

Appendix A: Graphical Tools Available for Quality Improvement Activities

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The How-To Guide on Quality Improvement, which is available [here](#), reviews how a clinic can begin quality improvement (QI) activities, the Plan-Do-Study-Act (PDSA) model and where to find indicators and benchmark measures. Graphical tools are extremely useful when undertaking QI projects, both when identifying potential causes of issues and analyzing QI data.

There are upwards of 148 quality improvement tools available (*Tague Quality Toolbox book*), but included below are a handful of basic tools that will help a clinic get started. The tools are organized by purpose: (1) cause analysis and (2) data collection and analysis. Each tool described below has a freely-available downloadable Excel template and a built-in graphical interface that can be customized for individual clinic use. Each Excel template, once downloaded, has an instruction page for how to input data and automatically creates the graph. The Excel templates originate from the American Society for Quality (<http://asq.org/learn-about-quality/quality-tools.html>) and from the Institute for Healthcare Improvement (<http://www.ihl.org/resources/pages/tools/runchart.aspx>).

Cause Analysis Tools

1. **Cause and Effect Diagram/ Fishbone Diagram.** The Cause and Effect Diagram (also known as the Fishbone Diagram because of its resemblance to a fish skeleton) is a visual tool used for identifying causes of a problem. Once a problem is described the task is to identify the causes. The causes can be generated through brainstorming sessions. Brainstorming sessions are more likely to reach the root cause by adhering to the advice to ask ‘Why’ at least five times after initially answering the following questions, as appropriate:
 - What causes the problem?
 - What contributes to that cause?
 - What deeper issues contribute to that cause?

In the example provided on page 2, Figure 1, the problem that the free/ charitable clinic wishes to address is uncontrolled diabetes, as measured by the percentage of patients whose HbA1c levels is above 9. The causes are identified and then categorized; in this example, the relevant causes are categorized into patient, provider, environment/equipment and system/procedures. The types of causes identified should be customized to the particular problem at hand. Other types of causes that might be useful include: Staff, Volunteers, Materials, Policies, Procedures, External Factors, etc. Having an understanding of the nature and extent of the causes of the problem provides insight into ways that a clinic might address a problem. It also provides perspective on how much of the problem can be tackled by the change being considered so that expectations about what can actually be accomplished by the change are tempered.

You can download the excel template for a Fishbone Diagram on page 2:
<http://asq.org/learn-about-quality/cause-analysis-tools/overview/fishbone.html>



Figure 1. Fishbone Diagram

Quality Tools

Cause and Effect Diagram

Description

This template illustrates a Cause and Effect Diagram, also called a Fishbone or Ishikawa Diagram. A detailed discussion of Cause and Effect Diagrams can be found at www.ASQ.org

[Learn About C and E Diagrams](#)

