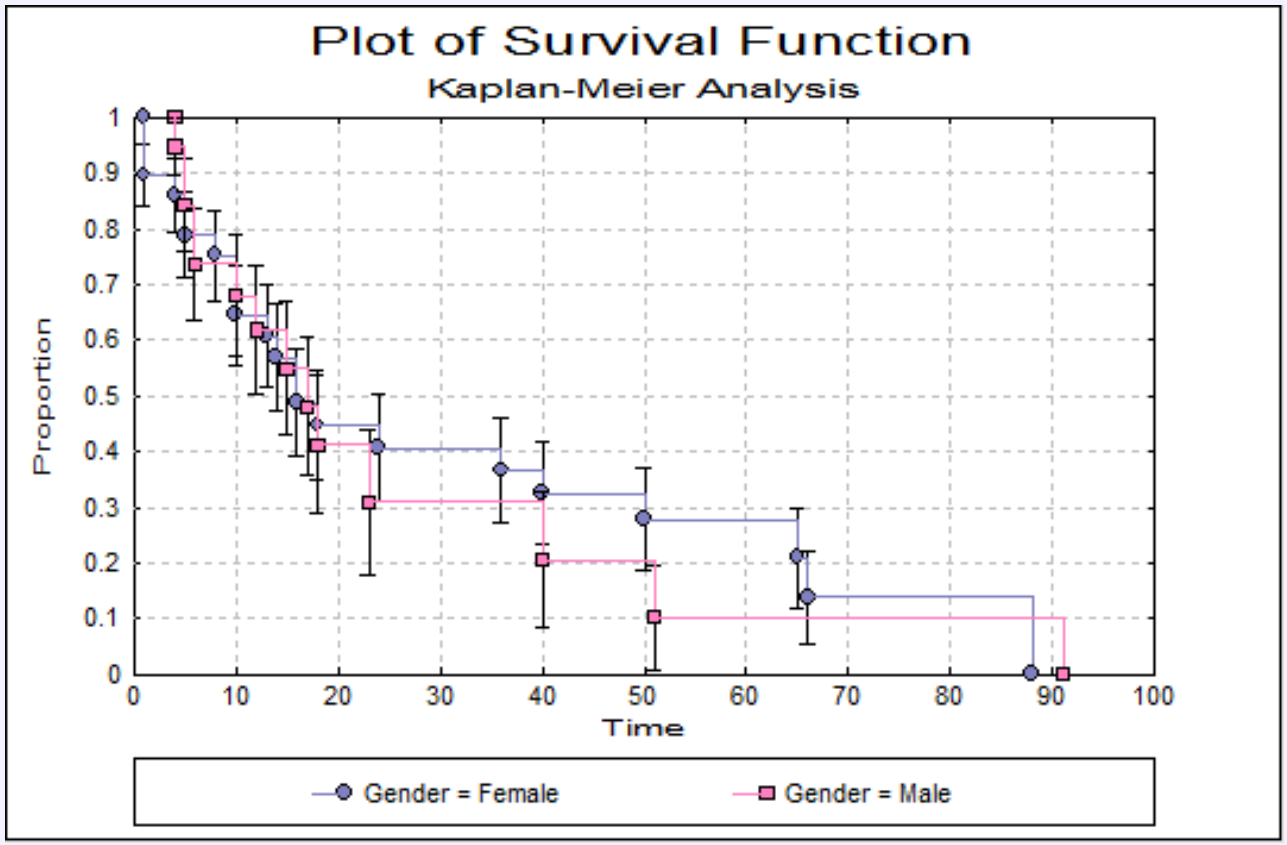

Showing Differences: Two Kaplan-Meier Curves

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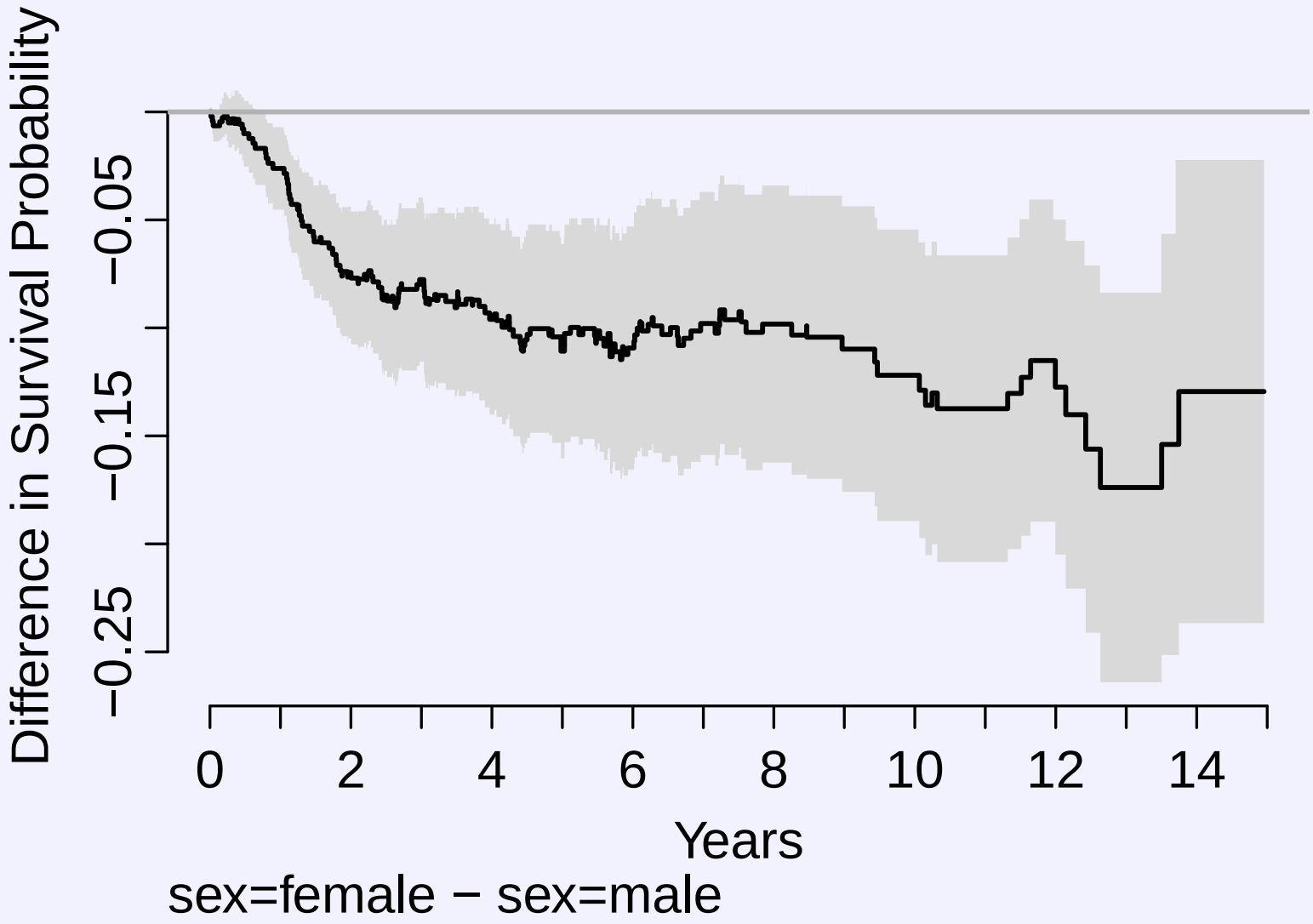

