

Tables, Graphs, Dashboards, & Reports: Data Visualization Best Practices

DATA VISUALIZATION BEST PRACTICES

Fundamental Best Practices

When to Use a Graph or a Table: Graphs and tables display data for different purposes.

Use a TABLE to:

- Look up specific values
- Compare specific values
- Display precise values
- Communicate more than one unit of measure

Table Checklist

Organization/Categorization

- ✓ Data are ordered following standardized healthcare data classification systems (taxonomies), such as TNM tumor classification or the International Classification of Diseases (ICD).
- ✓ Data is categorized in the most effective manner to communicate the story, such as by ranked results, by areas requiring attention (not meeting goal) versus others, by geographic region, or by medical service.
- ✓ If users need to perform a simple look-up, data are arranged alphabetically or numerically. This is best for data with no underlying order.
- ✓ Calculated columns are arranged in a logical manner reflecting how they were calculated. For example, numerator (column A) divided by denominator (column B) equals percentage or rate (column C); value (column A) minus value (column B) equals difference (column C).

Non-Data-Ink

✓	All gridlines are eliminated, or as many as possible.
✓	White space or light highlighting is used to differentiate rows and columns of data.
✓	Graphs are used in lieu of color-coded cells.
✓	Highlighting techniques, such as bolding or italics to highlight important data, are used sparingly.

Fonts

✓	Non-proportional sans serif fonts, such as Arial, are used to ensure values have equal space on the page.
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Number Alignment and Formatting

✓	All numbers are right justified to ensure values are aligned.
✓	Commas are used for numbers with more than three digits (for example, 1,000).
✓	Zeros are eliminated whenever possible (for example, \$1,000,000 displayed as \$1m).
✓	Minimal numbers are included after a decimal point to convey value and context to the data.
✓	Negative values are indicated by parentheses, a minus sign, or red font (examples: (65), -65, -65).

Labels

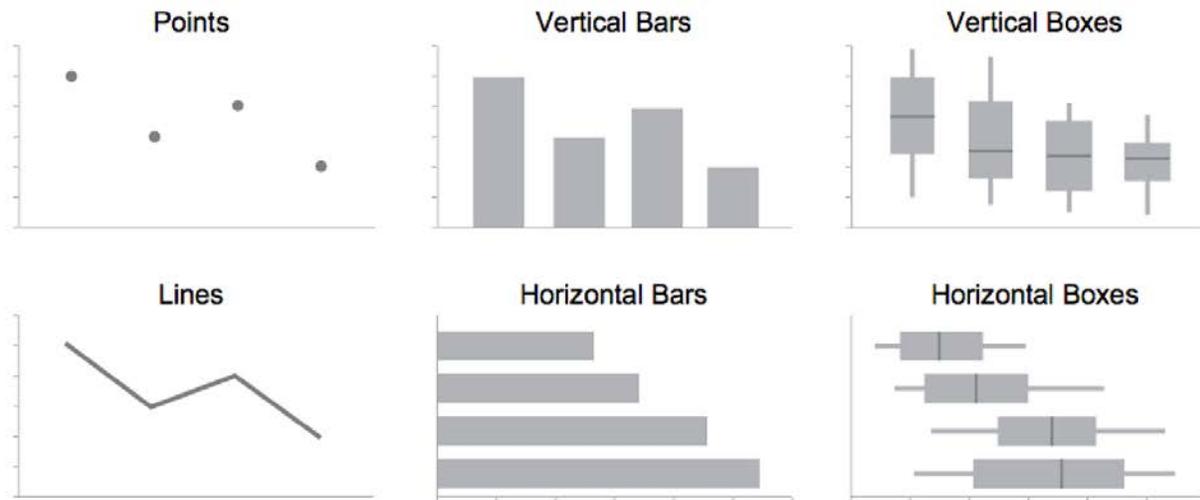
✓	Columns and rows are described in plain language.
✓	Units are shown, such as dollars (\$), percent (%), count (#), days, hours, or minutes.
✓	Labels are layered to allow for better descriptions. For example: <p style="text-align: center;">Average Days for New Patient Appointments Clinic A Clinic B Clinic C Clinic D</p>
✓	Summary calculations are included to help users understand the data being displayed. If possible, their definitions are incorporated into the labels so that footnotes have been eliminated or greatly reduced. (For example, the summary metric “total available operating room time that has been adjusted to account for room turnover times” could be labeled as “Available OR Minutes (less turnover)”.
✓	Labels are oriented horizontally.
✓	If table rows flow across pages, column headers are repeated on each page.

