



# QI Essentials Toolkit

- [Cause and Effect Diagram](#)
- [Driver Diagram](#)
- [Failure Modes and Effects Analysis \(FMEA\)](#)
- [Flowchart](#)
- [Histogram](#)
- [Pareto Chart](#)
- [PDSA Worksheet](#)
- [Project Planning Form](#)
- [Run Chart & Control Chart](#)
- [Scatter Diagram](#)

***IHI's QI Essentials Toolkit*** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template.

IHI offers a range of programs to help you and your team develop improvement skills:

### [IHI Open School](#)

The IHI Open School provides you with essential training and tools in an online, educational community. Eight improvement capability courses are available.

- **Level:** Novice to Beginner\*
- **Format:** Online, asynchronous courses that take 1-2 hours
- **Who should attend:** Students, residents, faculty, and professionals

### [Improvement Coach Professional Development Program](#)

If you are an improver who wants to coach and facilitate improvement teams and support the implementation of improvement strategies within your organization, the next step is to become an Improvement Coach.

- **Level:** Competent to Proficient\*
- **Format:** Twelve-week experiential program with a preparatory webinar, two 3-day in-person workshops, three 3-hour virtual workshops in between, and a concluding webinar. Previous team-based improvement experience required. Requires an improvement team with an improvement project to coach.
- **Who should attend:** Individuals with improvement experience who wants to coach and facilitate improvement teams.

### [Improvement Advisor Professional Development Program](#)

The Improvement Advisor (IA) program prepares you to become a highly effective leader in helping your organization or system implement strategically vital improvement initiatives.

- **Level:** Proficient to Expert\*
- **Format:** Eleven-month experiential program with a preparatory webinar, three 4-day workshops, and 10 monthly webinars in between. Previous experience leading improvement efforts required. Requires an improvement project that is strategically important to the sponsoring organization.
- **Who should attend:** Specialists in improvement and future improvement leaders; individuals/professionals who have or expect to have a major portion of their work focused on improvement.

For more information, see [ihi.org/ImprovementCapability](https://ihi.org/ImprovementCapability)



## QI Essentials Toolkit:

# Cause and Effect Diagram

A common challenge for improvement teams is determining what changes they can test to improve a process. A cause and effect diagram is an organizational tool that helps teams explore and display the many causes contributing to a certain effect or outcome. It graphically displays the relationship of the causes to the effect and to each other, helping teams identify areas for improvement.

The cause and effect diagram is also known as an Ishikawa diagram, for its creator, or a fishbone diagram, for its resemblance to the bones of a fish. Teams list and group causes under the categories of Materials, Methods, Equipment, Environment, and People.

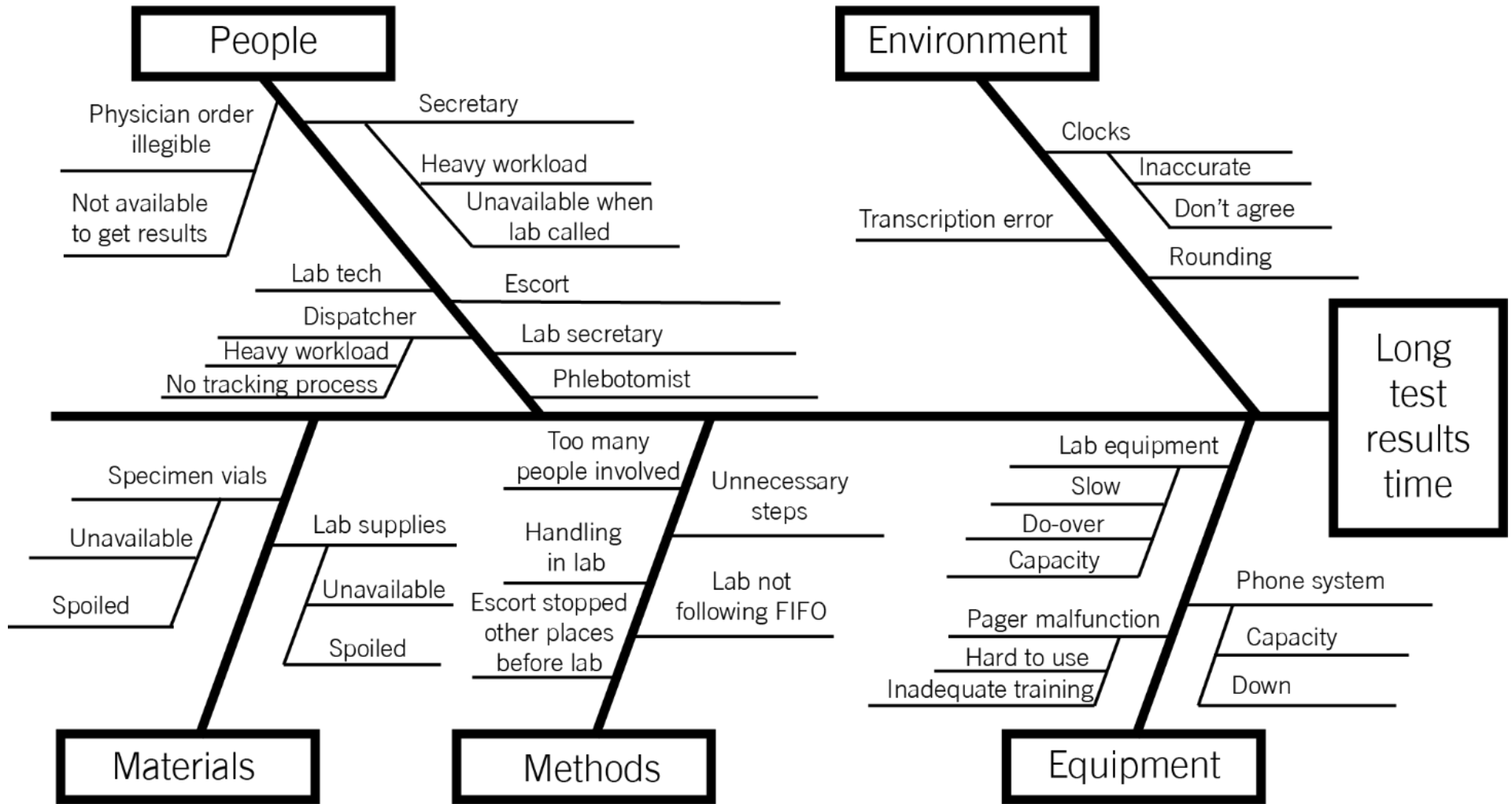
***IHI's QI Essentials Toolkit*** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

- **Cause and Effect Diagram**
- Driver Diagram
- Failure Modes and Effects Analysis (FMEA)
- Flowchart
- Histogram
- Pareto Chart
- PDSA Worksheet
- Project Planning Form
- Run Chart & Control Chart
- Scatter Diagram

# Instructions

- 1) Write the effect you wish to influence in a box on the right-hand side of the page.
- 2) Draw a horizontal line across the page to the left, starting at the box you just drew.
- 3) Decide on five or six categories of causes for the effect. The standard categories in a classic cause and effect diagram are Materials, Methods, Equipment, Environment, and People.
- 4) Draw diagonal lines above and below the horizontal line to create “fishbones,” and label each line at the end with one of the categories you have chosen. Draw a box around each label.
- 5) For each category, generate a list of the causes that contribute to the effect. List the causes by drawing “branch bones.” As necessary, draw additional branch bones from the causes to show sub-causes.
  - Tip: Develop the causes by asking “Why?” until you have reached a useful level of detail — that is, when the cause is specific enough to be able to test a change and measure its effects.