Depicting Uncertainty

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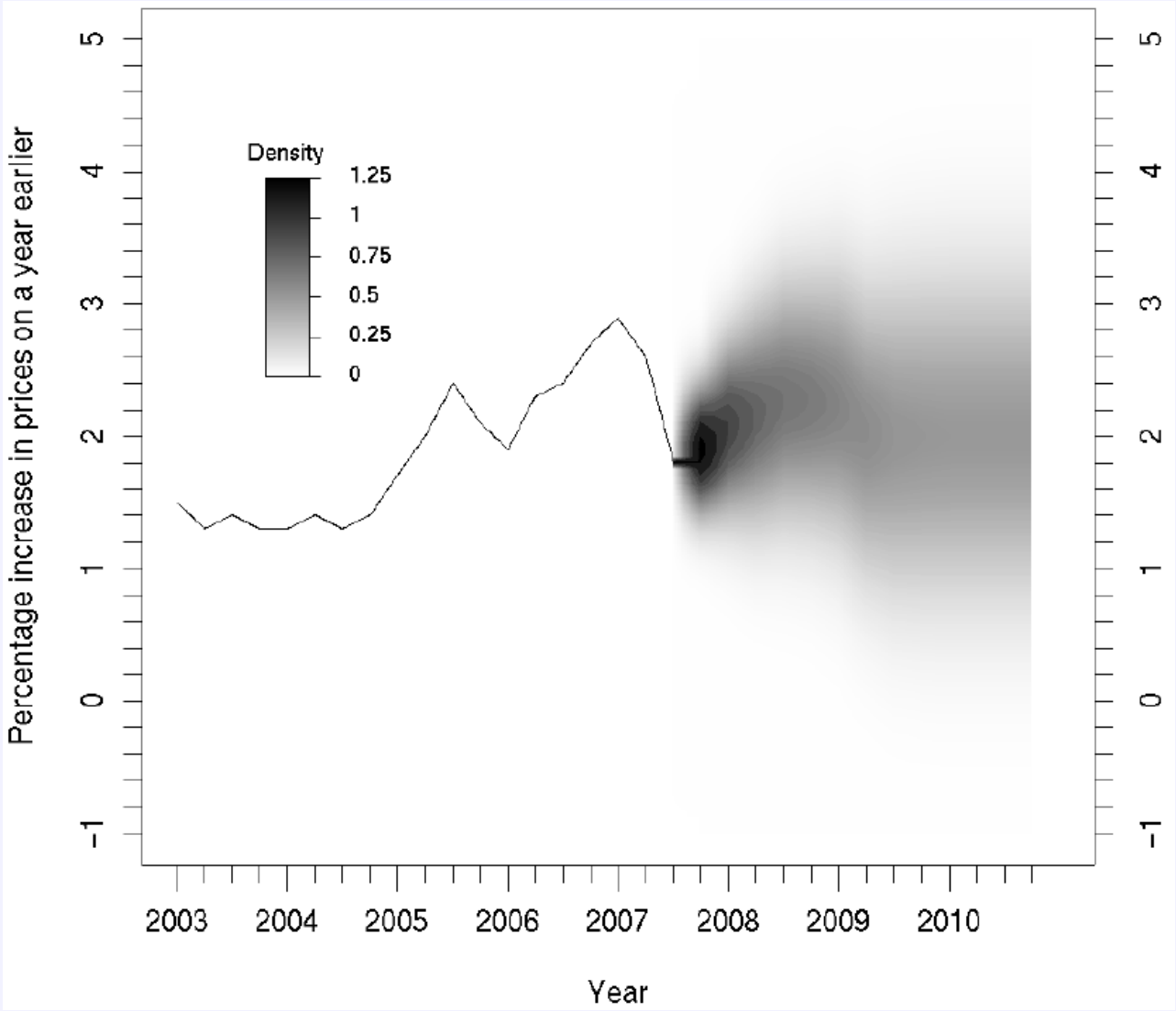

Jackson [2008]

General Examples: Dropouts

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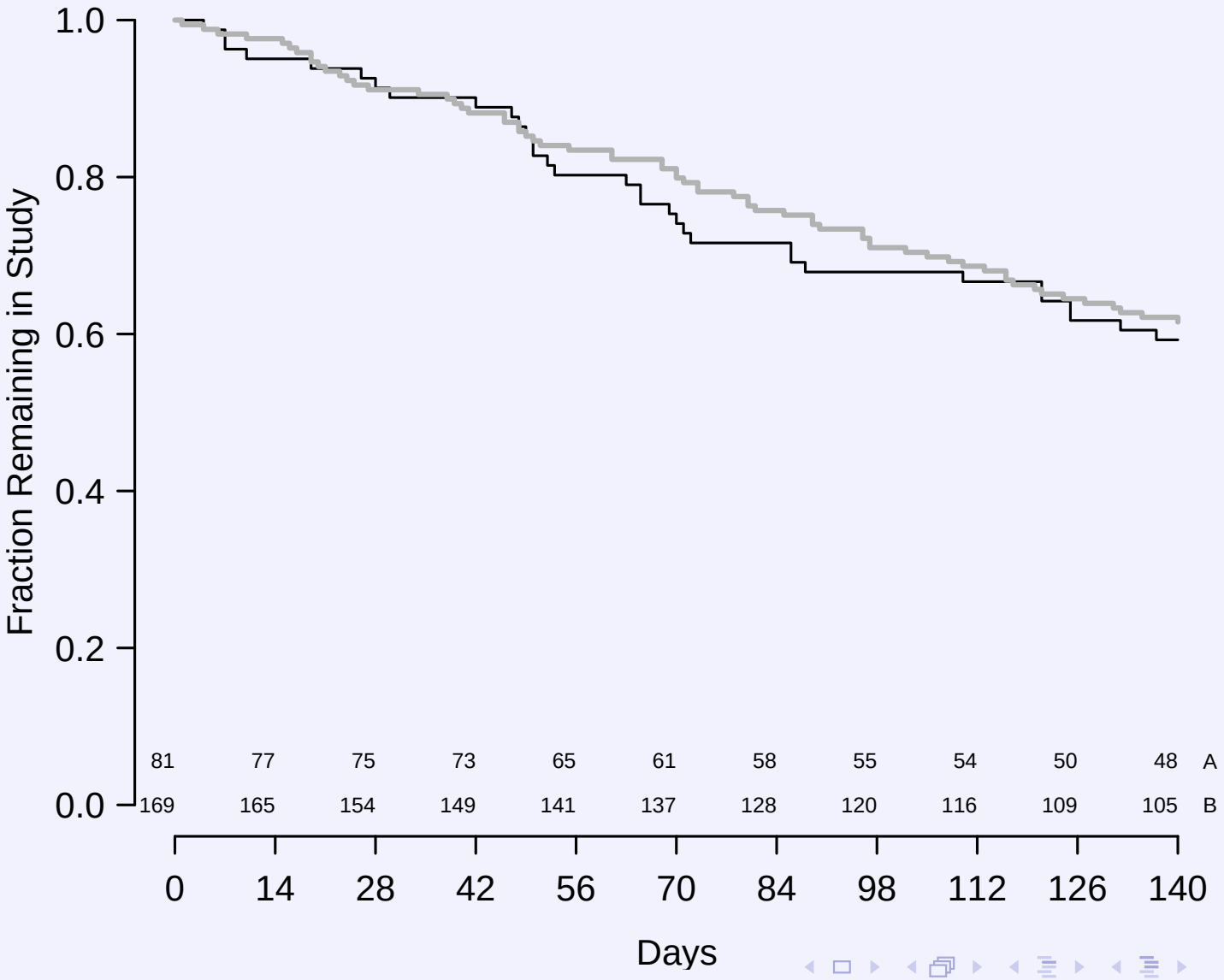