Use a GRAPH to:

- Show patterns
- Show trends
- Show exceptions
- Reveal relationships among multiple values

Chart Types: Just six chart types can create nearly all the dashboards and reports that tell the stories in our data:

- Points
- Vertical bars
- Vertical boxes
- Lines
- Horizontal bars
- Horizontal boxes



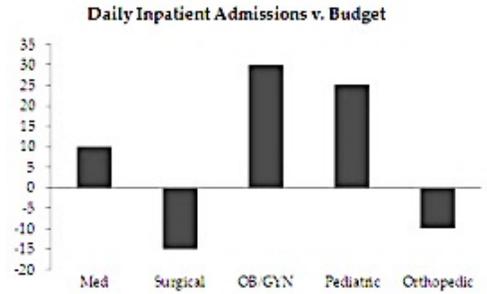
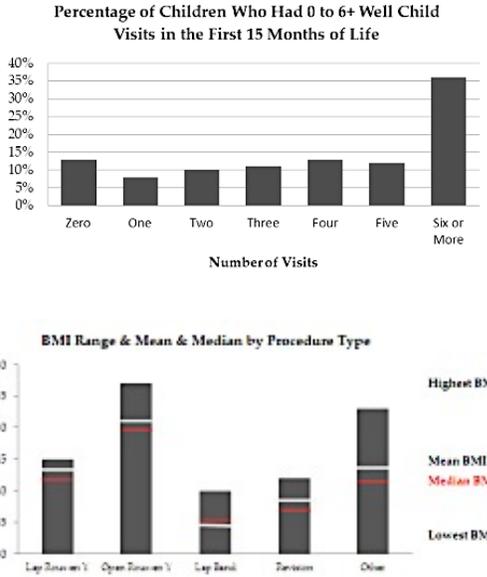
Source: Show Me the Numbers, 2012, S. Few

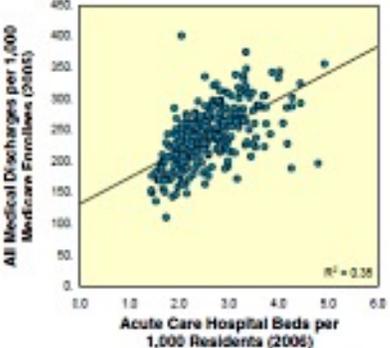
The following pages summarize the seven most common relationships in graphs. They relate the ways in which these six chart types may be used to display data visually.

The Seven Most Common Relationships in Graphs*

Relationship	Description	Encoding Methods/Chart Types	Example
1. Nominal Comparison	Comparison of the categorical subdivisions of one or more measures in no specific order.	<ul style="list-style-type: none"> ✓ Horizontal or vertical bars. 	<p style="text-align: center;">Childhood Immunization Rates</p>
2. Time-Series	Multiple instances of one or more measures taken at equidistant points in time.	<ul style="list-style-type: none"> ✓ Lines to emphasize overall pattern. ✓ Bars to emphasize individual values. ✓ Points connected by lines to show individual values while still highlighting the overall pattern of the data. ✓ Time is always on the horizontal X axis. 	<p style="text-align: center;">Children's Access to Primary Care</p>
3. Ranking	Categorical subdivisions of a measure ordered in ascending or descending size.	<ul style="list-style-type: none"> ✓ Horizontal or vertical bars. ✓ Sorting data in: <ul style="list-style-type: none"> ○ Descending order highlights high values. ○ Ascending order highlights low values. 	<p style="text-align: center;">Screening Rates</p>
4. Part-to-Whole	Measures of individual categorical subdivisions as ratios to the whole.	<ul style="list-style-type: none"> ✓ Horizontal or vertical bars only. ✓ Use stacked bars only when you must display measures of the whole as well as the parts. 	<p style="text-align: center;">Communication with Physicians</p>

* Adapted from Stephen Few, *Show Me the Numbers: Designing Tables and Graphs to Enlighten*. Second edition. June 2012.

