



Tips and Tools for Learning Improvement

Measurement Time Series Chart

What is a time series chart?

A time series chart is a line graph which plots the data of interest on the Y (vertical) axis and the time interval over which the data are displayed on the X (horizontal) axis, using any interval of time (e.g., minute, hourly, daily, weekly, monthly, quarterly, yearly, etc.). When conducting improvement work, common types of labels for the Y-axis are percentages (e.g., percentage of patients receiving care according to standards), rates (e.g., case fatality rate), time (e.g., waiting time), quantities (e.g., stock levels), or numbers (e.g., weight).

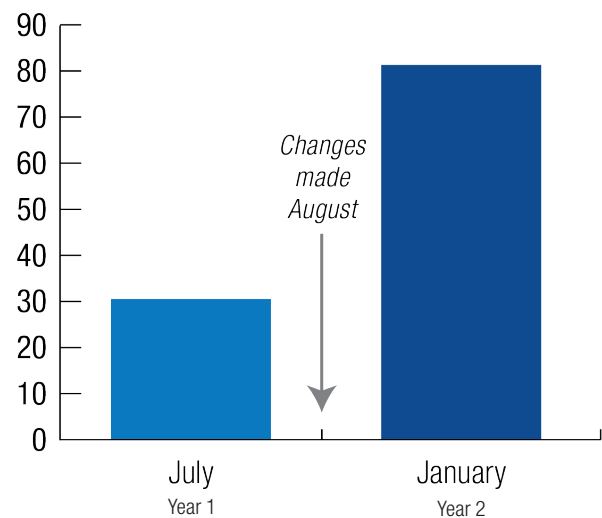
Why is a time series chart important?

Bar graphs, such as the one shown in Figure 1, are commonly used to show before and after results. The bar graph in Figure 1 implies that performance improved between July and January following the changes made in August. However, the bar graph may not tell the whole story. Unlike the bar graph, the ongoing monitoring of an indicator over time through a time series chart is valuable in improvement because:

- It allows you to track when specific changes were introduced;
- See the impact of those changes on a process or outcome; and
- Determine whether improvement is sustained over time.

The time series charts in Figure 2 show four different possible stories that more frequent data might tell based on the same two data points in Figure 1: 30% performance