Safety Variable Clustering

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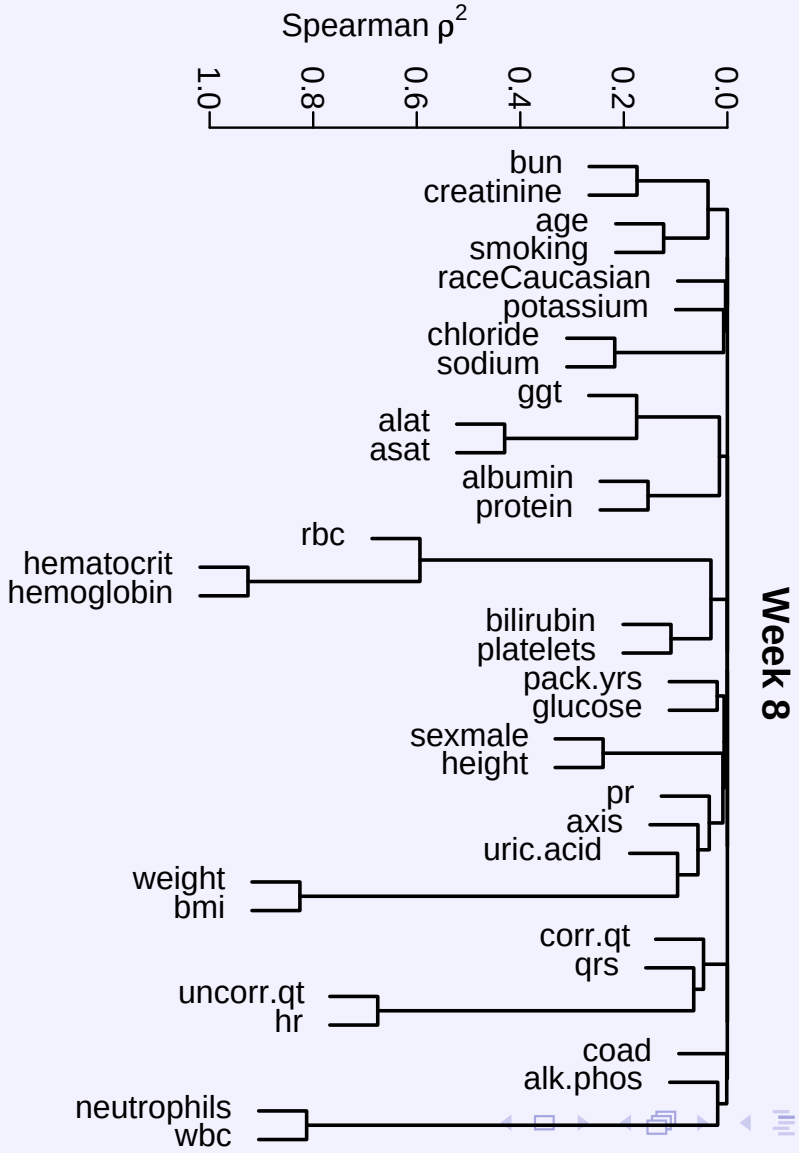

Cumulative Incidence of AEs

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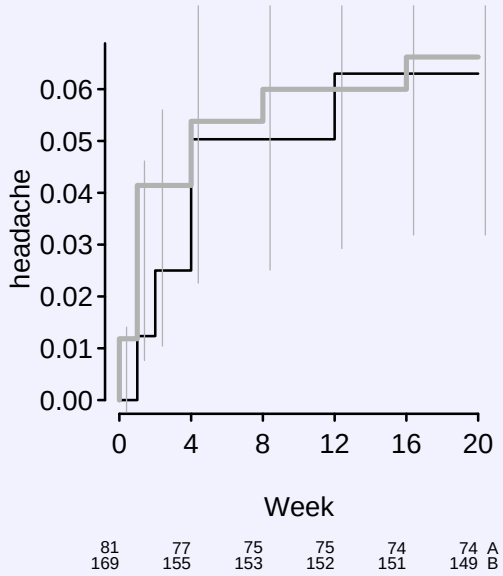