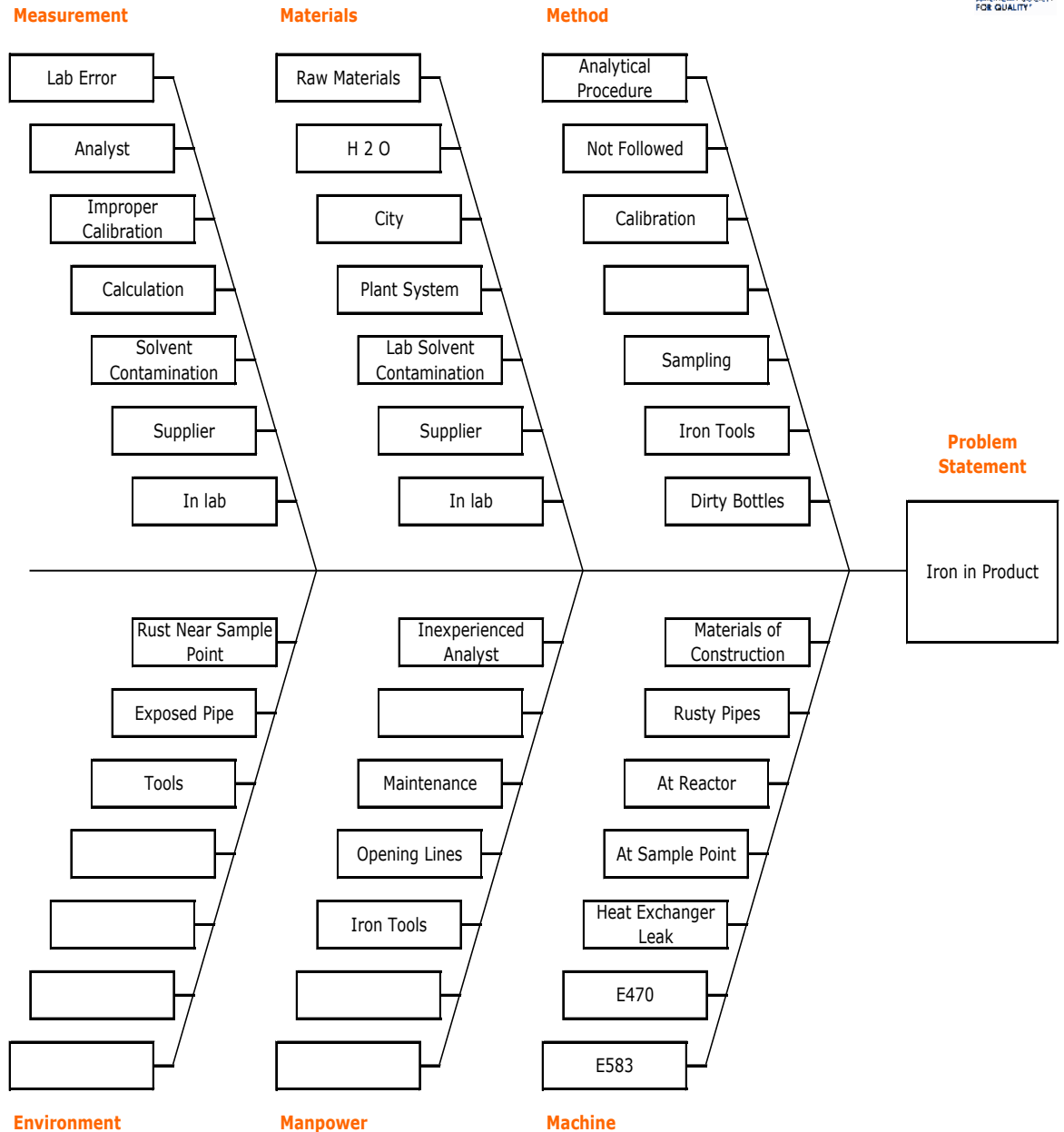
Instructions

- Enter the Problem Statement in box provided.
- Brainstorm the major categories of the problem. Generic headings are provided.
- Write the categories of causes as branches from the main arrow.

Learn More

To learn more about other quality tools, visit the ASQ Learn About Quality web site.

[Learn About Quality](#)



2. **Pareto Chart.** A Pareto Chart is simply a bar chart with an overlay of a cumulative frequency line on a separate axis. Two modifications to the common bar chart render the Pareto Chart especially useful in the context of quality improvement because its design identifies the areas where it is possible to make the greatest impact. First, the Pareto Chart displays the bars, left to right, from most frequent to least frequent, making it easy to identify repeated problems. Second, the cumulative frequency line displays the running total of the issues being investigated, revealing how much of the overall problem can be addressed by focusing attention on the most frequent problems.

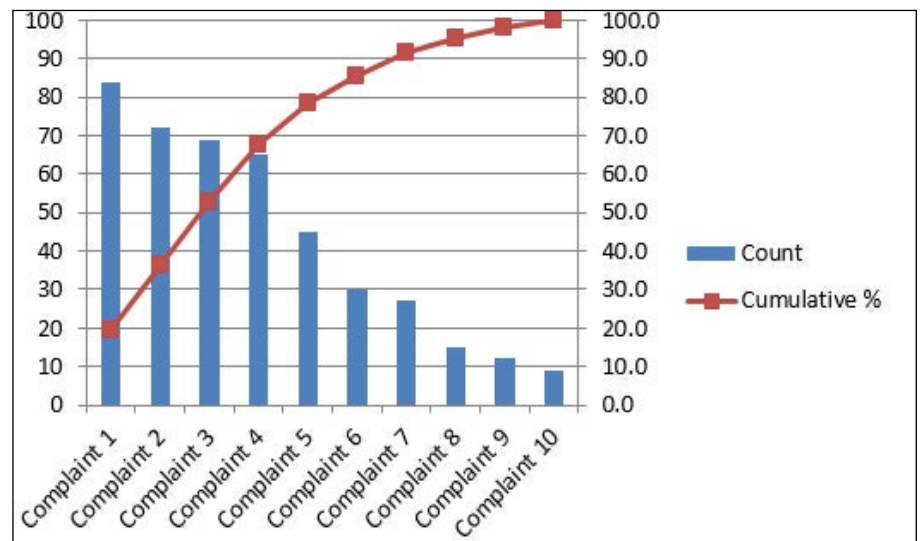
In the example below, Figure 2, patient complaints for a sample of 19 patients are graphed in a Pareto Chart. In this hypothetical example, the most frequently-cited complaint [first bar] is “had to wait too long to be seen” followed by “waiting room overcrowded” [second bar]. The cumulative frequency line shows that addressing just these two complaints would resolve 79 percent of all complaints, thus illuminating the areas where actions would yield the greatest return.