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5. Deviation	Categorical subdivisions of a measure compared to a reference measure, expressed as the difference between them.	<ul style="list-style-type: none"> ✓ Lines to emphasize the overall pattern only when displaying deviation and time-series relationships together. ✓ Points connected by lines to slightly emphasize individual data points while also highlighting the overall pattern when displaying deviation and time-series relationships together. ✓ Bars to emphasize individual values, but limit to vertical bars when a time-series relationship is included. ✓ Always include a reference line to compare the measures of deviation against. 	 <p>Daily Inpatient Admissions v. Budget</p> <table border="1"> <thead> <tr> <th>Department</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Med</td> <td>10</td> </tr> <tr> <td>Surgical</td> <td>-15</td> </tr> <tr> <td>OB/GYN</td> <td>30</td> </tr> <tr> <td>Pediatric</td> <td>25</td> </tr> <tr> <td>Orthopedic</td> <td>-10</td> </tr> </tbody> </table>	Department	Value	Med	10	Surgical	-15	OB/GYN	30	Pediatric	25	Orthopedic	-10																																		
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6. Distribution	<p>Counts of something per each subdivision of an interval scale</p> <p>Or</p> <p>The distribution of values for each of multiple categorical subdivisions.</p>	<ul style="list-style-type: none"> ✓ Vertical bars to emphasize individual values (histogram). ✓ Lines to emphasize the overall pattern (frequency polygon). ✓ Vertical or horizontal bars (range bars or boxes) to encode the full range from the low to the high value, or some portion of the range (e.g., one or two standard deviations). ✓ Points or lines to encode measures of center (e.g., mean, median). 	 <p>Percentage of Children Who Had 0 to 6+ Well Child Visits in the First 15 Months of Life</p> <table border="1"> <thead> <tr> <th>Number of Visits</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Zero</td> <td>12%</td> </tr> <tr> <td>One</td> <td>8%</td> </tr> <tr> <td>Two</td> <td>10%</td> </tr> <tr> <td>Three</td> <td>12%</td> </tr> <tr> <td>Four</td> <td>14%</td> </tr> <tr> <td>Five</td> <td>13%</td> </tr> <tr> <td>Six or More</td> <td>35%</td> </tr> </tbody> </table> <p>BMI Range & Mean & Median by Procedure Type</p> <table border="1"> <thead> <tr> <th>Procedure Type</th> <th>Lowest BMI</th> <th>Mean BMI</th> <th>Median BMI</th> <th>Highest BMI</th> </tr> </thead> <tbody> <tr> <td>Leg Trauma</td> <td>38</td> <td>42</td> <td>43</td> <td>45</td> </tr> <tr> <td>Open Trauma</td> <td>48</td> <td>50</td> <td>51</td> <td>55</td> </tr> <tr> <td>Leg Burn</td> <td>35</td> <td>36</td> <td>37</td> <td>40</td> </tr> <tr> <td>Fracture</td> <td>38</td> <td>39</td> <td>40</td> <td>42</td> </tr> <tr> <td>Other</td> <td>45</td> <td>47</td> <td>48</td> <td>53</td> </tr> </tbody> </table>	Number of Visits	Percentage	Zero	12%	One	8%	Two	10%	Three	12%	Four	14%	Five	13%	Six or More	35%	Procedure Type	Lowest BMI	Mean BMI	Median BMI	Highest BMI	Leg Trauma	38	42	43	45	Open Trauma	48	50	51	55	Leg Burn	35	36	37	40	Fracture	38	39	40	42	Other	45	47	48	53
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Relationship	Description	Encoding Methods/Chart Types	Example
7. Correlation	Comparison of two paired sets of measures to determine if they correlate and, if so, how strongly.	<ul style="list-style-type: none"> ✓ Points and a trend line in a scatter plot. ✓ Bars may be used in lieu of a scatter plot, arranged as a paired bar graph or a correlation bar graph. 	 <p>The scatter plot displays a positive correlation between the number of acute care hospital beds per 1,000 residents in 2006 and the number of all medical discharges per 1,000 Medicare enrollees in 2005. The x-axis ranges from 0.0 to 6.0, and the y-axis ranges from 0 to 450. A regression line is drawn through the data points, and the coefficient of determination is noted as $R^2 = 0.38$.</p>

What is a Data Dashboard?