Figure 1. Common Data Presentation
Common Before/After Data Presentation



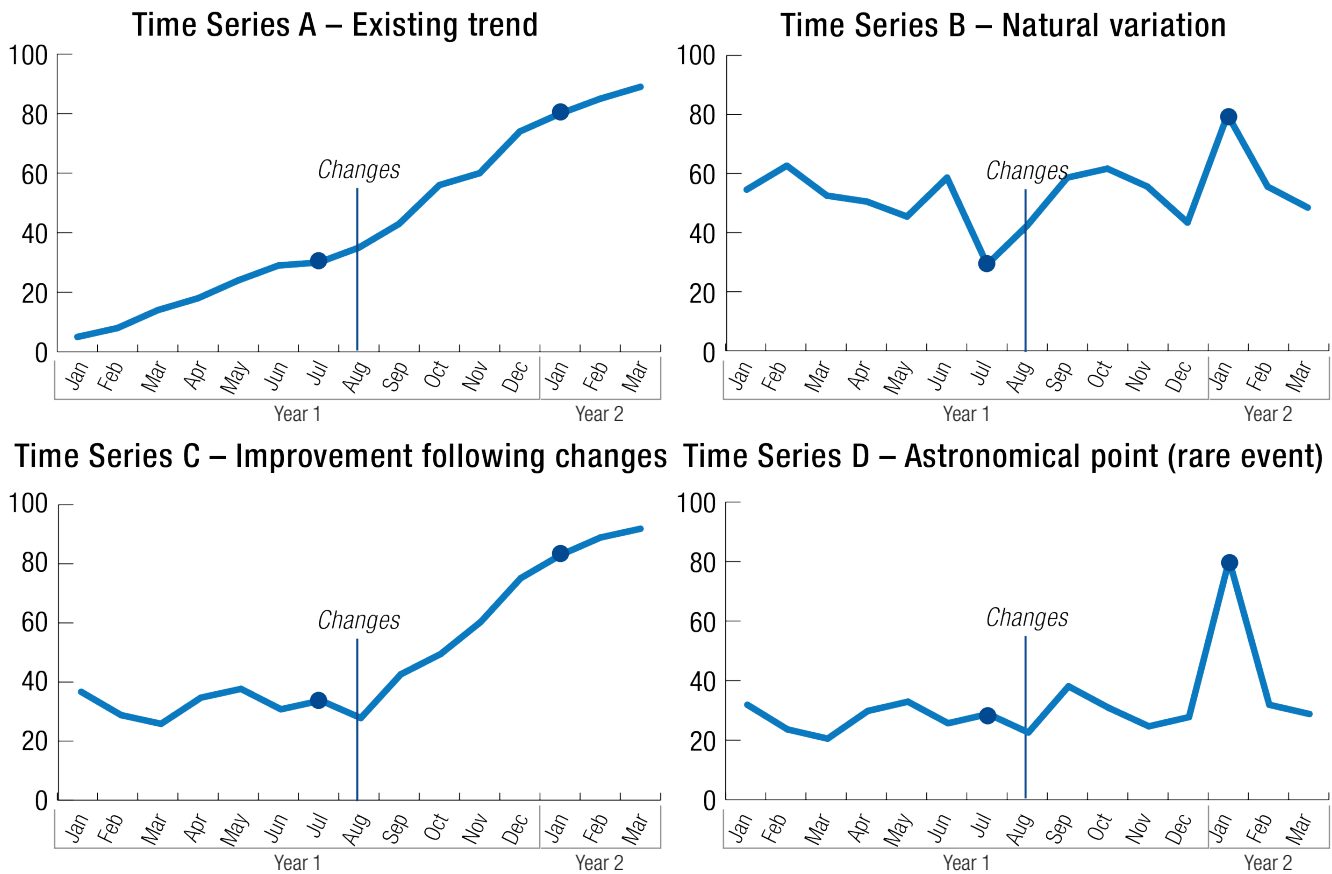
in July, changes made in August, and 80% performance the following January. In Figure 2, in Time Series A, the data show that improvement was occurring anyway and that the changes implemented probably were not related to the improved outcome. In Time Series B, the data show natural variation in the outcome being measured, with July and January being low and high points respectively, with no marked difference after the changes were introduced. In Time Series C, the data show that there was improvement after changes were made. In Time Series D, the data show natural variation, with the spike in value in January possibly being a rare event that caused higher performance but that could have been the result of something other than the changes introduced and that was not sustained.

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Figure 2. Time series charts tell a story

Why it is useful to look at data over time



How do you create a time series chart?

Basic steps in creating a time series chart are listed below.

Step 1. Collect data points (e.g., percentage, number, cost) at the given time interval. When possible, collect 6 to 8 baseline points before the intervention begins and indicate these as “baseline” on your graph.

Step 2. Determine the scale for the vertical axis, Y-axis. Often for percentages this will be 0% to 100%. For number counts, you can set the scale slightly above your anticipated target. Label the Y-axis with the scale and unit of measure.

Step 3. The horizontal X-axis marks the measure of time (minute, hour, day, week, month, year, etc.). Make sure the X-axis is labeled as such.

Step 4. Plot the points and connect them with a straight line between each point.

Step 5. Title the graph. Provide a well-defined title that includes what is presented, where, and during what period of time.

Figure 3 provides a generic example of what a time series chart should look like and describes the elements of it.