You can download the excel template for a Pareto Chart provided by Julie Darnell here:

Additionally, there is a template available through ASQ the bottom of this webpage: <http://asq.org/learn-about-quality/cause-analysis-tools/overview/pareto.html> (Caution: make sure that the counts are sorted from largest to smallest)

Figure 2. Pareto Chart (utilizing Julie Darnell’s template)

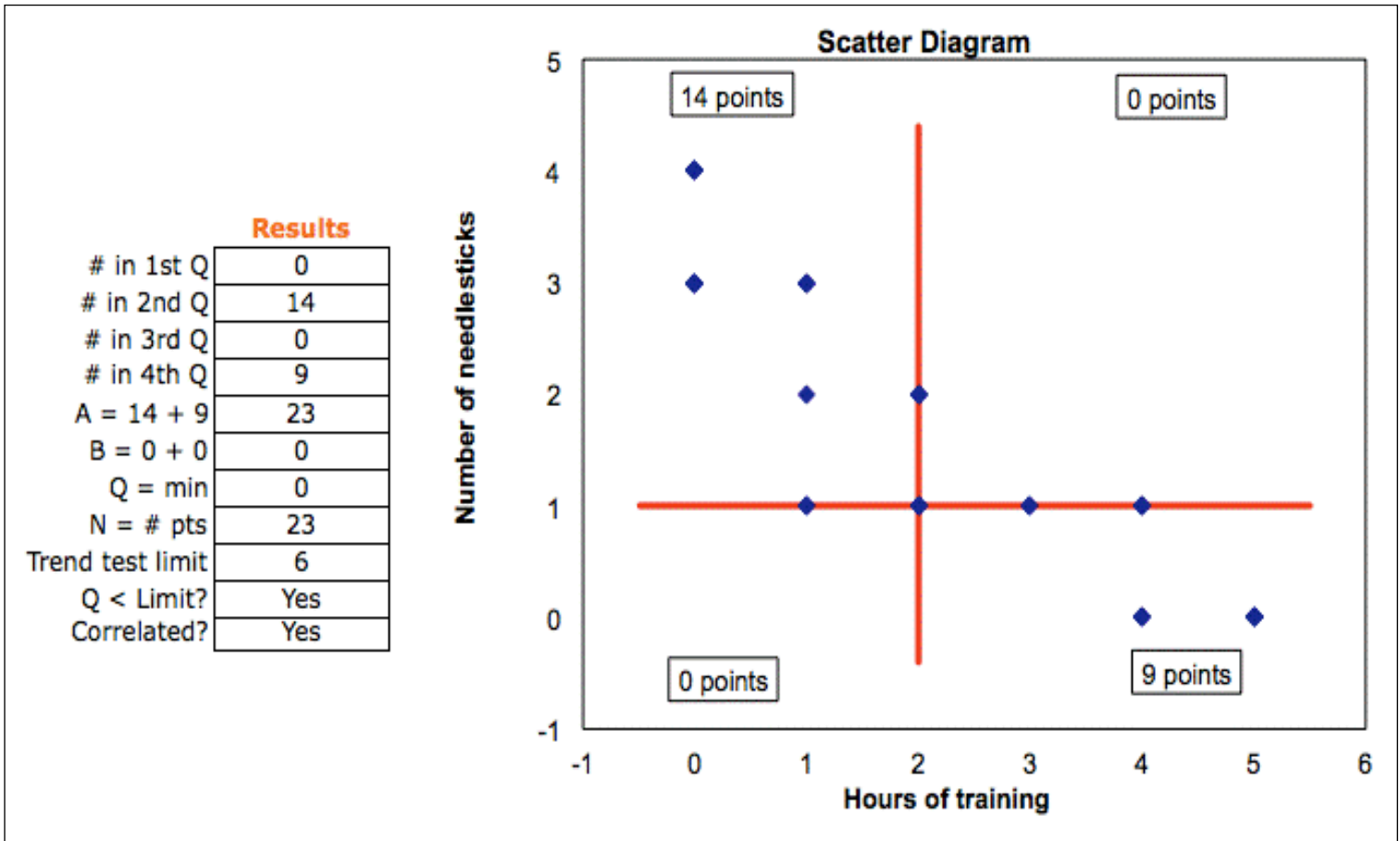
	A	B	C	D
1	Issues/Complaints			
2				
3	Issue/Complaint	Count	Cumulative Count	Cumulative %
4	Complaint 1	84	84	19.6
5	Complaint 2	72	156	36.4
6	Complaint 3	69	225	52.6
7	Complaint 4	65	290	67.8
8	Complaint 5	45	335	78.3
9	Complaint 6	30	365	85.3
10	Complaint 7	27	392	91.6
11	Complaint 8	15	407	95.1
12	Complaint 9	12	419	97.9
13	Complaint 10	9	428	100.0