## Example: Cause and Effect Diagram

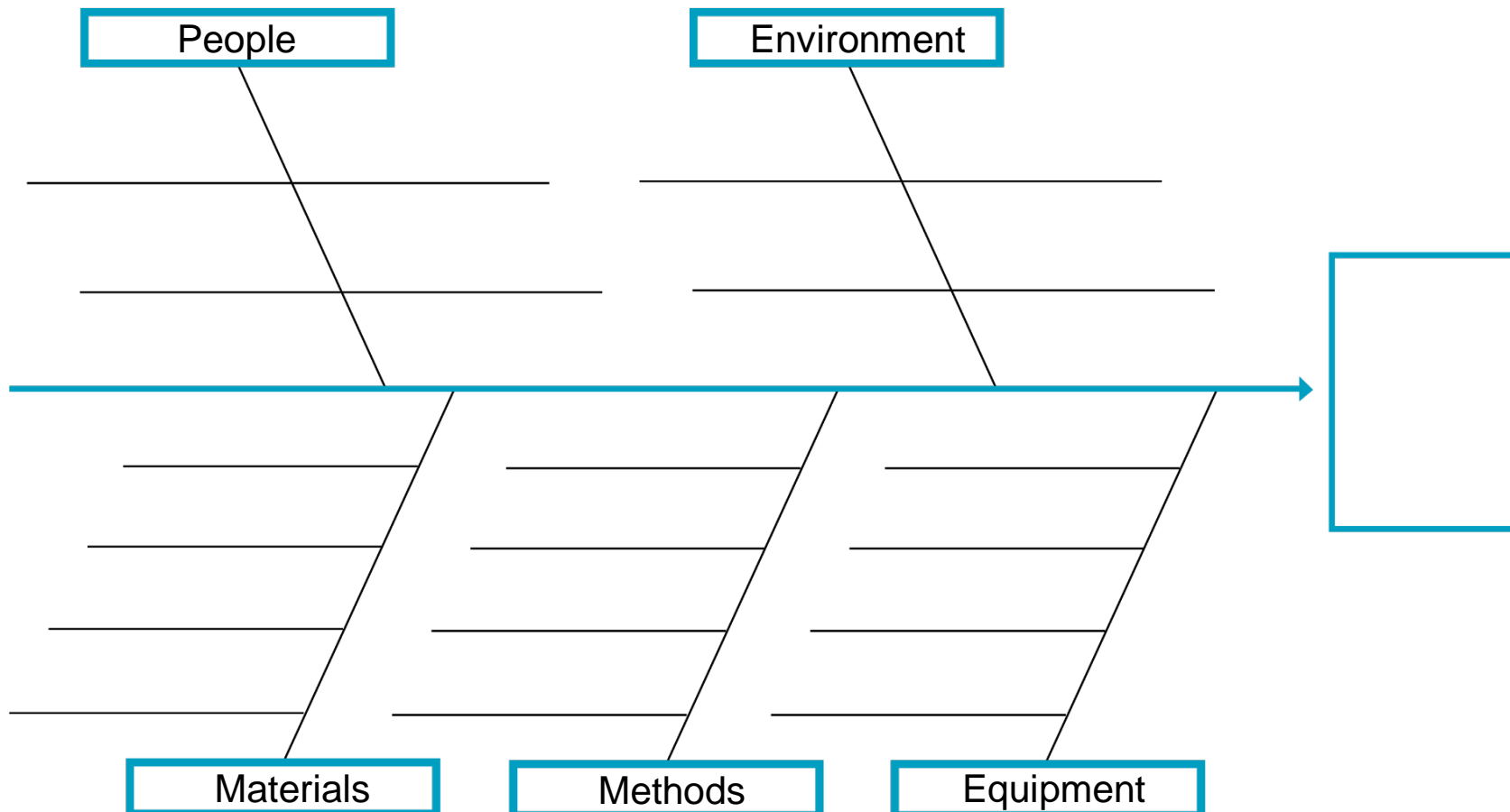


Before filling out this template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

## Template: Cause and Effect Diagram

Team: \_\_\_\_\_ Project: \_\_\_\_\_

- 1) Input the effect you'd like to influence.
- 2) Input categories of causes for the effect (or keep the classic five).
- 3) Input causes within each category.





## QI Essentials Toolkit:

# Driver Diagram

A driver diagram is a visual display of a team's theory of what "drives," or contributes to, the achievement of a project aim. This clear picture of a team's shared view is a useful tool for communicating to a range of stakeholders where a team is testing and working.

A driver diagram shows the relationship between the overall **aim** of the project, the **primary drivers** (sometimes called "key drivers") that contribute directly to achieving the aim, the **secondary drivers** that are components of the primary drivers, and **specific change ideas to test** for each secondary driver.

Primary drivers are the most important influencers on the aim, and you will have only a few (we recommend 2 to 5); secondary drivers are influencers on (or natural subsections of) the primary drivers, and you may have many. As you identify each driver, establish a way to measure it.

Remember: It's unlikely that a single individual has a clear view of an entire complex system. When developing a driver diagram, enlist the help of team members who are familiar with different aspects of the system under review.

**IHI's QI Essentials Toolkit** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

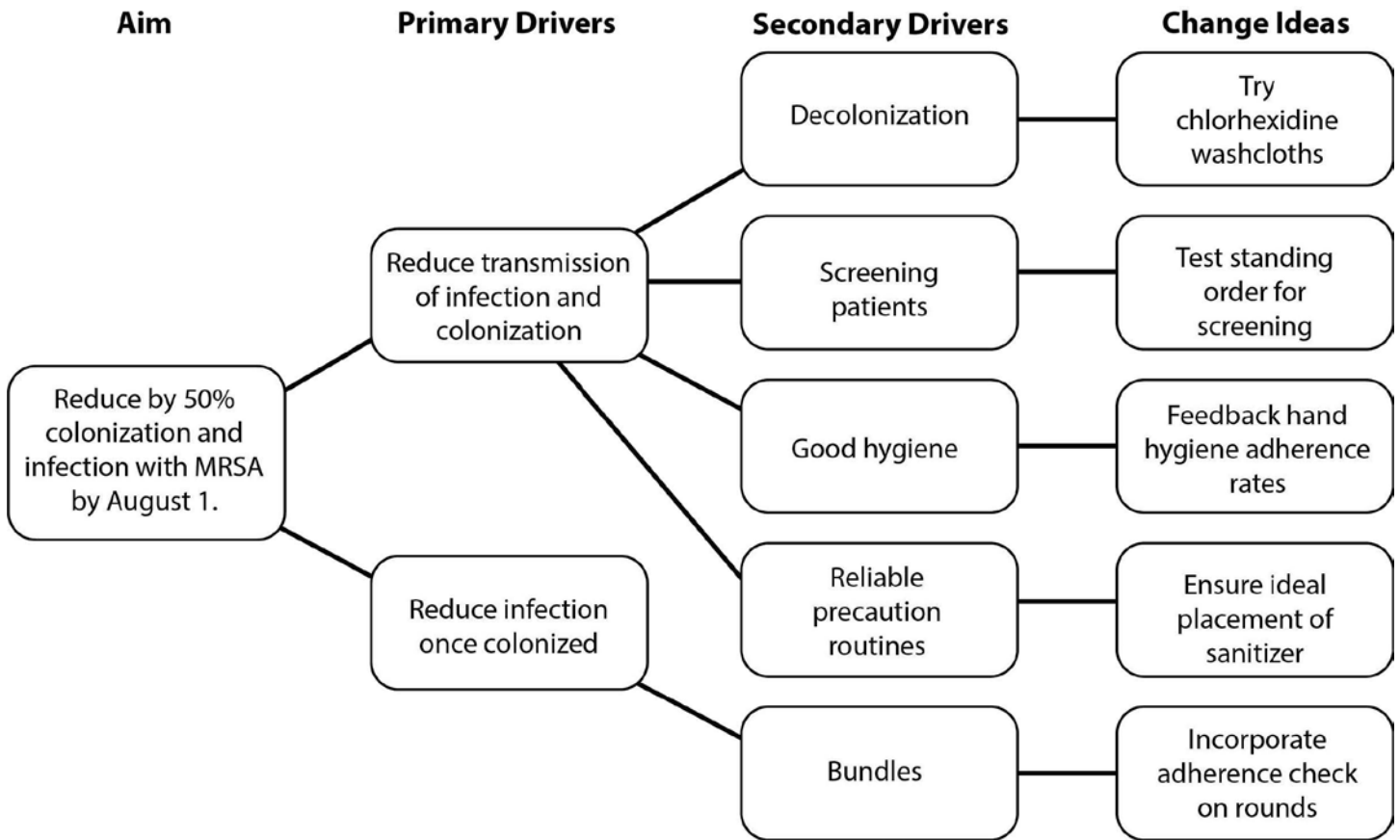
- Cause and Effect Diagram
- **Driver Diagram**
- Failure Modes and Effects Analysis (FMEA)
- Flowchart
- Histogram
- Pareto Chart
- PDSA Worksheet
- Project Planning Form
- Run Chart & Control Chart
- Scatter Diagram

## Instructions

- 1) On the left, list the project aim (what will be improved, by how much, for whom, and by when) and draw a box around it.
- 2) To the right of the aim, list a few “primary drivers” — the most significant high-level influencers on the aim you’ve identified. Draw a box around each of the primary drivers, and draw lines to connect the primary drivers to the aim.
- 3) To the right of each primary driver, list as many “secondary drivers” that influence the primary driver as you can think of. Draw a box around each secondary driver, and draw lines to connect the secondary drivers to the primary drivers. Note: Secondary drivers can connect to more than one primary driver.
  - Tip: To show strong relationships, use solid lines; to show weaker relationships, use dotted lines.
- 4) To the right of each secondary driver, list specific change ideas you will test to influence the secondary driver. Note: Change ideas can connect to more than one secondary driver.