The term dashboard is used to describe all types of data displays – often incorrectly. So, what is a data dashboard?

A dashboard is a high-level summary, displayed on one computer screen or printed page, that helps viewers monitor performance and quickly identify potential opportunities for further analysis and/or improvement.

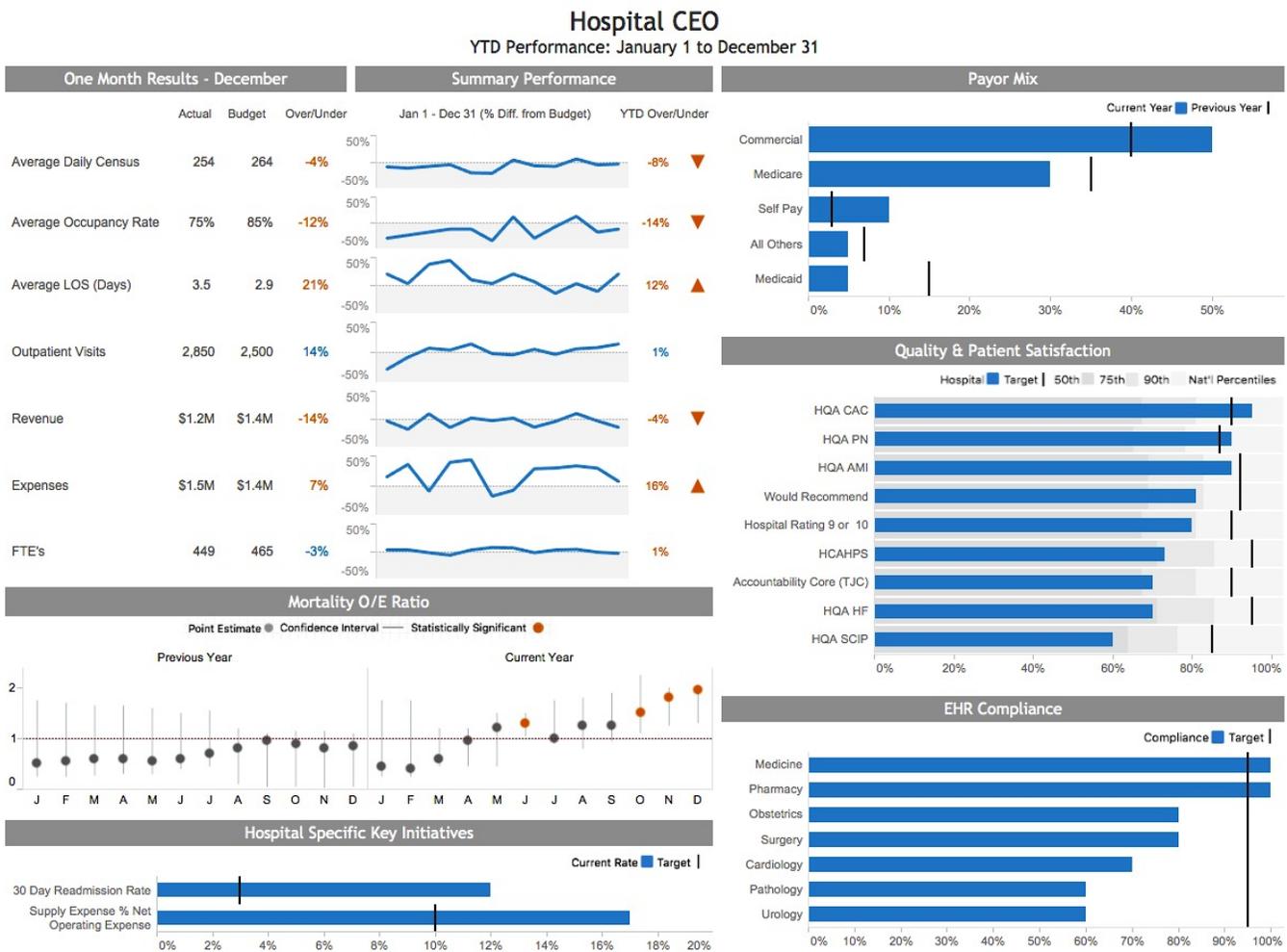
The key to creating an effective dashboard is to understand the people who will be using it, and the decisions they need to make. Armed with this knowledge, you will be able to design dashboards that deliver an overview of what is happening that empowers your viewers to quickly identify what needs action.