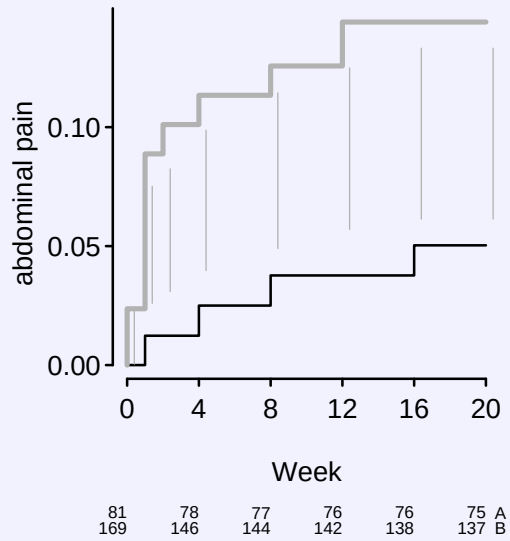

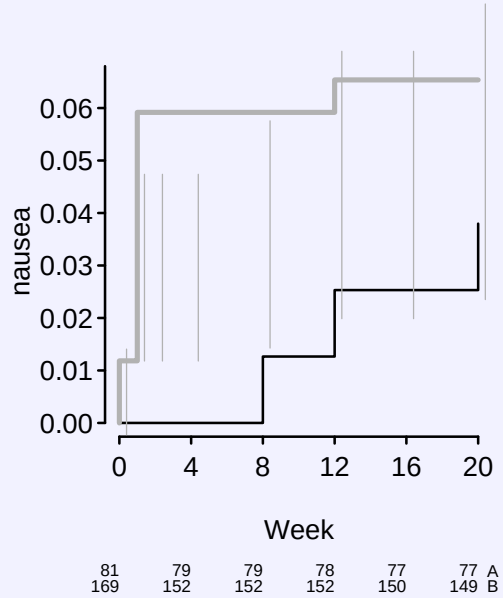

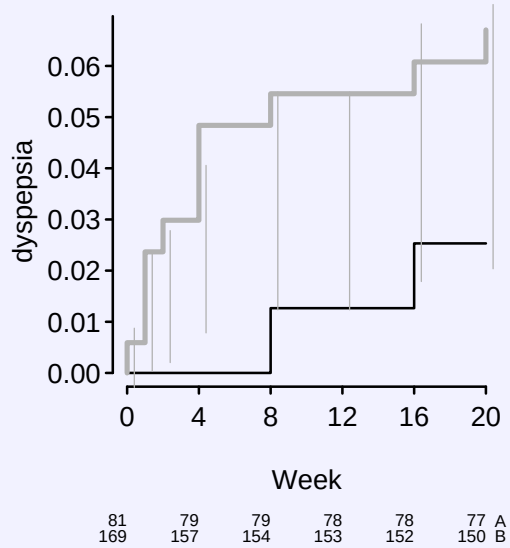

Empirical CDFs

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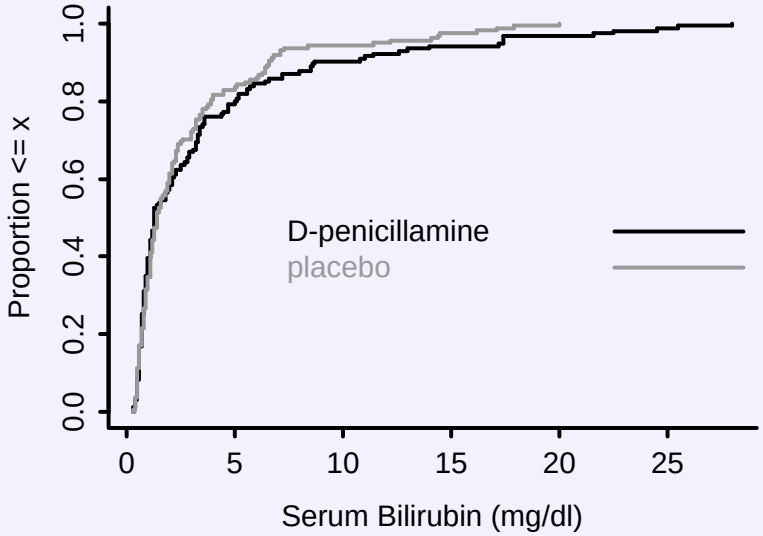