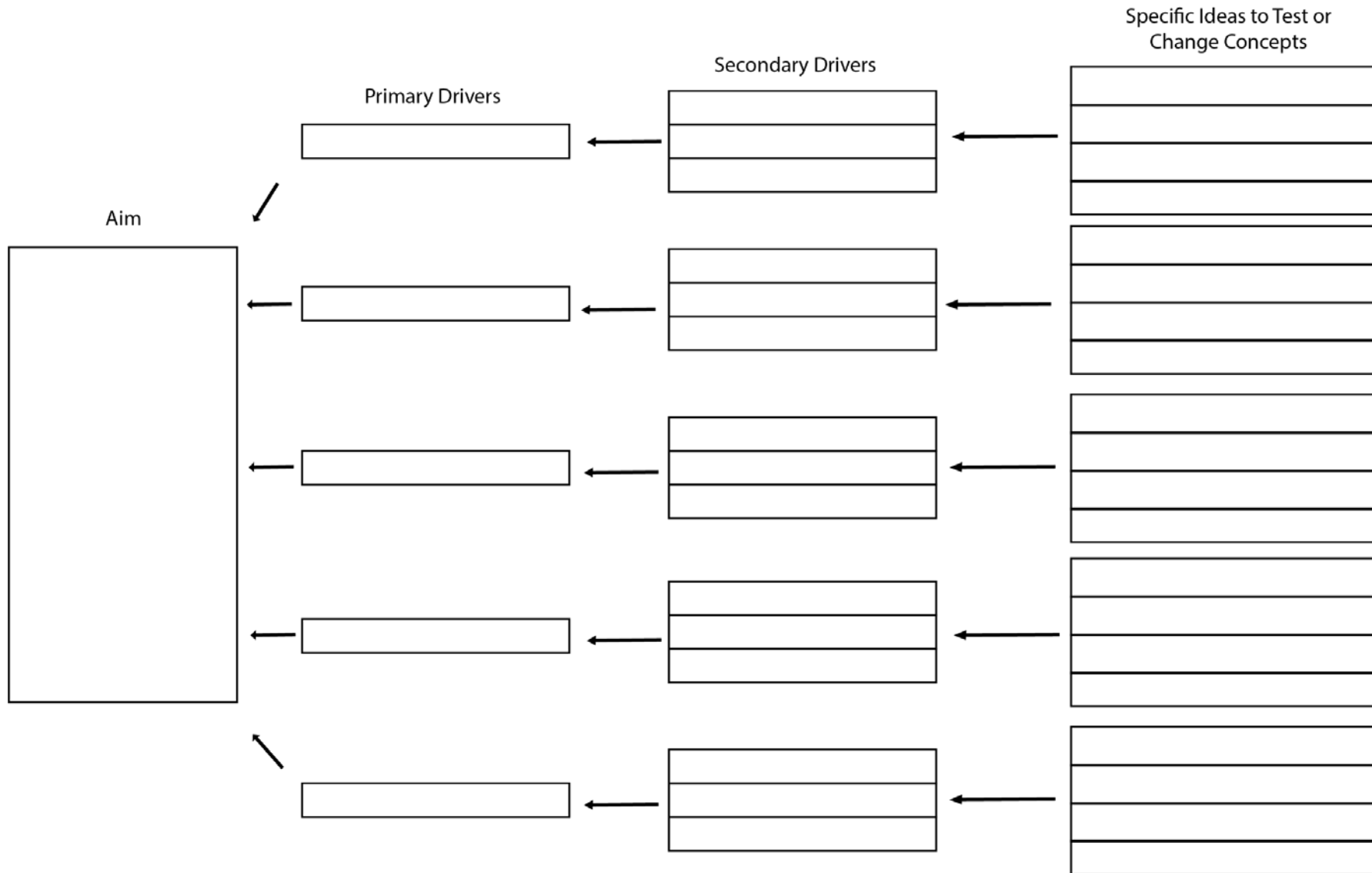


# Example: Driver Diagram



Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

# Template: Driver Diagram





## QI Essentials Toolkit:

# Failure Modes and Effects Analysis (FMEA)

Failure Modes and Effects Analysis (FMEA) is a tool for conducting a systematic, proactive analysis of a process in which harm may occur. In an FMEA, a team representing all areas of the process under review convenes to predict and record where, how, and to what extent the system might fail. Then, team members with appropriate expertise work together to devise improvements to prevent those failures — especially failures that are likely to occur or would cause severe harm to patients or staff.

The FMEA tool prompts teams to review, evaluate, and record the following:

- Steps in the process
- Failure modes (What could go wrong?)
- Failure causes (Why would the failure happen?)
- Failure effects (What would be the consequences of each failure?)

Teams use FMEA to evaluate processes for possible failures and to prevent them by correcting the processes proactively rather than reacting to adverse events after failures have occurred. This emphasis on prevention may reduce risk of harm to both patients and staff. FMEA is particularly useful in evaluating a new process prior to implementation and in assessing the impact of a proposed change to an existing process.

***IHI's QI Essentials Toolkit*** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

- Cause and Effect Diagram
- Driver Diagram
- **Failure Modes and Effects Analysis (FMEA)**
- Flowchart
- Histogram
- Pareto Chart
- PDSA Worksheet
- Project Planning Form
- Run Chart & Control Chart
- Scatter Diagram

# Instructions

**1) Select a process to evaluate with FMEA.**

Evaluation using FMEA works best on processes that do not have too many sub-processes.

If you're hoping to evaluate a large and complex process, such as medication management in a hospital, divide it up. For example, do separate FMEAs on medication ordering, dispensing, and administration processes.

**2) Recruit a multidisciplinary team.**

Be sure to include everyone who is involved at any point in the process. Some people may not need to be part of the team throughout the entire analysis, but they should certainly be included in discussions of those steps in the process in which they are involved. For example, a hospital may utilize couriers to transport medications from the pharmacy to nursing units. It would be important to include the couriers in the FMEA of the steps that occur during the transport itself, which may not be known to personnel in the pharmacy or on the nursing unit.

**3) Have the team list all of the steps in the process.**

Working with a team that represents every point in the process you're evaluating, establish a mutually agreed upon, ordered list of all the steps in the process.

- Tip: Flowcharting can be a helpful tool for visualizing a process. Learn more at <http://www.ihl.org/resources/Pages/Tools/Flowchart.aspx>.

Draw a nine-column table as shown below.

Steps in the Process	Failure Mode	Failure Causes	Failure Effects	Likelihood of Occurrence (1-10)	Likelihood of Detection (1-10)	Severity (1-10)	Risk Profile Number (RPN)	Actions to Reduce Occurrence of Failure
1								
2								
3								

#### 4) Fill out the table with your team.

In the left-most column, input the numbered list of the steps in the process. Then, working with the members of the team who are involved in specific steps, fill out the remaining columns as follows:

- **Failure Mode** [*What could go wrong?*]: List anything that could go wrong during that step in the process.
- **Failure Causes** [*Why would the failure happen?*]: List all possible causes for each of the failure modes you've identified.
- **Failure Effects** [*What would be the consequences of the failure?*]: List all possible adverse consequences for each of the failure modes identified.
- **Likelihood of Occurrence** (1–10): *On a scale of 1-10, with 10 being the most likely, what is the likelihood the failure mode will occur?*
- **Likelihood of Detection** (1-10): *On a scale of 1-10, with 10 being the most likely NOT to be detected, what is the likelihood the failure will NOT be detected if it does occur?*
- **Severity** (1-10): *On a scale of 1-10, with 10 being the most likely, what is the likelihood that the failure mode, if it does occur, will cause severe harm?*
- **Risk Profile Number** (RPN): For each failure mode, multiply together the three scores the team identified (i.e., *likelihood of occurrence x likelihood of detection x severity*). The lowest possible score will be 1 and the highest 1,000. To calculate the RPN for the entire process, simply add up all of the individual RPNs for each failure mode.
- **Actions to Reduce Occurrence of Failure**: List possible actions to improve safety systems, especially for failure modes with the highest RPNs.
  - a) Tip: Teams can use FMEA to analyze each action under consideration. Calculate how the RPN would change if you introduced different changes to the system.