Here are two prototype dashboard designs which illustrate these attributes.

Example Prototype Dashboards

CEO Dashboard

This dashboard considers the current environment in which hospital CEOs must navigate, one shaped by Value Based Purchasing (VBP) and public reporting, and where financial, clinical, information technology, and patient satisfaction results are all inextricably linked.



Hospital Occupancy and Financial Indicators

The upper left panel of the dashboard displays industry-standard metrics on the hospital's occupancy rate and average daily census along with high-level financial results (revenue and expenses). Up- and down-arrow icons are used to alert the CEO to specific areas that may require further inquiry. Deviation graphs show the direct variance of actual performance compared with budget for the preceding 12 months.

The next set of bar charts allows the CEO to easily monitor any changes in payer mix between the previous and current year. Presenting the information this way makes it easy to see any significant changes in measures which inform many of the financial management decisions made by a hospital.

Hospital Quality and Patient Satisfaction

The hospital's quality and patient satisfaction results for mandated performance measures are displayed by a black vertical line for each measure and include a target or goal encoded by the vertical line. This information is important not only as a measure of the quality of care, but also because a hospital must achieve specific targets to receive full reimbursement from third-party payers. This type of information display of this type allows a CEO to understand how well the staff is performing and where to focus improvement efforts.

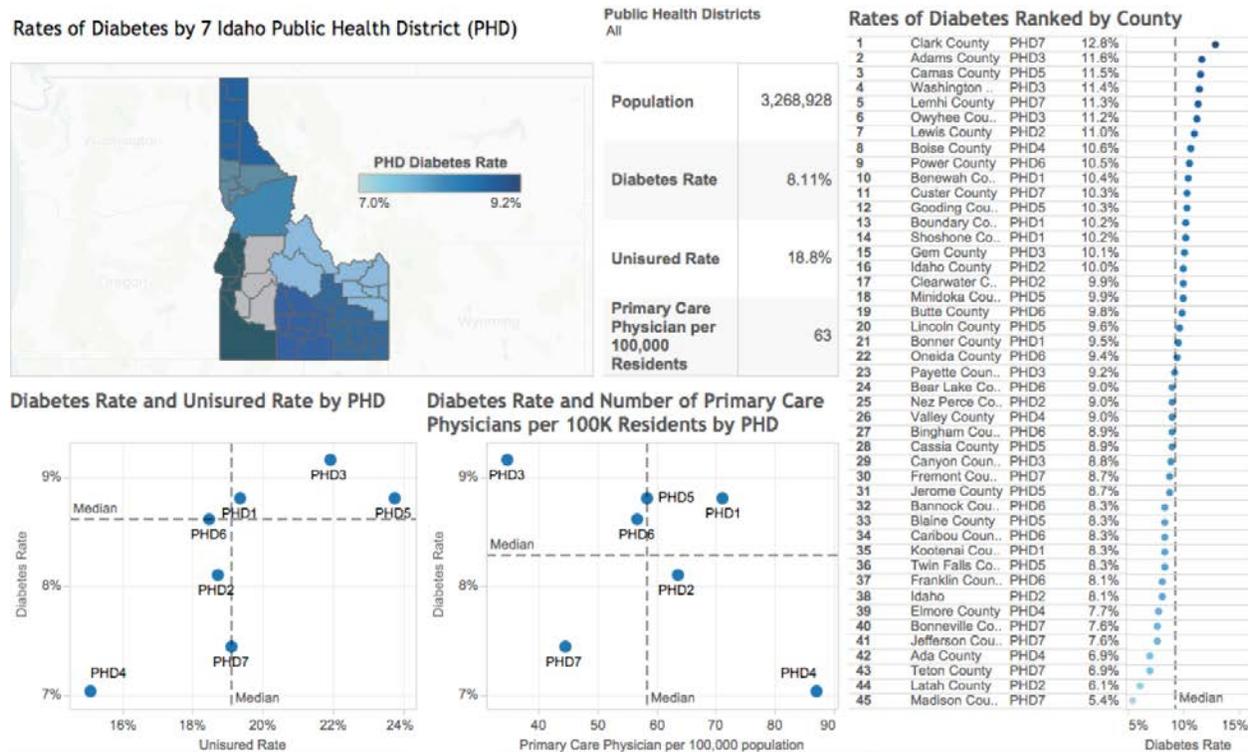
Quality and patient safety results, along with hospital mortality rates, are now being reported on public websites to help consumers make informed decisions about where to receive their care. Given such free and public circulation of these crucial benchmarks, the CEO cannot afford any surprises about her/his hospital's performance, and must have a fast, easy, and accessible way to continually monitor it. Displaying risk-adjusted mortality rates with accompanying confidence intervals over time allows a CEO to discuss them with clinicians in a direct, accurate, and useful way.