3. **Scatter Diagram.** A Scatter Diagram is a visual tool that reveals relationships between two factors. Take, for example, a free/charitable clinic that has identified a problem of needle stick injuries among its staff/volunteers and wants to test whether its new needle stick training program is effective in reducing the number of needle stick injuries. The Scatter Diagram will allow the clinic to determine if there is an association between the number of hours of training and number of injuries. As shown in Figure 3, the number of needle sticks decreases as the number of hours of training increases, indicating a strong relationship between the number of hours of training [x-axis] and the number of needle sticks [y-axis]. The Scatter Diagram is a highly versatile tool and may be used to study any two pairs of variables. Examples of other plotted relationships include the percentage of wellness classes completed and knowledge about self-management of diabetes, HbA1c levels and the percentage of appointments kept, or time spent with provider and patient satisfaction with care, etc.

You can download the excel template for a Scatter Diagram at the bottom of this page:
<http://asq.org/learn-about-quality/cause-analysis-tools/overview/scatter.html>

Figure 3. Scatter Diagram



Data Collection and Analysis Tools

4. **Check Sheet.** The Check Sheet is a simple data collection tool that can be used to track the frequency of events, either expected or unwanted. It is especially useful in determining the fidelity to a predefined process. In quality improvement projects the Check Sheet is often used to track problems by type, location (e.g., day of the week, time of day), or source (e.g., provider/staff). The Check Sheet template can be customized for any situation in which the objective is to count the number of occurrences of an event. The simplest way to use the form is to indicate each time an event occurs with a tally mark.

In the example below, Figure 4, a Check Sheet is used to investigate the problem of repeat laboratory tests. The Check Sheet can help the clinic better understand the nature of the problem they are experiencing by examining the types of rejected specimens, the location/time when the specimen was drawn, and the causes of the problem (e.g., patient or staff). Check Sheets require that the categories are known in advance (when the categories/types are not predefined, a recording form is needed to capture the possibilities). In this example, mislabeled specimens occur the most, with eight events during the data collection period. Samples prepared on Tuesdays and Saturdays are the most prone to rejection. These results can be used in combination with a Pareto Chart to guide action.