#### 5) Use RPNs to plan improvement efforts.

Failure modes with high RPNs are probably the most important parts of the process on which to focus improvement efforts. Failure modes with low RPNs are not likely to affect the overall process much, even if eliminated completely, and they should therefore be at the bottom of the list of priorities.

Identify the failure modes with the top 10 highest RPNs. These are the ones the team should consider first as improvement opportunities.

- **Use FMEA to plan actions to reduce harm from failure modes.**
  - a) If the failure mode is likely to occur:
    - Evaluate the causes and see if any or all of them can be eliminated.
    - Consider adding a forcing function (that is, a physical constraint that makes committing an error impossible, such as medical gas outlets that are designed to accept only those gauges that match).
    - Add a verification step, such as independent double-checks, bar coding on medications, or alert screens.
    - Modify other processes that contribute to causes.

- b) If the failure is unlikely to be detected:
  - Identify other events that may occur prior to the failure mode and can serve as “flags” that the failure mode might happen.
  - Add a step to the process that intervenes at the earlier event to prevent the failure mode. For example, add pharmacy rounds to remove discontinued medications from patient care units within 1 hour of discontinuation, to decrease the risk that the medications will still be available for use (the failure mode).
  - Consider technological alerts such as devices with alarms to alert users when values are approaching unsafe limits.
- c) If the failure is likely to cause severe harm:
  - Identify early warning signs that a failure mode has occurred, and train staff to recognize them for early intervention. For example, use drills to train staff by simulating events that lead up to failure, to improve staff ability to recognize these early warnings.
  - Provide information and resources, such as reversal agents or antidotes, at points of care for events that may require immediate action.
- **Use FMEA to evaluate the potential impact of changes under consideration.**

Teams can use FMEA to discuss and analyze each change under consideration and calculate the change in RPN if the change were implemented. This allows the team to “verbally simulate” the change and evaluate its impact in a safe environment, prior to testing it in a patient care area. Some ideas that seem like great improvements can turn out to be changes that would actually increase the estimated RPN.
- **Use FMEA to monitor and track improvement over time.**

Teams should consider calculating a total RPN for the process as described above and then set a goal for improvement. For example, a team may set a goal of decreasing the total RPN for the medication ordering process by 50% from the baseline.

## Example: Failure Modes and Effects Analysis (FMEA) – Medication Dispensing Process

Steps in the Process	Failure Mode	Failure Causes	Failure Effects	Likelihood of Occurrence (1-10)	Likelihood of Detection (1-10)	Severity (1-10)	Risk Profile Number (RPN)	Actions to Reduce Occurrence of Failure
Orders are written for new medications.	The first dose may be given prior to pharmacist review of the orders.	Medication ordered may be available and easily accessed in the dispensing machine.	Patient may receive incorrect medication, incorrect dose, or a dose via incorrect route.	6	5	1	30	Assign clinical pharmacists to patient care units so that all medication orders can be reviewed as they occur.
Orders are written to discontinue a medication or change the existing order.	Orders are written to discontinue a medication or change the existing order.	All doses needed for a 24-hour period are delivered to the drawer. Drawer is not changed until next routine delivery.  24-hour supply of refrigerated medications is delivered.  Multi-dose vials may be kept in the patient-specific drawer. Medications are available in dispensing machine.	Patients may receive medications that have been discontinued or the incorrect dose of a medication that has been changed.	10	5	5	250	Schedule pick-ups of discontinued medications, including refrigerated medications, twice per day.  Use dispensing machine screen to verify all information regarding current and discontinued medications prior to each administration.
Orders are written for a non-standard dose of a medication.	Nursing staff may prepare an incorrect dose when manipulating the medication.	Staff prepare the dose using medications from the dispensing machine and manipulate them to get the dose ordered.	Patient may receive an incorrect dose.	3	5	4	60	Prepare all non-standard doses in the pharmacy and dispense each as a patient-specific unit dose.

Steps in the Process	Failure Mode	Failure Causes	Failure Effects	Likelihood of Occurrence (1-10)	Likelihood of Detection (1-10)	Severity (1-10)	Risk Profile Number (RPN)	Actions to Reduce Occurrence of Failure
Pharmacy staff fill dispensing and storing devices with medications.	Errors may occur during filling and medications may be placed in incorrect bins.	Many medications are placed in the dispensing machine at one time.  Multiple medications and doses are placed in patient-specific drawers.	Patient may receive a medication that has not been prescribed.	3	5	5	75	Use bar code scanning for all medications to verify information prior to administration.  Involve patients and families in verification before each administration.
Medications requiring refrigeration and intravenous solutions are stored separately.	The wrong medication may be selected.	Medications are stored together and may not be in patient-specific bins, so it is easy to select the wrong one.	Patient may receive an incorrect medication, incorrect dose, or via incorrect route.	3	5	5	75	Use bar code scanning for all medications to verify information prior to administration.  Involve patients and families in verification before each administration.
Medications packaged in multi-dose vials are available.	The incorrect dose may be drawn from the vial.	Staff must draw each dose prior to administration without a double-check.	Patient may receive an incorrect medication, incorrect dose, or via incorrect route.	4	5	7	140	Prepare each dose in pharmacy and dispense each as a single-unit dose.  Remove multi-dose vials from dispensing machines.



Steps in the Process	Failure Mode	Failure Causes	Failure Effects	Likelihood of Occurrence (1-10)	Likelihood of Detection (1-10)	Severity (1-10)	Risk Profile Number (RPN)	Actions to Reduce Occurrence of Failure
Nursing staff access medications for administration from storage device.	Nursing staff may bypass proper procedure to access medications.	Nursing bypass of procedure may depend on proximity of machines to patient rooms, as nurses may want to decrease time traveling back and forth.	Patient may receive an incorrect medication, incorrect dose, or via incorrect route.	7	5	8	280	Use bar code scanning for all medications to verify information prior to administration.  Involve patients and families in verification before each administration.
Staff access narcotics for administration.	Staff with substance abuse problems may be diverting narcotics.	System for access may allow incorrect information to be entered (e.g., staff may be able to enter names of other staff).	Clinical staff may be working in an impaired state.	5	5	10	250	Use individually assigned identification cards that must be swiped through a card reader or use thumbprint readers to access narcotics.

Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

## Template: Failure Modes and Effects Analysis (FMEA)

Steps in the Process	Failure Mode	Failure Causes	Failure Effects	Likelihood of Occurrence (1-10)	Likelihood of Detection (1-10)	Severity (1-10)	Risk Profile Number (RPN)	Actions to Reduce Occurrence of Failure
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
							<b>Total RPN (sum of all RPNs):</b>	

**Failure Mode:** What could go wrong?

**Failure Causes:** Why would the failure happen?

**Failure Effects:** What would be the consequences of failure?

**Likelihood of Occurrence:** 1–10 [10 = very likely to occur]

**Likelihood of Detection:** 1–10 [10 = very unlikely to detect]

**Severity:** 1–10 [10 = most severe effect]

**Risk Priority Number (RPN):** Likelihood of Occurrence × Likelihood of Detection × Severity



## QI Essentials Toolkit:

# Flowchart

A flowchart — also known as a “process map” — is a visual representation of the sequence of steps in a process. Understanding the process as it currently operates is an important step in developing ideas about how to improve it. This makes flowcharts especially useful in the early phases of improvement work.

To create a flowchart, teams brainstorm all the steps in the process as it currently exists. Teams write each process step in a box (or on a sticky note). In addition to the steps themselves, they use a diamond shape (or sticky note turned on its corner) to indicate points in the process where a decision needs to be made. For decision steps, the team writes a yes/no question. Then they use lines to show the connections between the boxes and diamonds.

Having a shared understanding of the current process helps teams identify problems or bottlenecks, focus discussions, and identify resources. For example, teams can identify steps in the process that do not add value, such as delays; unnecessary work, duplication, or expense; and breakdowns in communication. It is at these points where the improvement work can start.