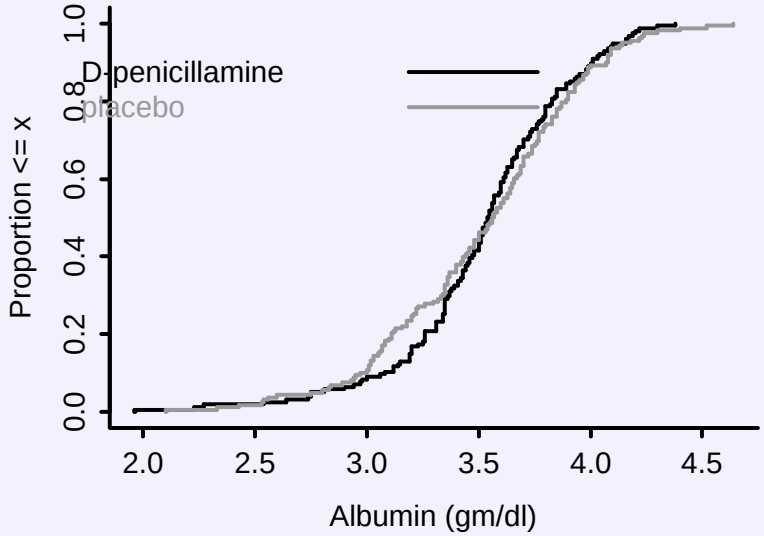

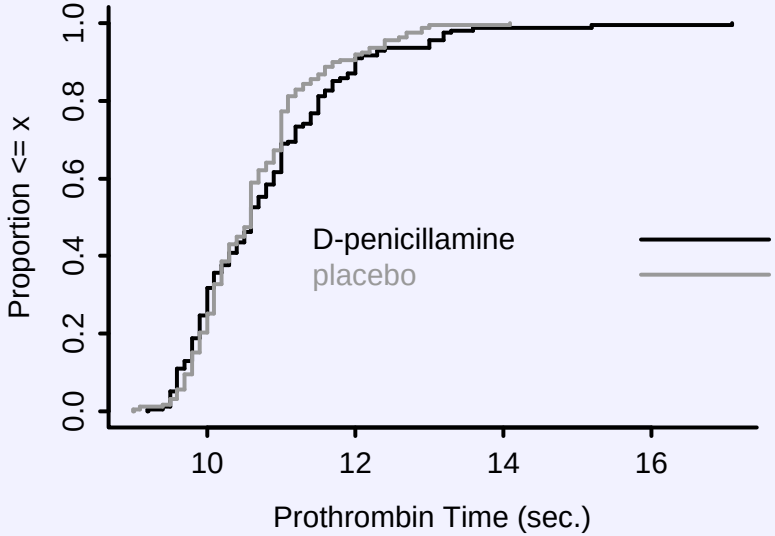

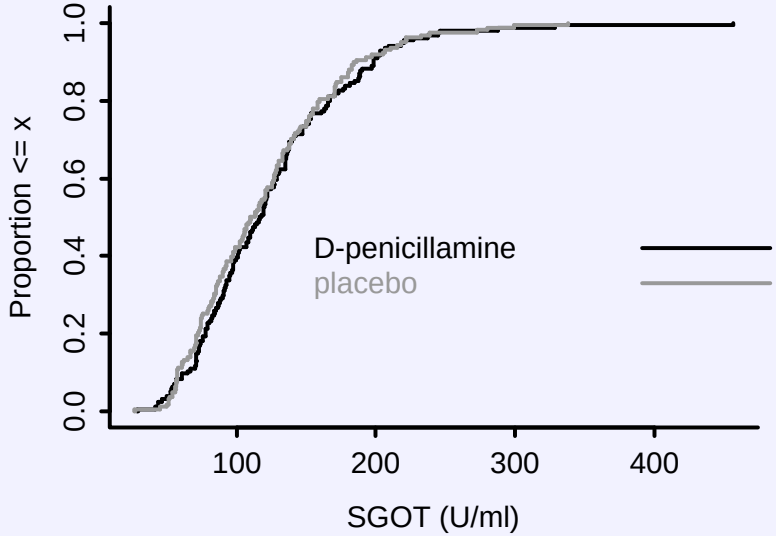

Extended Box Plots

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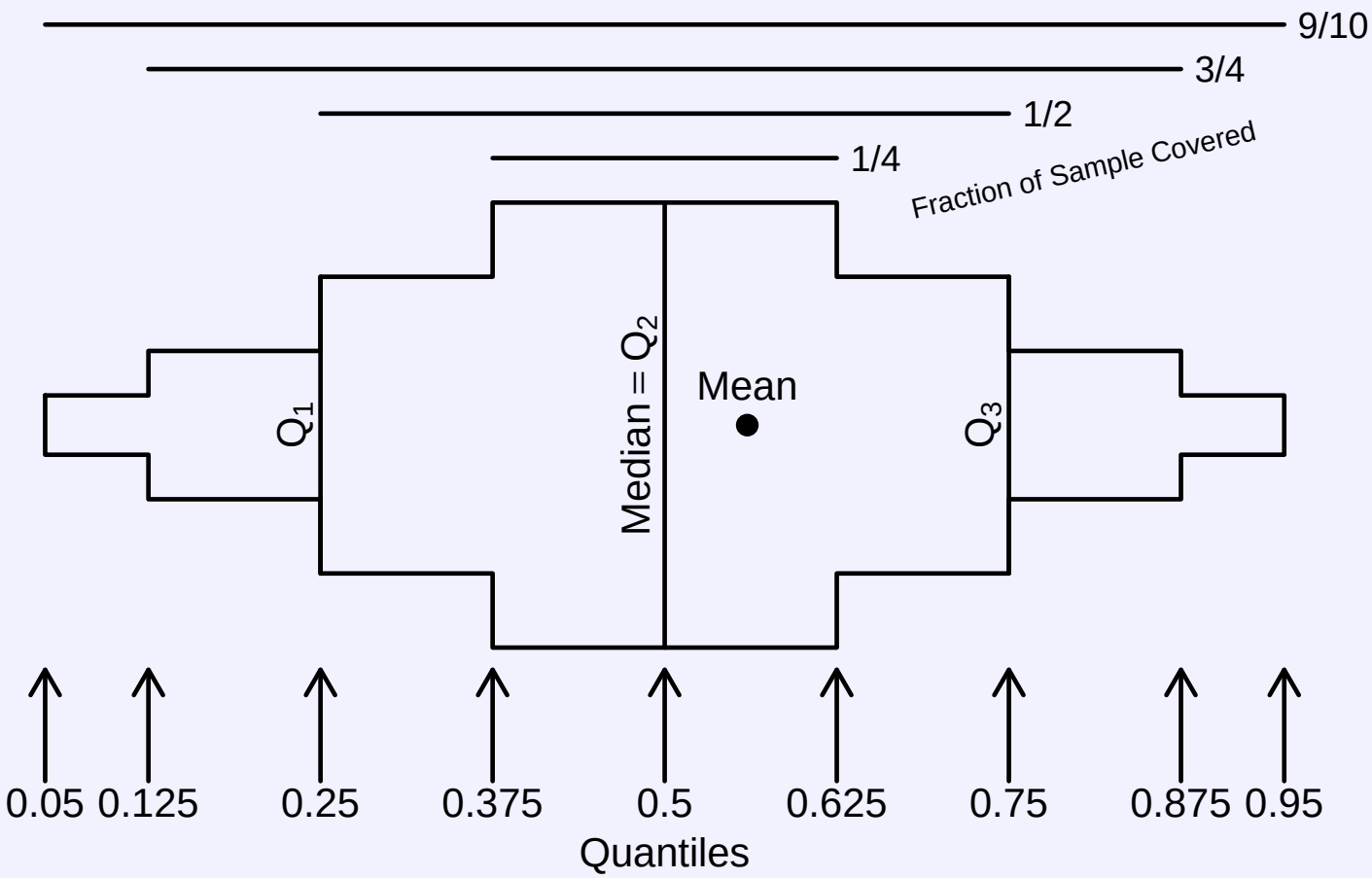

Multi-Panel Extended Box Plots

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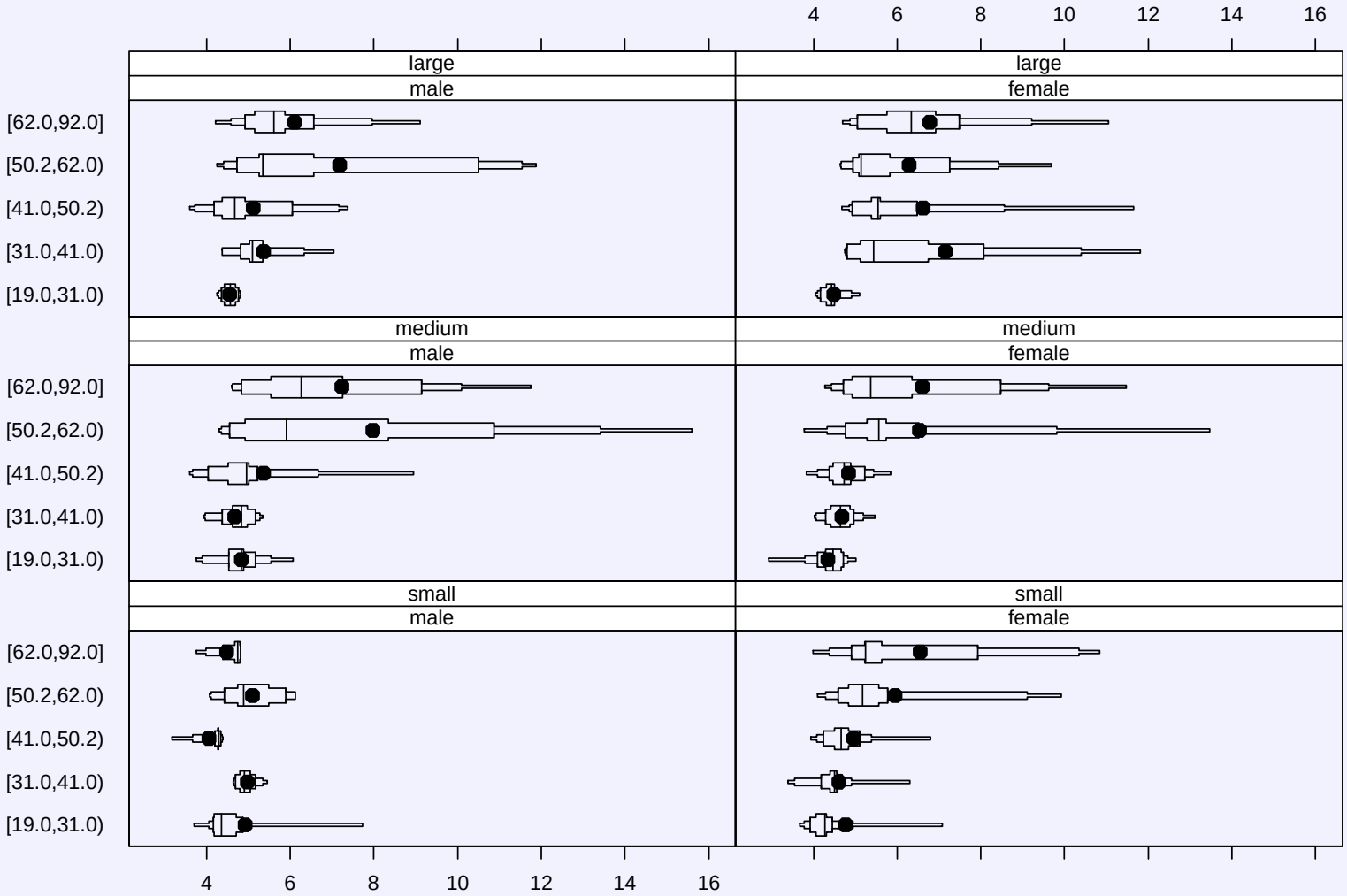