You can download the excel template for a Check Sheet at the bottom of this page:
<http://asq.org/learn-about-quality/data-collection-analysis-tools/overview/check-sheet.html>

Figure 4. Check Sheet

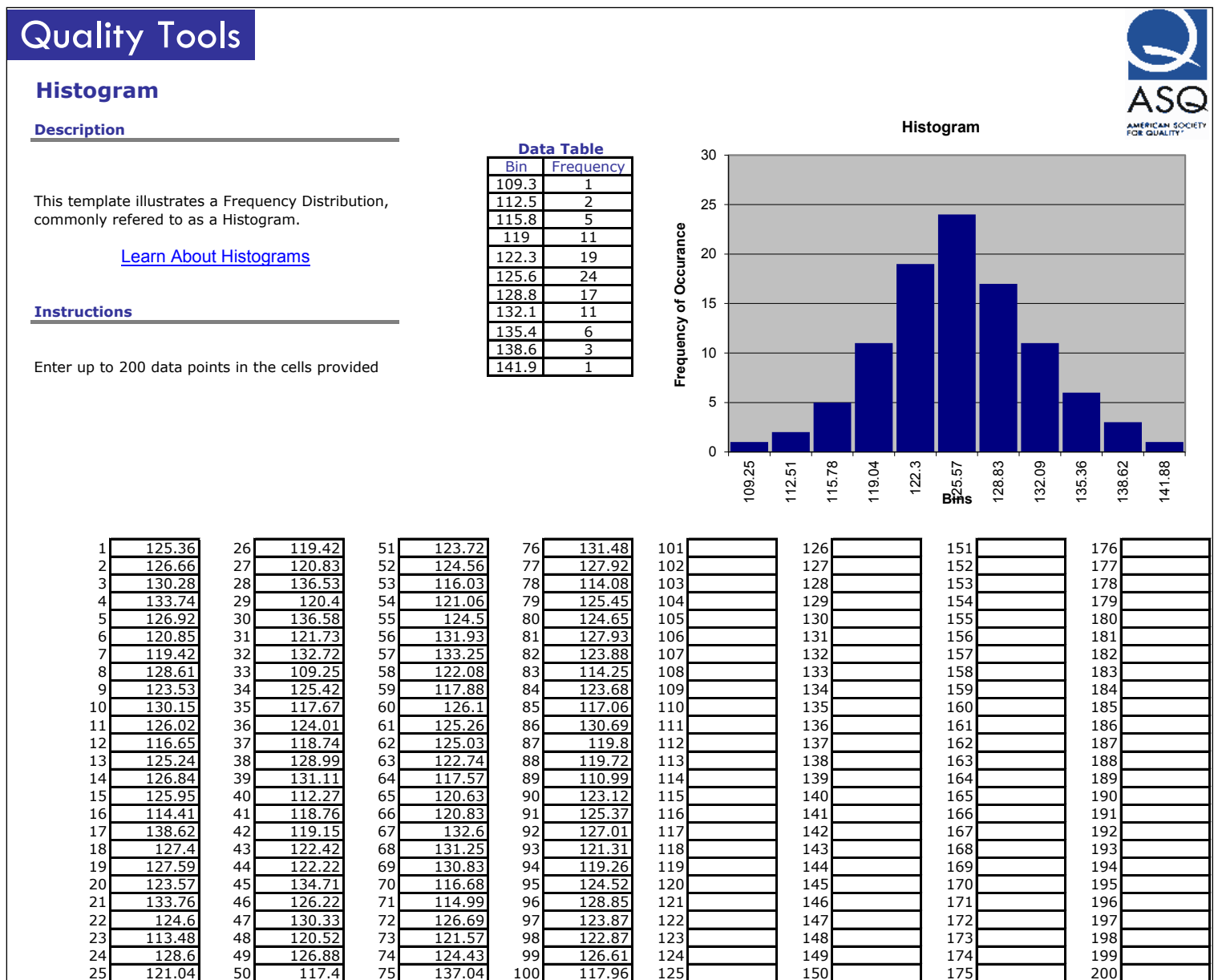
Project Name:	Rejected Specimen						
Name of Data Recorder:	Jane Doe						
Location:	Community Free Clinic						
Data Collection Dates:	September 2013						
Defect Types/ Event Occurrence	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL
Improper storage						1	1
Without request form			1				1
Mislabeled		4		2		2	8
Leaking container						2	2
Soiled form	1	1	1	1	1	1	6
Insufficient sample volume	1					1	2
Improper container or tube		3					3
TOTAL	2	8	2	3	1	7	23

2. **Histogram.** Like the Check Sheet, Histograms plot the frequency of events. Unlike the Check Sheet, however, Histograms are designed to plot one event at a time and require data that are numerical (i.e., numbers that are countable on a scale). Histograms show the graphical distribution (i.e., shape and spread) of data. At least 50 observations are needed to generate reliable information.