**IHI's QI Essentials Toolkit** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

- Cause and Effect Diagram
- Driver Diagram
- Failure Modes and Effects Analysis (FMEA)
- **Flowchart**
- Histogram
- Pareto Chart
- PDSA Worksheet
- Project Planning Form
- Run Chart & Control Chart
- Scatter Diagram

# Instructions

- 1) Get the “right” people in the room — those who know the process best.
- 2) Start by defining the first and the last step in the process — so that everyone has a shared understanding of where the process you’re working on begins and ends.
- 3) Using the shapes below, fill in all the steps in the process from first to last. Show the process as it actually works (not as it should work).
  - Tip: Use sticky notes (one for each step) to create a flowchart. This allows you to add steps and move steps around as you depict the process.
  - Tip: Note that some steps are parallel — that is, they happen at the same time.
- 4) Review the flowchart to check for accuracy and completeness.
- 5) Assign action items to team members to fill in unfamiliar steps and verify accuracy.
- 6) When the flowchart is complete and accurate, analyze it, use it, revisit it, and keep it up to date.



Start and end of a process



Activity or task

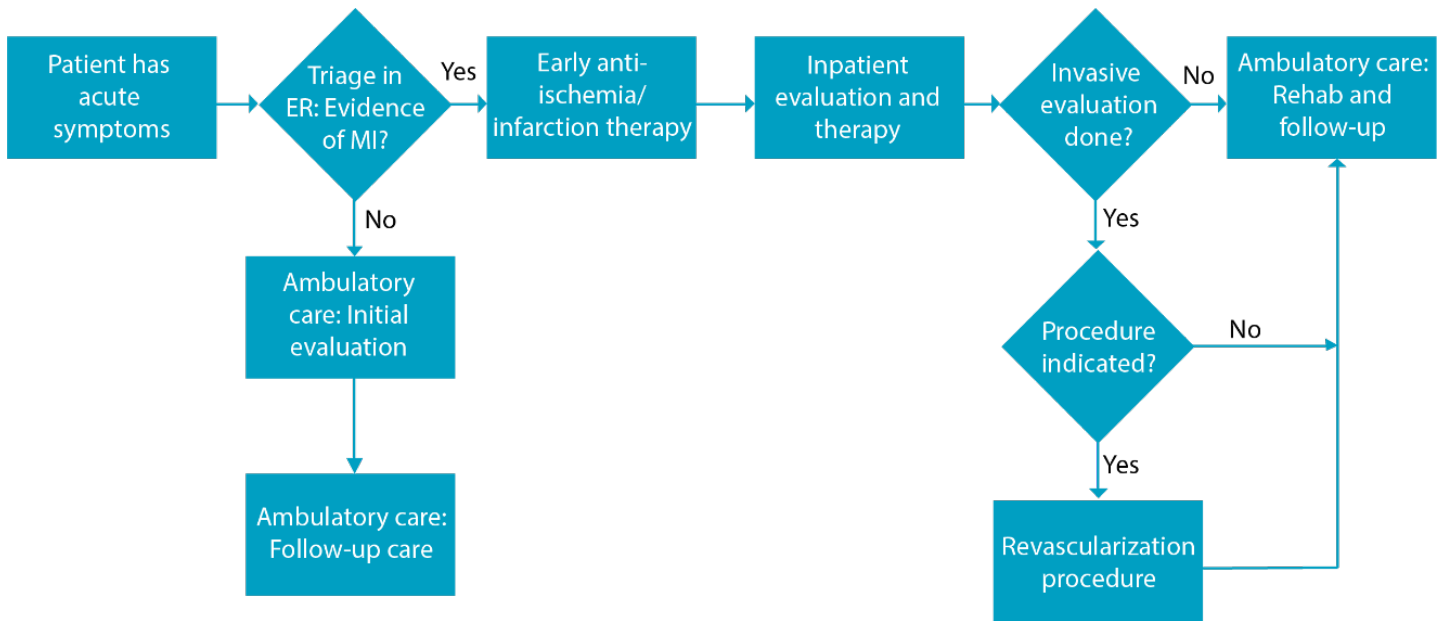


Decision point (yes/no question)



Flow line

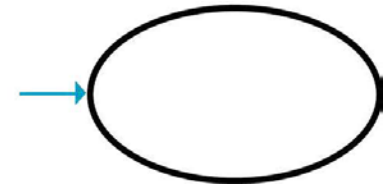
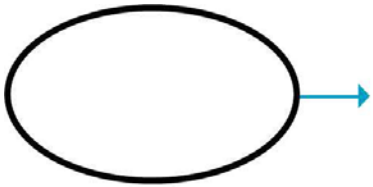
# Example: Flowchart



Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

## Template: Flowchart

Use the symbols on the previous page to map out your system.





## QI Essentials Toolkit:

# Histogram

Often, summary statistics alone do not give a complete and informative picture of the performance of a process. A histogram is a special type of bar chart used to display the variation in continuous data like time, weight, size, or temperature.

A histogram enables a team to recognize and analyze patterns in data that are not apparent simply by looking at a table of data, or by finding the average or median.

***IHI's QI Essentials Toolkit*** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

- Cause and Effect Diagram
- Driver Diagram
- Failure Modes and Effects Analysis (FMEA)
- Flowchart
- **Histogram**
- Pareto Chart
- PDSA Worksheet
- Project Planning Form
- Run Chart & Control Chart
- Scatter Diagram

# Instructions

- 1) Collect continuous data (time, weight, size, or temperature).
- 2) Sort and tally individual values in the data set and determine the high and low values (for example, 1 and 20 days, in the sample histogram on the next page).
- 3) Choose a cell width (for example, 2 days, in the sample histogram) that divides the range into 6 to 12 categories of equal width. Favor narrower cells, or choices that highlight gaps in the data.
- 4) Determine the cell boundaries.
  - Choose a convenient starting point at, or below, the lowest value.
  - Be consistent in handling values that fall on the boundaries (put all boundary values in next higher cell).
- 5) Tally number of observations in each cell.
  - Check total tally.
- 6) Draw and provide clear labels on axes.
  - The vertical axis is frequency; the horizontal axis is the variable being analyzed.
- 7) Draw bars to represent number of data values in cell. Adjacent bars should touch.
- 8) Title the chart, indicate total number of data values, and show any standards and limits.
- 9) Analyze and develop explanations for the pattern.



## Example: Histogram

One team used histogram analysis to understand the patterns of variation in electrocardiogram (EKG) turnaround time. The team gathered data on EKG turnaround time in days, collecting 32 data points (see data table). The average turnaround time was 8.3 days, which revealed relatively little about the performance of the process. To get a better understanding of the data, the team then sorted the data, tallying the number of data points in each of 10 categories: 1-2 days, 3-4 days, and so on. The team then displayed the data in a histogram. The histogram provided the team valuable new information about the distribution of EKG turnaround times: the vast majority of turnaround times fall in the 1- to 2-day range, with a smaller clump in the 7- to 10-day range, and a third clump in the 13- to 20-day range.

