**Seeing is believing: Good graphic design principles for medical research**

Susan P. Duke (GlaxoSmithKline), Fabrice Bancken (Novartis), Brenda Crowe (Eli Lilly and Company), Mat Soukup (FDA-CDER), Taxiarchis Botsis (FDA-CBER) and Richard Forshee (FDA-CBER)

**Statistical graphs should exploit the brain’s pattern recognition ability**

- Adverse events data during medical product development is complex.
- Good designs can help decision makers (e.g., regulators) interpret data accurately

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## Graphics Principles from the Safety Graphics Working Group

1. **Content**: Every graph should stand on its own.
2. **Communication**: Tailor each graph to its primary communication purpose.
3. **Information**: Maximize the data-to-ink ratio.
4. **Annotation**: Provide legible text and information.
5. **Axes**: Design axes to aid interpretation of a graph.
6. **Styles**: Make symbols and plot lines distinct and readable.
7. **Colors**: Make use of color appropriate for the medium.
8. **Techniques**: Use established techniques to clarify the message.
9. **Types of plots**: Use the simplest plot that is appropriate for the information to be displayed.

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### Example 1: Tailor graphs to their primary communication purpose

**Erythrocyte Mean Corpuscular Hemoglobin (fmol Fe)** in Males vs Females Over Time in Three Treatment Groups

The human eye might not immediately capture from a standard graph the distribution differences over time and by treatment group. Violin plots can address this problem.

<table>
<thead>
<tr>
<th>Box Plot</th>
<th>Violin Plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Option</td>
<td>SSWG Option</td>
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</table>

- Violin plot of data is smoother and adds details of the distribution of the variable than boxplots.
- The reader’s mental map easily interprets the visual changes in the violin shapes and associates it with the corresponding differences in the distribution.
- Broadening and narrowing of violin plots represent the levels of hemoglobin iron among the samples tested.

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### Example 2: Bring closer together the items readers must compare to understand the meaning of the data

**Comparing Effect of Multiple Doses of Experimental Treatment “X” on Systolic Pressure Males (M) and Females (F): 95% confidence interval (CI)**

<table>
<thead>
<tr>
<th>Bar Plot</th>
<th>Dot Plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Option</td>
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</table>

- **Dot Plot**: Uses single plotting character to depict uncluttered view of parameter estimates; lines correspond to 95% CI.
- **Adjacent panels**: Enable easy comparison of mean systolic blood pressure and CI between treatment arms and the control.

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### Example 3: Handle x-axis data properly and avoid misinterpretation by separating endpoint data from time-elapsed data

**Percentage of subjects with eye redness over time among three treatment groups**

<table>
<thead>
<tr>
<th>Bar Chart</th>
<th>Dot Plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Option</td>
<td>SSWG Option</td>
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</tbody>
</table>

- **Color in bars**: Obscures measure of variability; height is important, not color.
- **Variable (%) subjects with eye redness was not measured at equal time intervals, but X-axis makes it appear it was.**
- **Data to light coloring of bars can be mistaken as quantitative changes in values, rather than different groups (placebo, Drug A, Drug B).**
- **X-axis makes it appear it was.**
- **Endpoint not clearly distinguished from data at specific weeks.**

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**Effective statistical graphics quickly communicate key findings to decision makers who rely on statistical analyses in medical research reports, regulatory applications, and publications.**