Histograms are especially well-suited to plot clinical values, such as HbA1C levels, as shown below in Figure 5. The figure displays the frequencies of HbA1c values for 50 hypothetical patients. The ASQ graphical template automatically distributes the data into equal intervals, or bins. In this example, the height of the bars reflects the relative frequency. The bin 8.94 tells us that the greatest number of patients have HbA1c levels of about 9. The HbA1c levels range from 5.2 to 11.7. The Histogram shows the overall distribution of data, allowing the user to determine whether the data are distributed normally (a bell-shaped curve) or skewed, with data points concentrated on the left and/or the right. The Histogram also shows outliers; in this example, there is one patient whose blood sugar level is above 11 and two patients whose values are below 6.

You can download the excel template for a Histogram at the bottom of this page:
<http://asq.org/learn-about-quality/data-collection-analysis-tools/overview/histogram.html>

Figure 5. Histogram



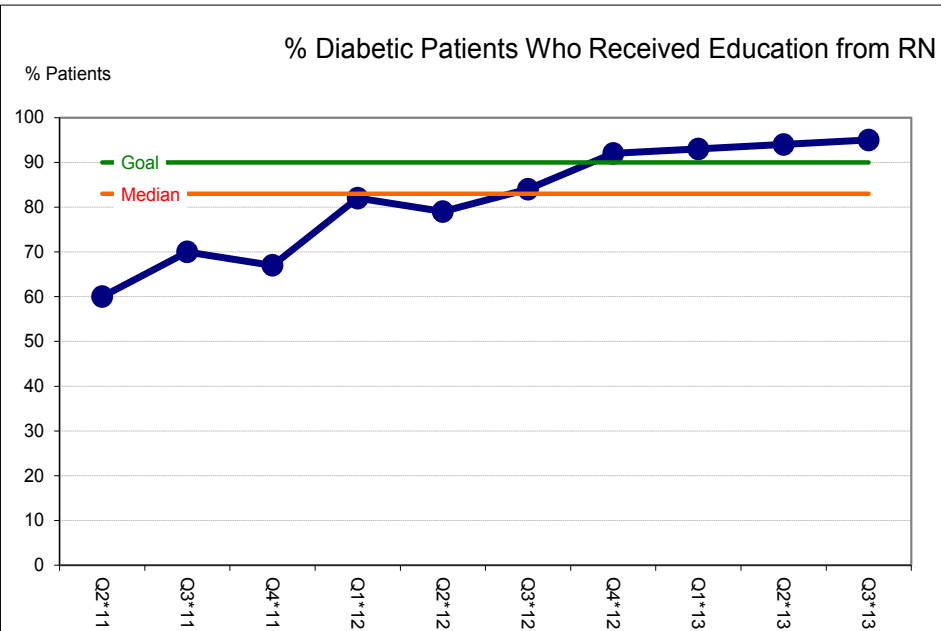
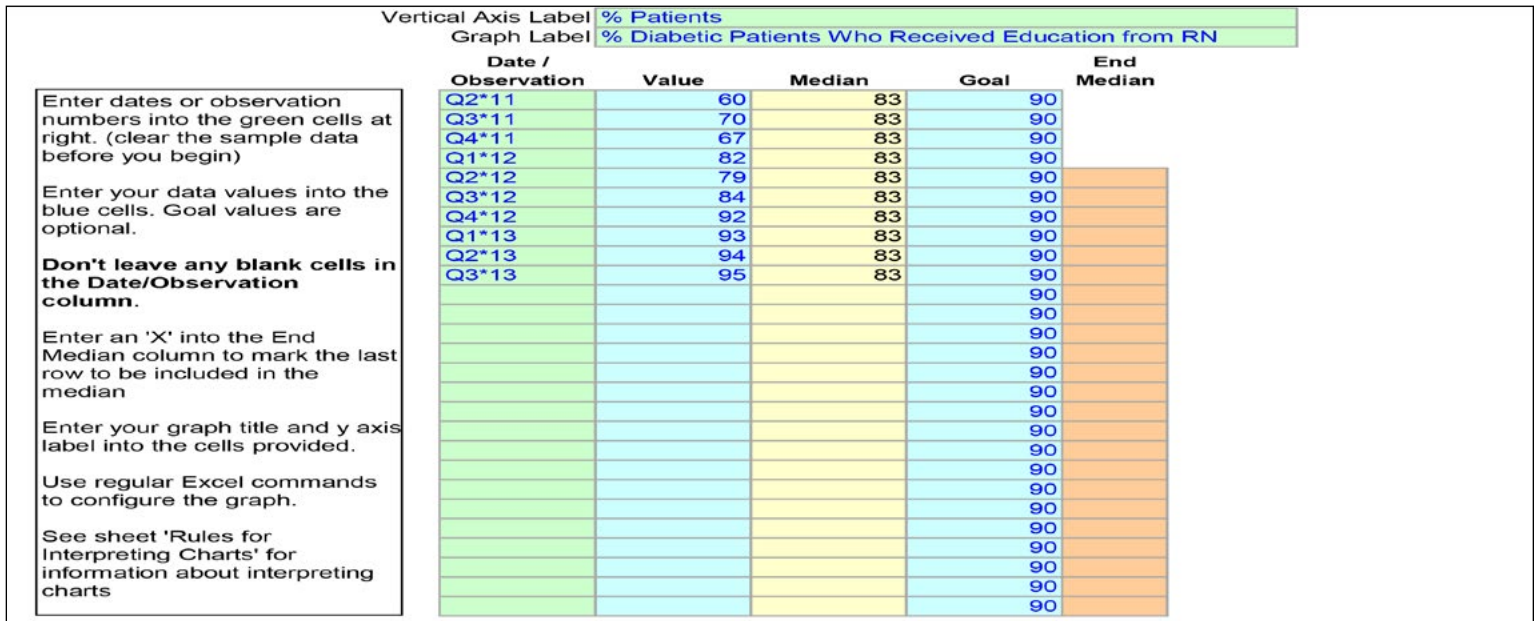
3. **Run Chart.** A Run Chart is a line graph that displays variations in data over time. Time is plotted on the x-axis and the factor under investigation (e.g., prescription refill rates, percentage of patients receiving an annual foot exam, etc.) is plotted on the y-axis. If data are already collected, it is advantageous to overlay the median value as a reference point to assist in recognizing patterns in the data. A "shift" occurs when there are six or more consecutive points above or below the median. Five or more consecutive points all increasing or decreasing denotes a "trend." (Langley et al. 2009).