### Sample Data Table: EKG Turnaround Time

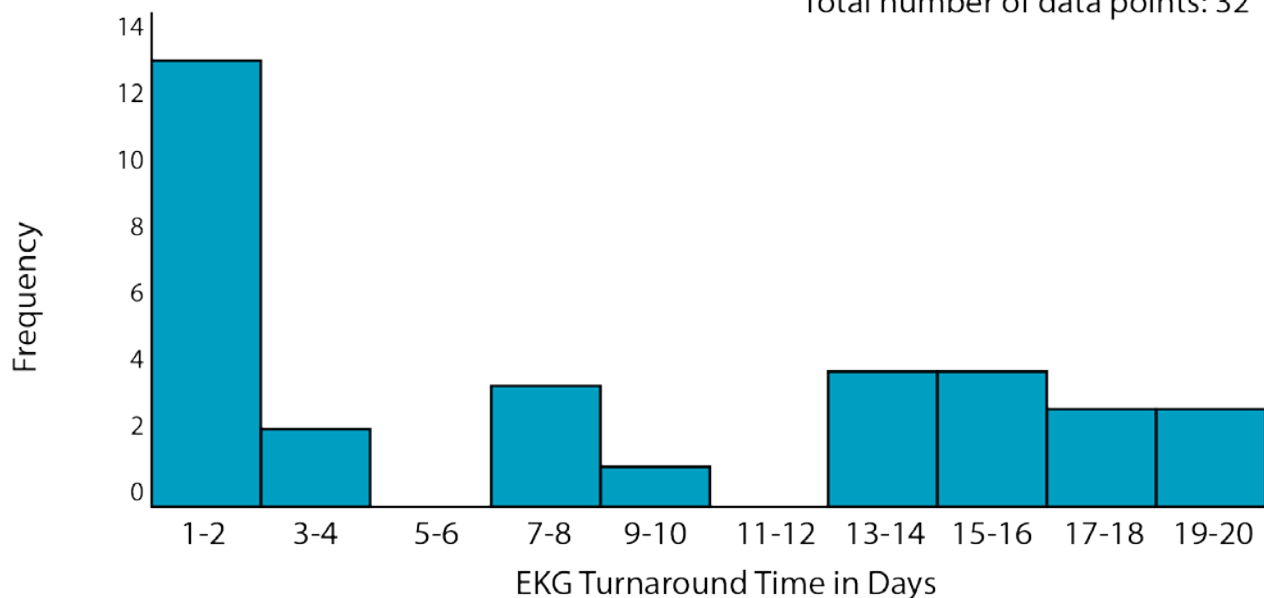
EKG Turnaround Time in Days

9	16	1	4
15	8	13	1
13	16	14	17
7	2	20	2
2	2	18	3
1	1	2	7
1	2	15	2

Average = 8.3 Days

### Sample Histogram: EKG Turnaround Time

Total number of data points: 32



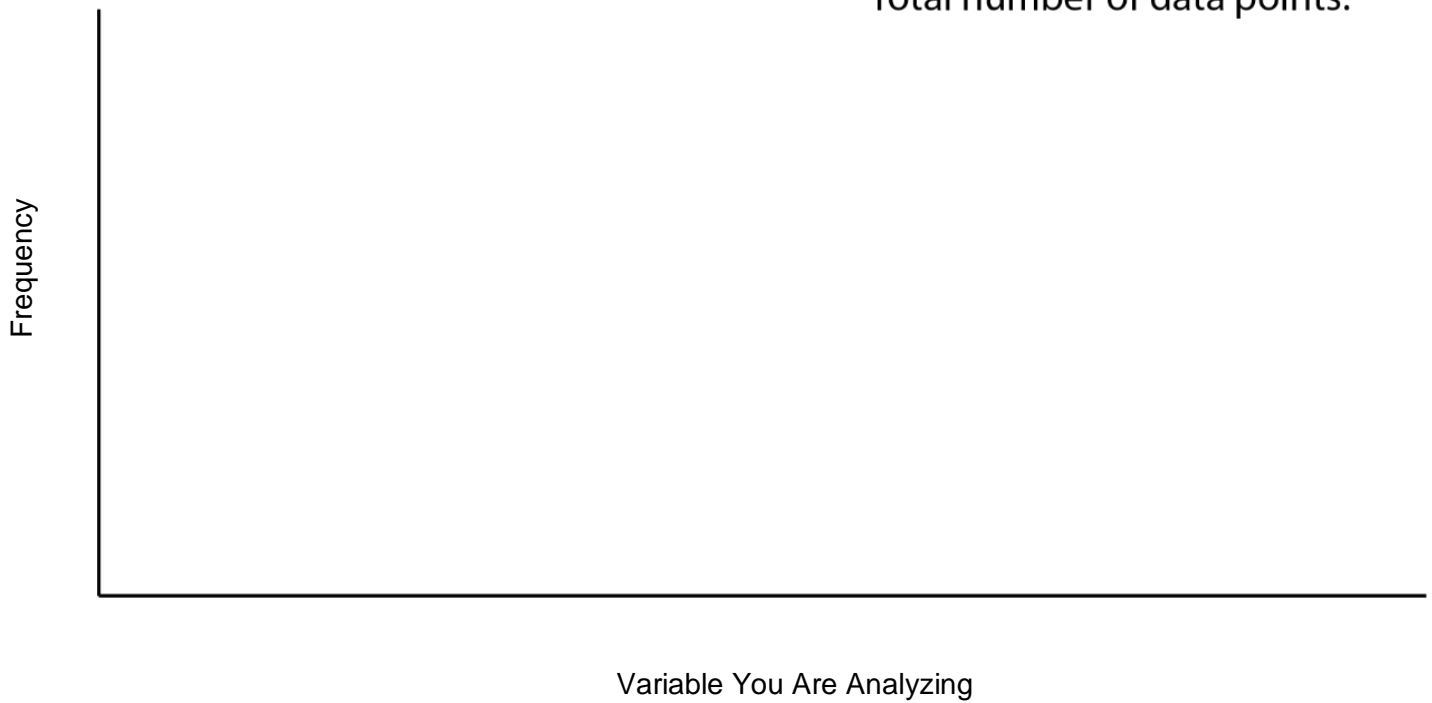
Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

# Template: Data Table & Histogram

## Data Table


## Histogram

Total number of data points:





## QI Essentials Toolkit:

# Pareto Chart

According to the “Pareto principle” — also known as the “80/20 rule” — in any group of factors that contribute to an overall effect, roughly 80% of the effect comes from 20% of the causes.

A Pareto chart is a type of bar chart in which the various factors that contribute to an overall effect are arranged in order from the largest to the smallest contribution to the effect. This ordering helps identify the “vital few” (the factors that have the largest contribution to the effect and therefore warrant the most attention), as distinguished from the “useful many” (factors that, while useful to know about, have a relatively smaller contribution to the effect).

Using a Pareto chart helps teams concentrate their improvement efforts on the factors that have the greatest impact. It also helps teams explain their rationale for focusing on certain areas and not others.

***IHI's QI Essentials Toolkit*** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

- Cause and Effect Diagram
- Driver Diagram
- Failure Modes and Effects Analysis (FMEA)
- Flowchart
- Histogram
- **Pareto Chart**
- PDSA Worksheet
- Project Planning Form
- Run Chart & Control Chart
- Scatter Diagram

# Instructions

## Collecting Your Data

- 1) Write your data in a simple table, listing the contributing factors to a particular effect (for example, types of errors during surgical setup) and the magnitude of each factor (for example, frequency of each type of error).
- 2) Order the factors according to the magnitude of contribution to the effect, from largest to smallest. If there are many insignificant factors, you can group them together into one category labeled “Other.”
- 3) Calculate the percentage of the total that each factor represents. For example, number of times a certain error occurred last year divided by the total number of errors last year, multiplied by 100.
- 4) Working from the largest category to the smallest, calculate the cumulative percentage for each category until you reach 100%.

## Drawing Your Pareto Chart

- 1) Draw and label the left vertical axis (Y) with the unit of comparison (for example, “Number of Errors,” from 0 to the total).
- 2) Draw and label the horizontal axis (X) with the categories (for example, “Type of Error”), largest to smallest from left to right.
- 3) Draw and label the right vertical axis “Cumulative Percentage,” from 0% to 100%, with the 100% value at the same height as the total mark on the left vertical axis.
- 4) Draw a bar chart to depict the magnitude of effect. Using the units on the left vertical axis as a guide, draw a solid bar to represent the magnitude of contribution for each category on the horizontal axis.
- 5) Draw a line graph of the cumulative percentage, beginning in the lower left corner of the graph (the “0” point) and ending at 100% in the upper right.
- 6) Annotate the diagram to indicate the cumulative percentage associated with the “vital few” (for example, circle or draw an arrow to the first three error types that account for 75% to 80% of all errors).