Instead of Table 1: Baseline Variables vs. Outcome

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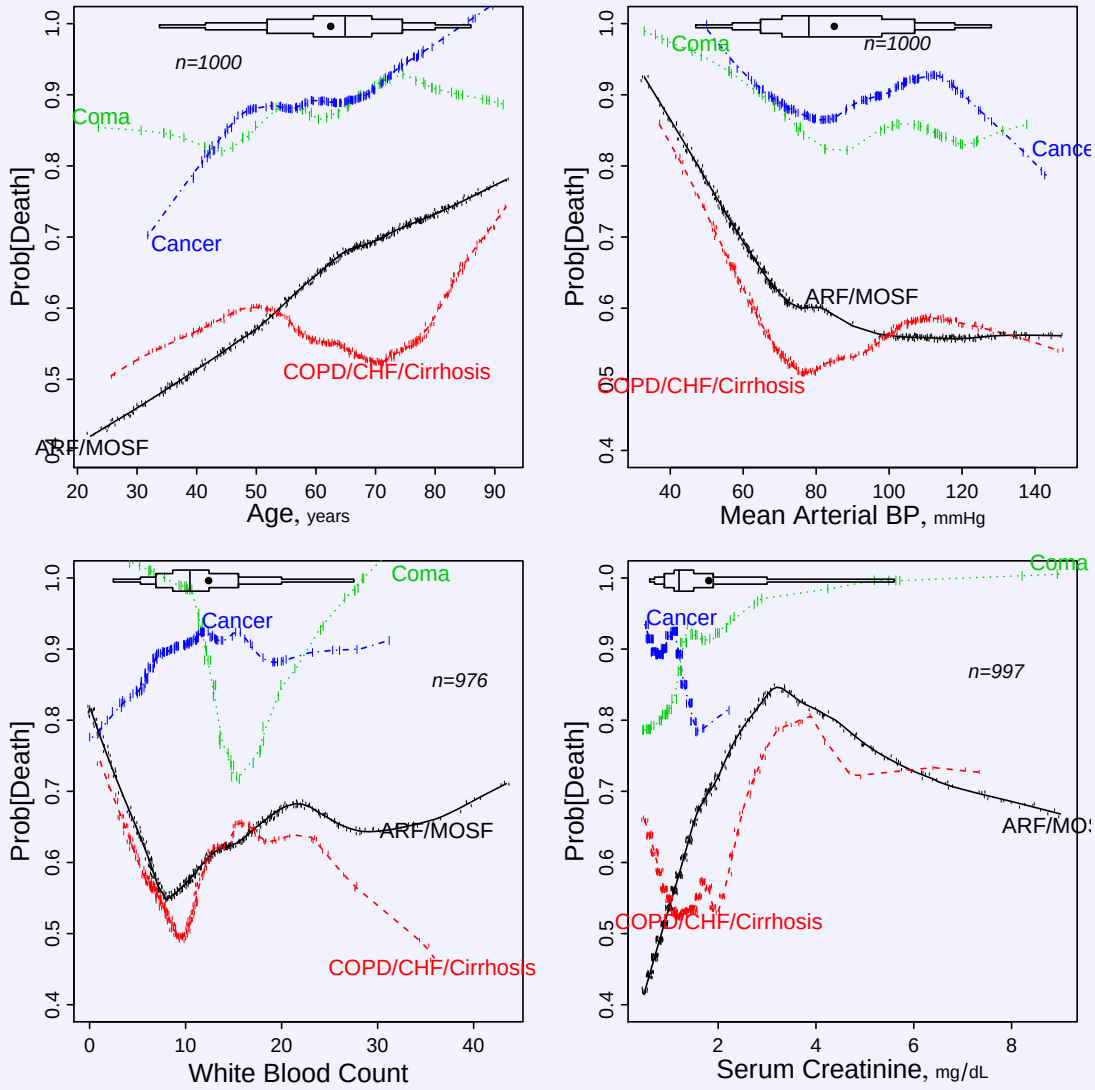

Multi-Panel Dot Plots

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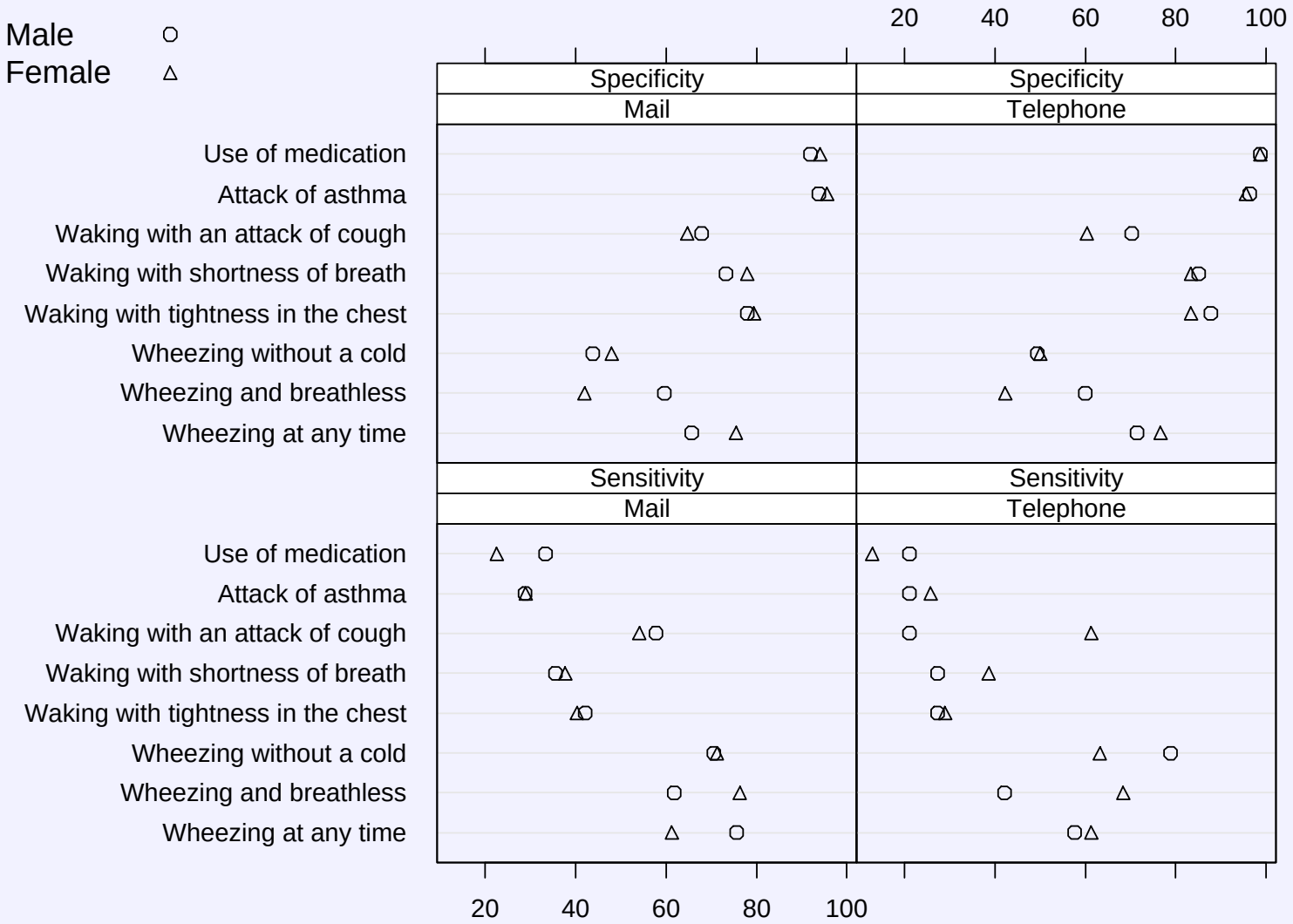