In the example below, Figure 6, the percentage of diabetic patients who received diabetes education is plotted quarterly over the span of three years. The actual percentages [blue line] are compared to the predefined goal [red line]. The red and blue lines are generated automatically when data are entered into the Excel template. The median was calculated separately and plotted as a black line. This graph shows that the clinic has achieved the goal set to provide diabetes education to a certain percentage of its diabetic patients.

You can download the excel template for a Run Chart at the bottom of this page:

<http://www.ihi.org/resources/pages/tools/runchart.aspx>

Figure 6. Run Chart



4. **Box Plot.** The Box Plot (also called the Box and Whisker Plot) is a graphical tool that shows the distribution of data. Like the histogram, the Box Plot displays the shape and spread of data. The Box Plot has one important advantage over the Histogram in that it calculates the median value, a measure of central tendency. Because data are put into bins (i.e., intervals) in the Histogram, an exact measure of central tendency cannot be calculated.

The Box Plot communicates a lot of statistical information once one becomes oriented to its layout. Figure 7, below, plots the HbA1c levels for diabetic patients over a two-year period, shown by Year 1 and Year 2.

The first statistic to locate is the median value or the exact middle point, also known as the 50th percentile, of the distribution of data. It is always located somewhere inside the box. In this example, the median value in Year 1 is 9.2, which means that half of all patients have A1C levels below 9.2 and half have A1C levels above 9.2

The second set of statistics to examine is the box itself, which outlines the lower and upper quartiles (called the interquartile range); the lower quartile is the lower 25th percentile and the upper quartile is the upper 75th percentile. The 25th percentile tells us that 25 percent of all patients had A1C levels below the 25th percentile [7.5 in Year 1]. Another way to think of the 25th percentile is the half-way point between the median and the lowest point. (The same rule applies to the 75th percentile, but it is the half-way point between the median and the highest point.) The lowest and highest points are shown in the example in pink (minimum value) and green (maximum value). The green and pink dots thus signify the spread of data. In this example, in Year 1, the minimum A1C level is 5.8 and the maximum A1C level is 12. In other words, the A1C values for the Year 1 sample range from 5.8 to 12.