# Example: Data Table and Pareto Chart

## Errors During Surgical Set-up

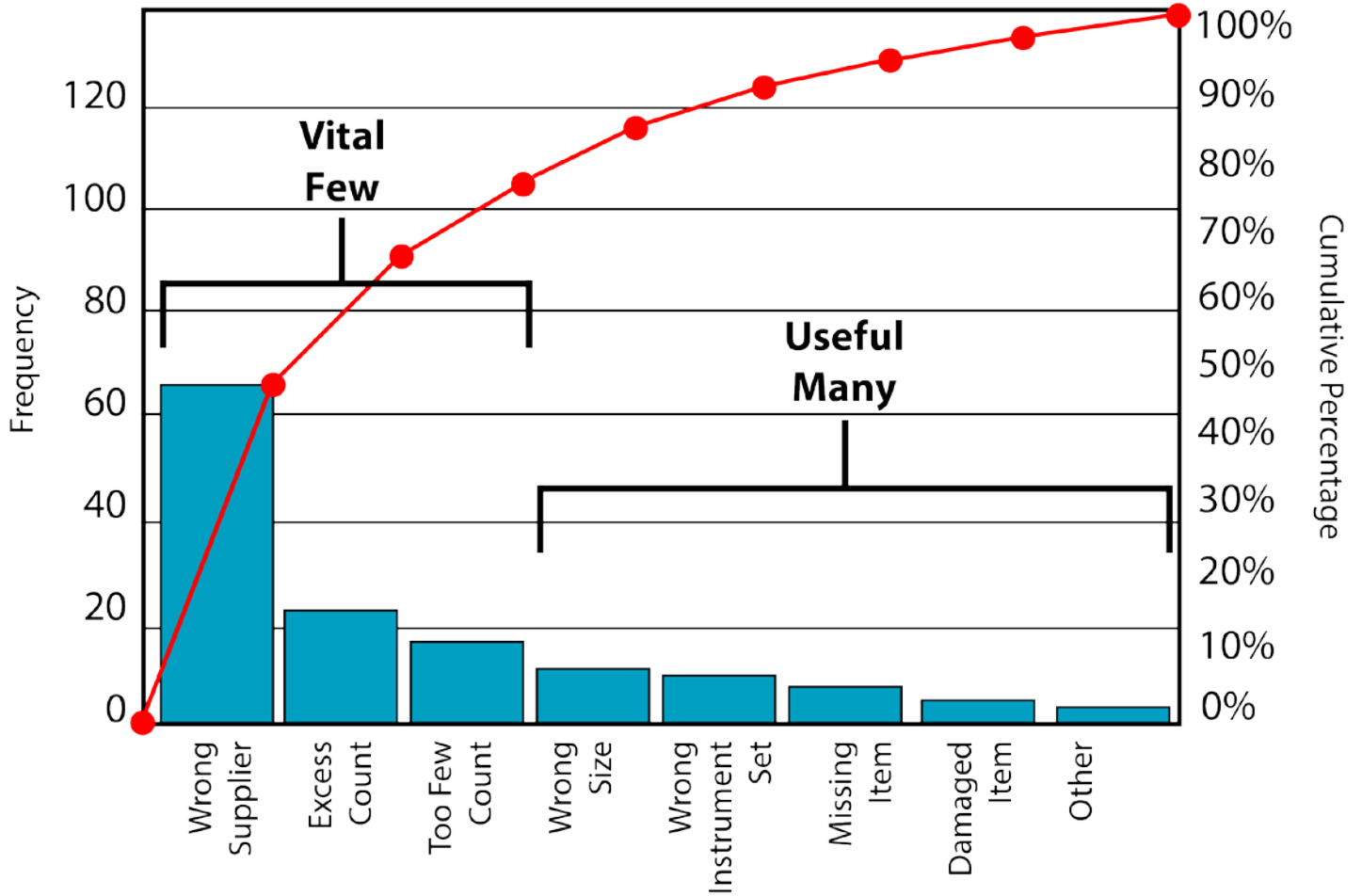
One team used Pareto analysis to identify the “vital few” factors that contributed to errors during surgical setup. The team identified eight **types** of surgical set-up errors, and collected data on the **frequency** of each type (see table). They calculated the **percentage** of the total effect for each error type, then listed error types in order from largest to smallest effect. Finally, they calculated the **cumulative percentage** of effect.

When the team displayed this data in a Pareto chart, they discovered that **three types of errors accounted for 75% of all errors**. Instead of working on all error types, the team decided to focus its efforts on these three “vital few” error types — Wrong Supplier, Excess Count, and Too Few Count — because together they account for roughly 80% of the problem.

### Data Table: Types of Errors Discovered During Surgical Set-up

Error Type	Frequency	Percent	Cumulative %
Wrong Supplier	67	46.5	46.5
Excess Count	24	16.7	63.2
Too Few Count	17	11.8	75
Wrong Size	10	6.9	81.9
Wrong Sterile Instrument Set	10	6.9	88.8
Missing Item	8	5.6	94.4
Damaged Item	6	4.2	98.6
Other	2	1.4	100
<b>TOTAL</b>	<b>144</b>	<b>100</b>	

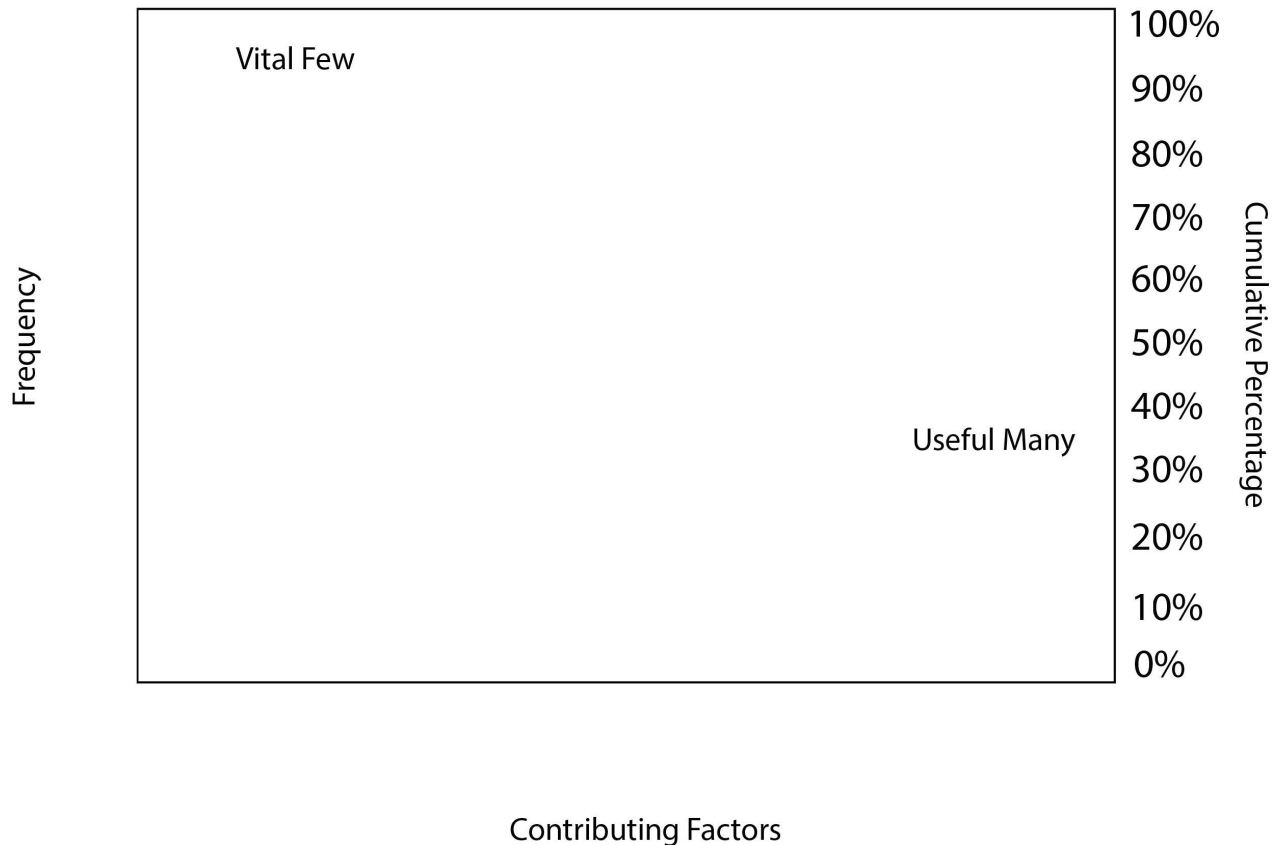
### Pareto Chart: Types of Errors Discovered During Surgical Set-up



Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

## Template: Data Table and Pareto Chart

Contributing Factor	Frequency	Percent	Cumulative %
<b>TOTAL</b>			









## QI Essentials Toolkit:

# PDSA Worksheet

The Plan-Do-Study-Act (PDSA) cycle is a useful tool for documenting a test of change. Running a PDSA cycle is another way of saying testing a change — you develop a plan to test the change (Plan), carry out the test (Do), observe, analyze, and learn from the test (Study), and determine what modifications, if any, to make for the next cycle (Act).

Fill out one PDSA worksheet for each change you test. In most improvement projects, teams will test several different changes, and each change may go through several PDSA cycles as you continue to learn. Keep a file (either electronic or hard copy) of all PDSA cycles for all the changes your team tests.