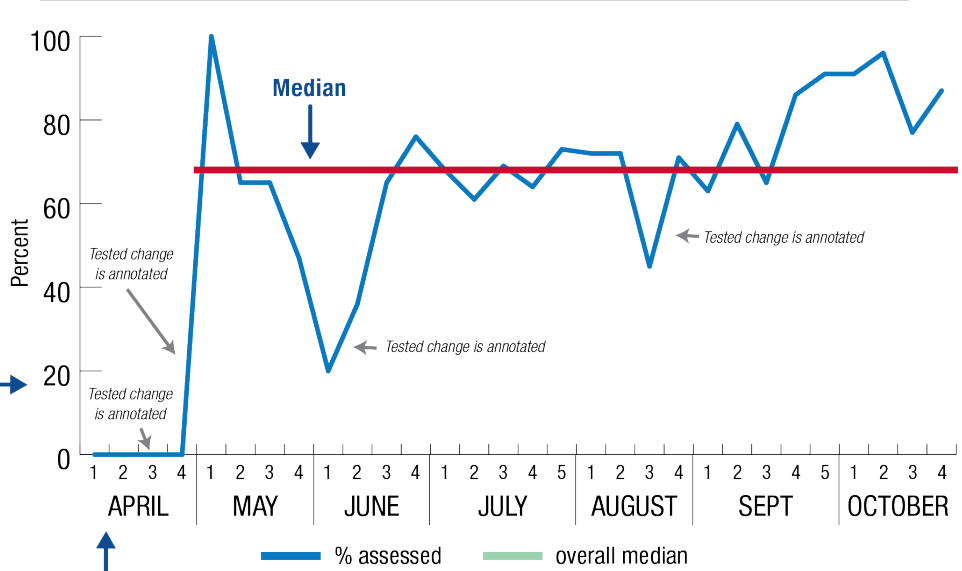
The most useful time series charts are **annotated**. Annotating a time series chart involves simply drawing a text box (by hand or on a computer) next to a data point with a brief explanation of what change was introduced or key event occurred that may have affected the result (improvement, decline or no change) at that point in time. Annotation allows you to see how performance may link with changes implemented or other events that might affect performance. Examples of annotations might be the implementation of a change idea, such as “Began using checklist”, or an unusual event, such as “medication stock-out”.

When analyzing further a **median line** (center value) should be added. This is covered in the **Tips and Tools for Learning Improvement** handout “Measurement – Variation vs. Improvement”.

Figure 3. Time series chart

Well-defined title that includes what is presented, where, and when

Title with measure, location, and date



Y- and X-axes have clear "scale" and includes indicator "label"

Exercise 1: Plotting a time series chart

Create a simple time series chart with basic information about how many cups of tea were consumed each day. Put on the graph:

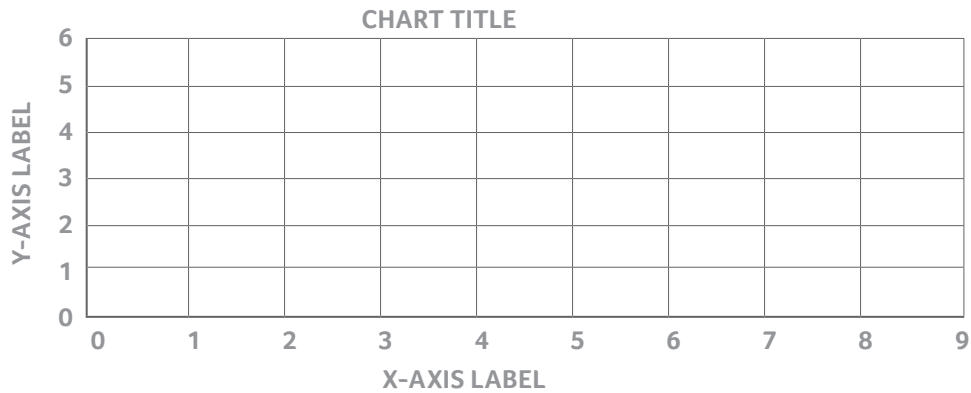
- Title: Numbers of cups of tea consumed each day
- Y-axis label: Number of cups of tea
- X-axis label: Day

Plot the data on the right using the graph below using the following steps:

1. Find the day on the graph on the X-axis (horizontal axis).
2. Find the number of cups of tea for that day on Y-axis (vertical axis).
3. Put a dot on the spot where the day and number of cups of tea meet.
4. Draw a line to connect all the dots.

Data for the graph:

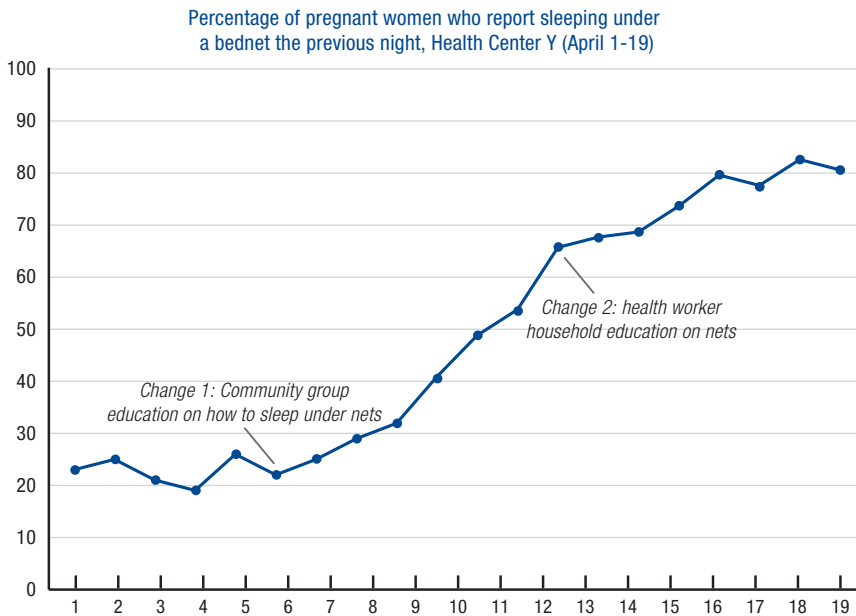
Day	Cups of tea
1	4
2	5
3	4
4	2
5	1
6	2
7	0
8	1



Exercise 2: Identifying parts of a time series chart

Review each chart and determine which component is missing.

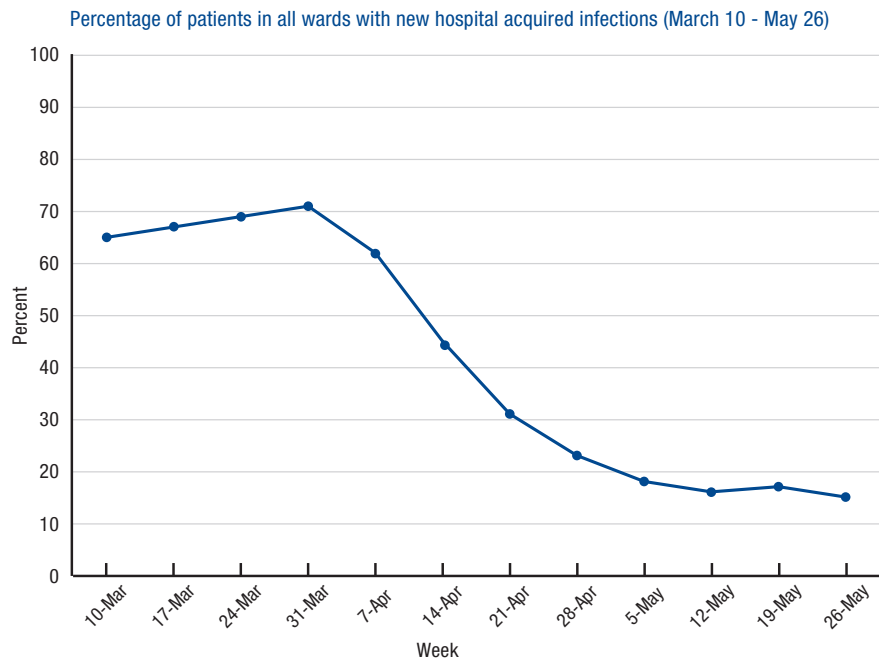
Time Series Chart 1



Check what is missing from Time Series Chart 1:

- Line to connect all points
- Title
- Annotations of changes
- Axis labels

Time Series Chart 2



Check what is missing from Time Series Chart 2:

- Line to connect all points
- Title
- Annotations of changes
- Axis labels

Exercise 3: Creating a time series chart

Use the information and blank graph provided below to create a time series chart. Remember:

- Title the graph
- Label the X-axis (horizontal axis) with label and numbers
- Label the Y-axis (vertical axis) with label and numbers
- Plot each x, y point
- Connect each data point with a line
- Annotate the graph with key events

For Exercise 3, please use this following information:

1. Indicator being plotted: Percentage of newborns receiving all elements of essential newborn care within one hour, per national standards
2. Place: National Hospital
3. Date range: (July-October 2016)
4. X-axis label: Weeks (1 to 16)
5. Y-axis label: Percent (0 to 100 in increments of 10)
6. Annotation:
 - a. Change 1: Newborn care supplies at bedside in Week 7
 - b. Change 2: Assign nurse to newborn care in Week 9

Week	Percent
1	14
2	16
3	11
4	19
5	15
6	12
7	25
8	29
9	48
10	45
11	52
12	57
13	55
14	61
15	64
16	66