Dispense with Lab Parameter Change Tables

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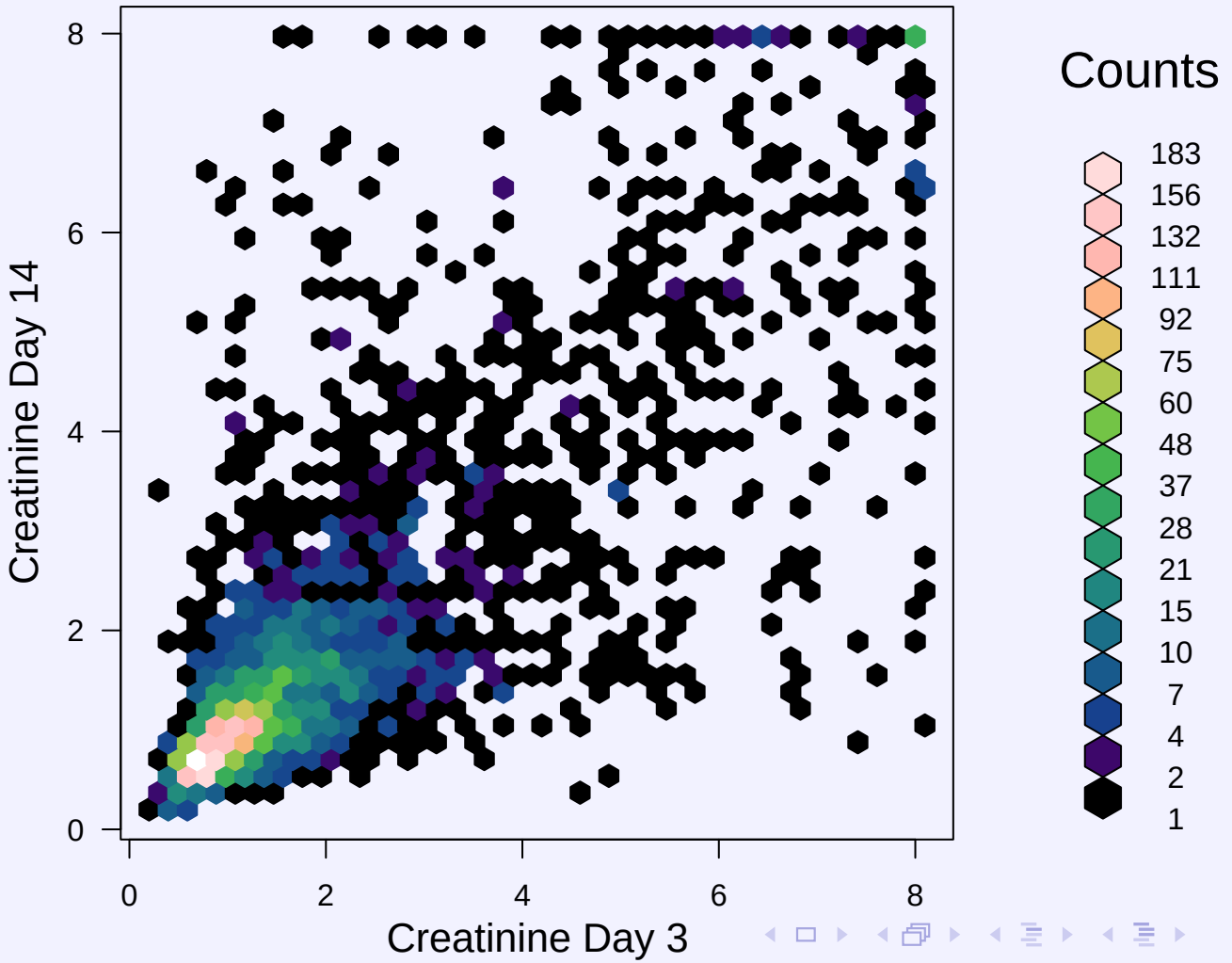

AEs

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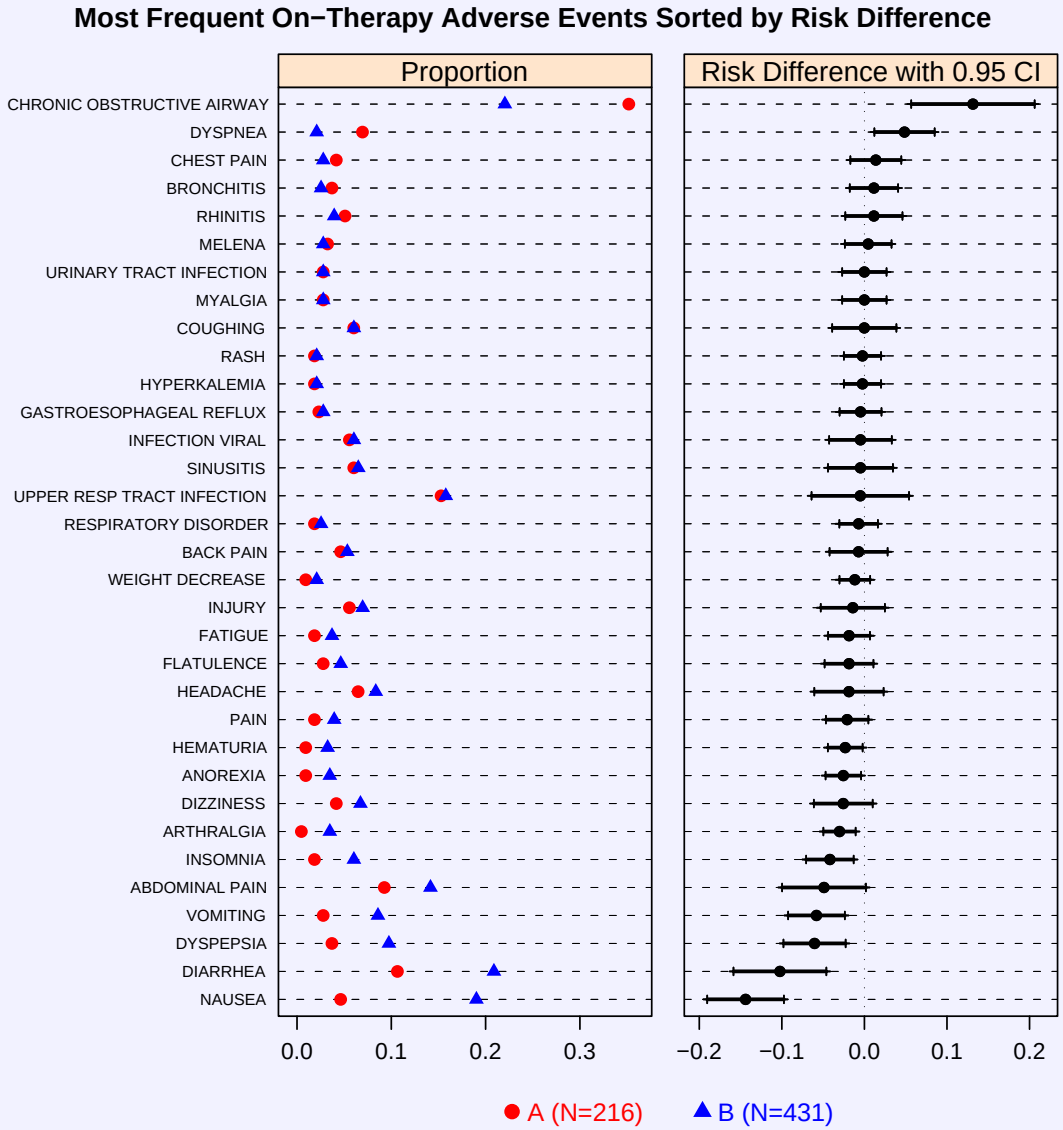

Modification of Amit et al. [2008]