The size of the box itself is informative, as it tells us how clustered together the A1C levels are across the sample of patients. A wider box suggests greater variation among the sample. In the example below, the patients' A1C levels are closer together in Year 1 [the first box], yielding a smaller box than in Year 2, where the patients' A1C levels are more different and the resulting box larger.

By comparing the box plots from Year 1 and Year 2, the clinic can see that the median A1C level of its diabetic patient population decreased from 9.2 to 7.

You can download the excel template for a Box Plot at the bottom of this page:

<http://asq.org/learn-about-quality/data-collection-analysis-tools/overview/box-whisker-plot.html>

Figure 7A. Box Plot

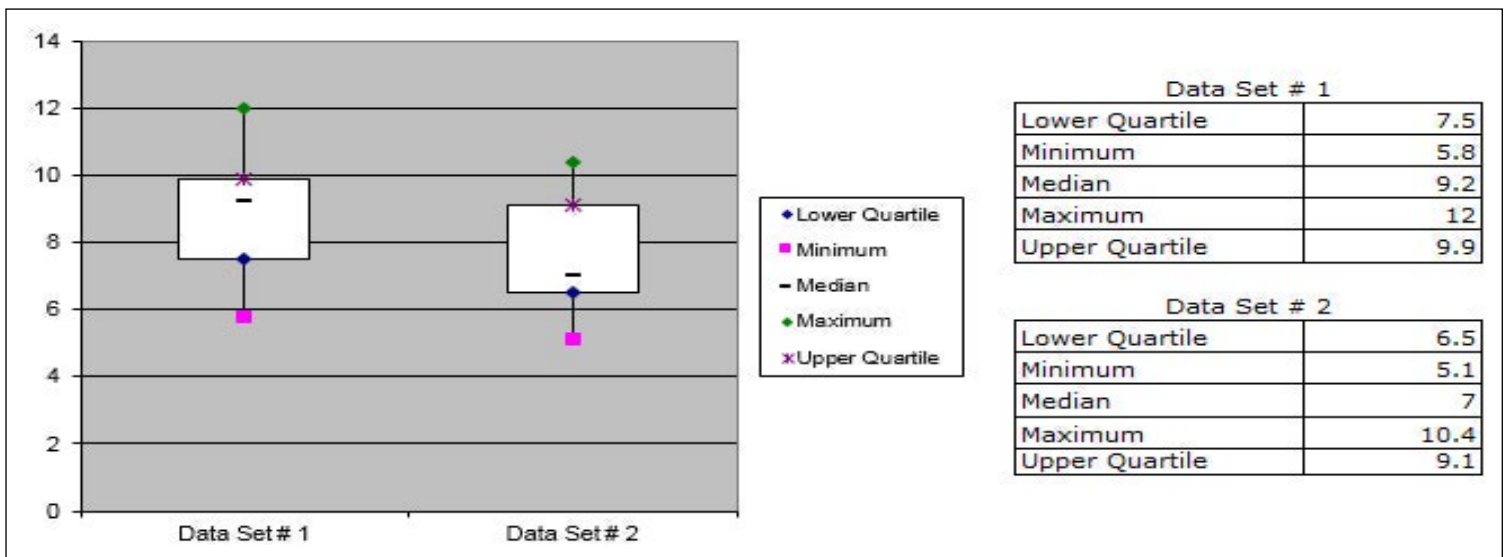


Figure 7B. Box Plot Data Set (Year 1)

Data Set # 1					
1	10	26	9.8	51	76
2	10.2	27	9.5	52	77
3	9.2	28	10.2	53	78
4	9.4	29	10.3	54	79
5	8.9	30		55	80
6	8.7	31		56	81
7	7.2	32		57	82
8	7.5	33		58	83
9	9.4	34		59	84
10	9.5	35		60	85
11	9.9	36		61	86
12	7	37		62	87
13	7	38		63	88
14	8.1	39		64	89
15	9.5	40		65	90
16	7.5	41		66	91
17	8.2	42		67	92
18	10.5	43		68	93
19	9	44		69	94
20	12	45		70	95
21	11.6	46		71	96
22	7	47		72	97
23	5.8	48		73	98
24	6.3	49		74	99
25	7	50		75	100