Strategic Projects

Hospital CEOs must also monitor Electronic Health Record (EHR) compliance, not only because these records hold the promise of improved patient care, but also because the federal government offers significant financial incentives to hospitals that can demonstrate their Meaningful Use (MU). When EHR compliance by sub-specialty is ranked in a horizontal bar graph that includes a target compliance rate, a CEO can easily and quickly see where attention and resources need to be focused regarding EHR use.

State Public Health Dashboard

This prototype state public health dashboard allows viewers to see the rate of diabetes throughout the State of Idaho with the use of a choropleth map. Viewers can consider underlying factors that may need to be addressed in developing policies and resource allocations, such as uninsured populations and the availability of primary care physicians in different regions of the state.



State Map

In choropleth maps, higher saturations of color are used to display higher rates of the variable or outcome of interest – such as diabetes rates – and less saturated colors are used to show lower rates. This varied color saturation makes it easy for a viewer to quickly and easily see how rates differ across a region or area of interest. A small key defining the rates and associated darkening color is included directly on the display.

Table

Tables are often a great way to display summary statistics of interest. Dashboard developers frequently fall into the trap of thinking that they need to display everything using a graph. However, as the dashboard above shows, tables offer a simple way to display the rates of diabetes and other contextual data such as population size, uninsured rates, and rates of primary care physicians per 100,000 residents.

Ranked Rates by County

Using a combination of a ranked table and points to display the rates of diabetes in each county makes it easy for viewers to see the details displayed in the Choropleth map. Because some of the rates are so similar, the use of the blue points helps us visualize the small differences in the rates for each county much more easily than the figures

alone can. Additionally, we can see the Public Health Region in which each county is located (displayed in the middle column).

Quadrant Displays

The bottom row of the dashboard displays two quadrant displays. The first displays diabetes rates for the different Public Health Regions (PH) on the Y axis and uninsured rates on the X axis. The second displays the diabetes rates and PCP's per 100,000 residents. By placing this information side by side, the viewer can consider and further explore the impact these factors may have on diabetes rates and study these factors and any opportunities to improve them.

Resources

Unleash Your Inner Healthcare Data – Free monthly newsletter about the best practices of data visualization and analysis for health and healthcare professionals. Written by Katherine S. Rowell, M.S., M.H.A.
<http://www.healthdataviz.com/blog/>

Stephen Few. ***Show Me the Numbers: Designing Tables and Graphs to Enlighten. Second edition.*** June 2012.

Stephen Few. ***Information Dashboard Design: Displaying Data for At-a-Glance Monitoring. Second edition.*** August 2013.

Edward R. Tufte. ***Visual Explanations: Images and Quantities, Evidence and Narrative.*** February 1997.

Edward R. Tufte. ***The Visual Display of Quantitative Information. Second edition.*** January 2001.