SAEs by Body System and Preferred Term

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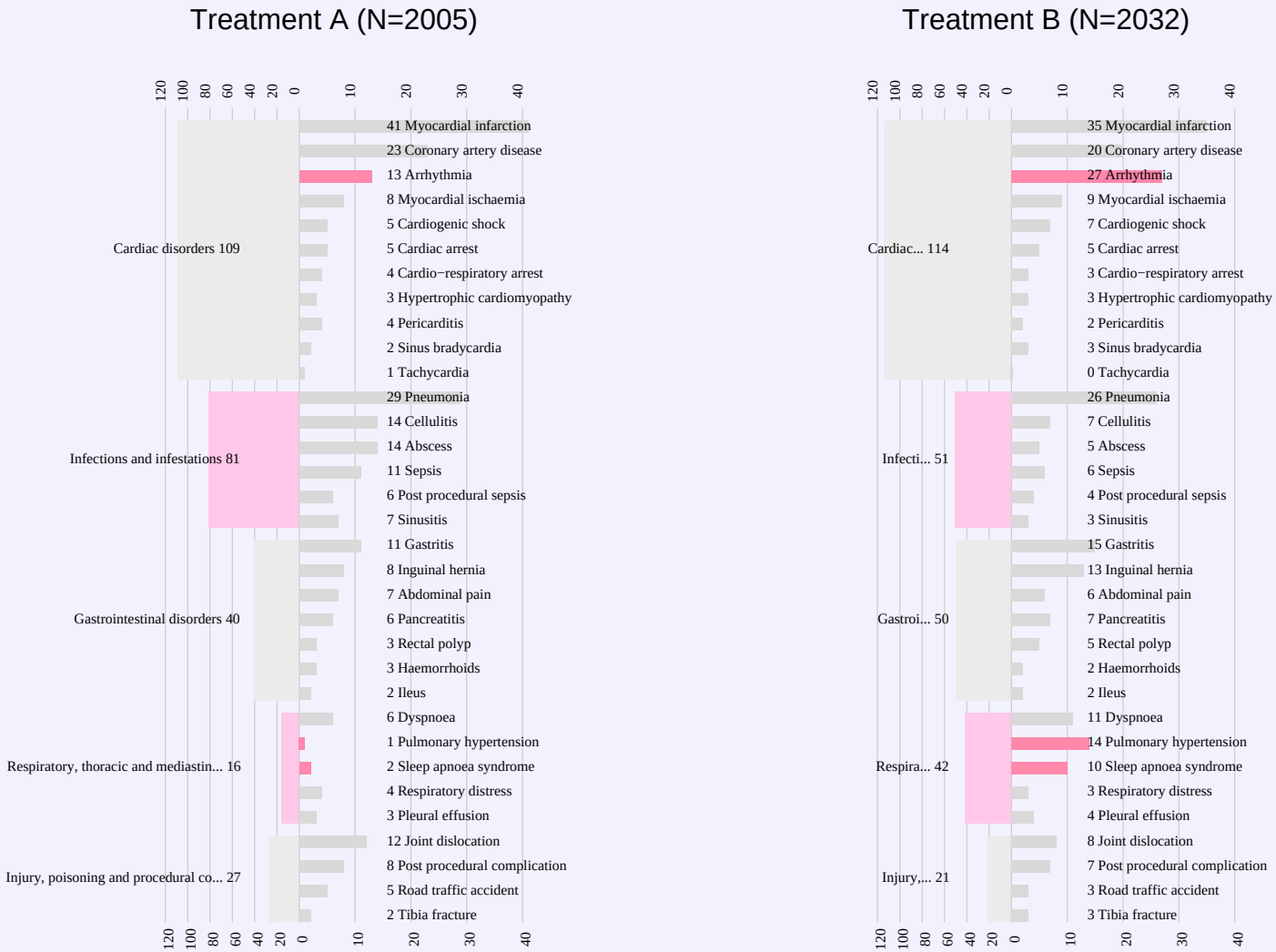

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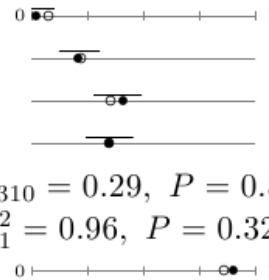
		D-penicillamine $N = 154$	placebo $N = 158$	Test Statistic
Serum Bilirubin	mg/dl	0.725 **1.300** 3.600	0.800 **1.400** 3.200	$F_{1,310} = 0.04,\ P = 0.842^1$
Albumin	gm/dl	3.34 **3.54** 3.78	3.21 **3.56** 3.83	$F_{1,310} = 0,\ P = 0.951^1$
Histologic Stage Ludwig Criteria				$\chi^2_3 = 4.63,\ P = 0.201^2$
1		3% $\frac{4}{154}$	8% $\frac{12}{158}$	
2		21% $\frac{32}{154}$	22% $\frac{35}{158}$	
3		42% $\frac{64}{154}$	35% $\frac{56}{158}$	
4		35% $\frac{54}{154}$	35% $\frac{55}{158}$	
Prothrombin Time	sec.	10.0 **10.6** 11.4	10.0 **10.6** 11.0	$F_{1,310} = 0.29,\ P = 0.589^1$
sex				$\chi^2_1 = 0.96,\ P = 0.326^2$
female		90% $\frac{139}{154}$	87% $\frac{137}{158}$	
Age		41.4 **48.1** 55.8	43.0 **51.9** 58.9	$F_{1,310} = 5.52,\ P = 0.019^1$
spiders		29% $\frac{45}{154}$	28% $\frac{45}{158}$	$\chi^2_1 = 0.02,\ P = 0.885^2$



$a\ b\ c$ represent the lower quartile a, the median b, and the upper quartile c for continuous variables.
Tests used: [1]Wilcoxon test; [2]Pearson test

Mixing Tables and Graphics, *continued*

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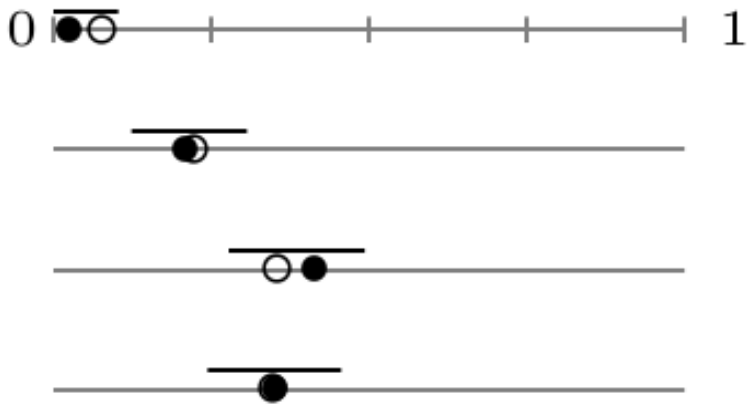
$$\chi^2_3 = 4.63, \; P = 0.201^2$$



$$F_{1,310} = 0.29, \; P = 0.589^1$$

$$\chi^2_1 = 0.96, \; P = 0.326^2$$

Suggested Model for Reports

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- Primary presentation completely graphical
- `pdf` hyperlink to dense tables for value look-ups
- Alternative 1: table pop-up when hover over graphics
- Alternative 2: micrographics inside tables (limiting, difficult)
- **Better**: supplement graphics with denominators, %, etc.
- R, LaTeX, `knitr`, `Markdown`, `RStudio`

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References

`ctspedia.org/StatGraphHome`

FDA/Industry/Academia Safety Graphics Working Group

References

O. Amit, R. M. Heiberger, and P. W. Lane. Graphical approaches to the analysis of safety data from clinical trials. *Pharm Stat*, 7:20–35, 2008. URL http://www3.interscience.wiley.com/journal/114129388/abstract.

C. H. Jackson. Displaying uncertainty with shading. *Am Statistician*, 62(4):340–347, 2008.

P. Murrell. Infovis and statistical graphics: Comment. *J Comp Graph Stat*, 22(1):33–37, 2013. doi: 10.1080/10618600.2012.751875. URL http://www.tandfonline.com/doi/abs/10.1080/10618600.2012.751875.