***IHI's QI Essentials Toolkit*** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

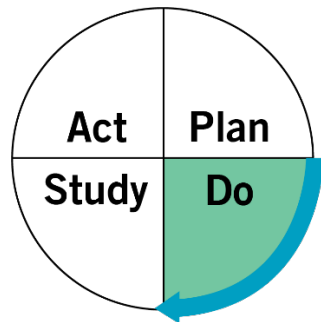
- Cause and Effect Diagram
- Driver Diagram
- Failure Modes and Effects Analysis (FMEA)
- Flowchart
- Histogram
- Pareto Chart
- **PDSA Worksheet**
- Project Planning Form
- Run Chart & Control Chart
- Scatter Diagram

# Instructions



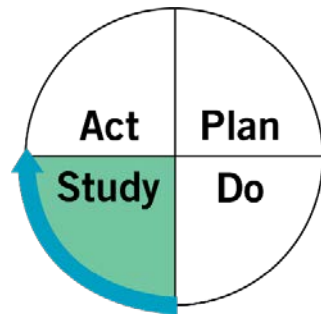
**Plan:** Plan the test, including a plan for collecting data.

- State the question you want to answer and make a prediction about what you think will happen.
- Develop a plan to test the change. (Who? What? When? Where?)
- Identify what data you will need to collect.



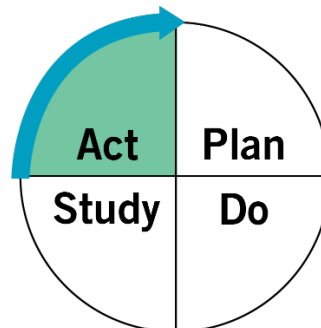
**Do:** Run the test on a small scale.

- Carry out the test.
- Document problems and unexpected observations.
- Collect and begin to analyze the data.



**Study:** Analyze the results and compare them to your predictions.

- Complete, as a team, if possible, your analysis of the data.
- Compare the data to your prediction.
- Summarize and reflect on what you learned.



**Act:** Based on what you learned from the test, make a plan for your next step.

- Adapt (make modifications and run another test), adopt (test the change on a larger scale), or abandon (don't do another test on this change idea).
- Prepare a plan for the next PDSA.

# Example: PDSA Worksheet

**Objective:** Test using Teach-Back (a closed-loop communication model, in which the recipient of information repeats the information back to the speaker) with a small group of patients, in hopes of improving patients' understanding of their care plans.



**1. Plan:** Plan the test, including a plan for collecting data.

## Questions and predictions:

- How much more time will it take to use Teach-Back with patients? It will take more time at first (5 to 10 minutes per patient), but we will start to learn better communication skills and get more efficient.
- Will it be worthwhile? The extra time will feel worthwhile (and possibly prevent future rework).
- What will we do if the act of “teaching back” reveals a patient didn’t understand the care plan? If a patient is not able to explain his or her care plan, we will need to explain it again, perhaps in a different way.

## Who, what, where, when:

On Monday, each resident will test using Teach-Back with the last patient of the day.

## Plan for collecting data:

Each resident will write a brief paragraph about their experience using Teach-Back with the last patient.



**2. Do:** Run the test on a small scale.

## Describe what happened. What data did you collect? What observations did you make?

Three residents attempted Teach-Back at the end of the day on Monday. Two residents did not find anything they needed to ask patients to Teach-Back. Jane found that her patient did not understand the medication schedule for her child. They were able to review it again and, at the end, Jane was confident the mother was going to be able to give the medication as indicated.



**3. Study:** Analyze the results and compare them to your predictions.

**Summarize and reflect on what you learned:**

- Prediction: It will take more time at first (5 to 10 minutes per patient), but we will start to learn better communication skills and get more efficient. *Result: Using Teach-Back took about 5 minutes per patient.*
- Prediction: The extra time will feel worthwhile (and possibly prevent future rework). *Result: Jane felt the time she invested in using Teach-Back significantly improved the care experience.*
- Prediction: If a patient is not able to explain his or her care plan, we will need to explain it again, perhaps in a different way. *Result: After a second review of the medication orders, the patient was able to Teach-Back the instructions successfully.*

In addition to the team confirming all three predictions, Jane realized the medication information sheets she had been handing out to parents weren't as clear as she thought. She realized these should be re-written — maybe with the input of some parents.



**4. Act:** Based on what you learned from the test, make a plan for your next step.

**Determine what modifications you should make — adapt, adopt, or abandon:**

Jane is planning to use Teach-Back any time she prescribes medication. Although it may take more time, she now understands the importance. The other residents are going to work on using Teach-Back specifically for medications for the next week.

They would like to pull together a team to work on some of the medication information sheets with parent input, but they are first going to gather more information through more interactions in the coming days.

Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

# Template: PDSA Worksheet

**Objective:**

---

---

---



**1. Plan:** Plan the test, including a plan for collecting data.

**Questions and predictions:**

- ---

---

---
- ---

---

---

**Who, what, where, when:**

---

---

---

**Plan for collecting data:**

---

---

---



**2. Do:** Run the test on a small scale.

**Describe what happened. What data did you collect? What observations did you make?**

---

---

---



**3. Study:** Analyze the results and compare them to your predictions.

**Summarize and reflect on what you learned:**

---

---

---



**4. Act:** Based on what you learned from the test, make a plan for your next step.

**Determine what modifications you should make — adapt, adopt, or abandon:**

---

---

---



## QI Essentials Toolkit:

# Project Planning Form

The Project Planning Form is a useful tool to help teams think systematically about their improvement project. By tracking a list of the changes that the team is testing — including all of the Plan-Do-Study-Act (PDSA) cycles, the person responsible for different aspects of each test, and the timeframe for each phase of the work — the form allows a team to see at a glance the full picture of a project.

***IHI's QI Essentials Toolkit*** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

- Cause and Effect Diagram
- Driver Diagram
- Failure Modes and Effects Analysis (FMEA)
- Flowchart
- Histogram
- Pareto Chart
- PDSA Worksheet
- **Project Planning Form**
- Run Chart & Control Chart
- Scatter Diagram

# Instructions

- 1) Use the form at the beginning of an improvement project to initiate planning.
- 2) In the top left corner, create a numbered list of the drivers on which the team will focus. “Drivers” are key leverage points in the system that are your opportunities to influence the outcome and achieve your aim.
  - Tip: We recommend using a tool called a driver diagram (one of the tools in the QI Essentials Toolkit) to establish primary and secondary drivers with your team.
- 3) Next to each driver, identify a process measure and goal as follows:
  - Process measure: Define in specific terms how you will measure the driver, to evaluate the results of your tests of change.
  - Goal: State a measureable goal for that driver (i.e., define in specific terms what you want the results to be after your changes).
- 4) Fill out the grid for each driver using the following questions to prompt you:
  - Change Idea: What idea for improvement will you test?
  - Tasks to Prepare for Tests: What tasks will you need to perform to set up and run the test?
  - Person Responsible: Who is responsible for each task you’ve identified?
  - PDSA: What are the details of your test?
  - Timeline: How many weeks do you expect to need for each phase of the improvement cycle (Testing, Implementation, and Spread)? Indicate where each phase will end with the letter T, I, or S.
- 5) As the project continues, update the Project Planning Form regularly with your ongoing tests of change.



# Example: Project Planning Form

**Team:** John, Sally, Mark, Dave, Laura, and Beth      **Project:** Lowering Depression Scores: Achieve a 15-point decrease in PHQ-9 scores for 50% of depressed patients by May 1.

Driver – list the drivers you’ll be working on	Process Measure	Goal
1. Patient education	% of patients in depressed population receiving education materials before leaving office will have documented use of education materials	90% of patients in depressed population will have documented use of educational materials before leaving office
2. Follow-up assessment	% of patients in depressed population that have a follow-up assessment within the first eight weeks of their initial diagnosis	75% of patients in depressed population have a follow-up assessment within the first eight weeks of their initial diagnosis
3.		
4.		
5.		
6.		

Driver Number (from above)	Change Idea	Tasks to Prepare for Tests	PDSA	Person Responsible	Timeline (T = Test; I = Implement; S = Spread)																			
					Week																			
					1	2	3	4	5	6	7	8	9	10	11	12	13	14						
1	Provide pamphlet and link to short video at time of patient discharge	Need to make sure we have enough pamphlets on site; need to ensure link to video works	Nurse will hand materials to patient before leaving the exam room with all patients scoring high on the PHQ-9	Beth and Mark	T	T																		
2	Patients will come back to the office for a follow-up assessment within eight weeks of depression diagnosis	Need to schedule appointments within timeframe and get patients to attend follow-up appointment; need to make sure secretaries are aware of this test	Have secretaries write down the date and time of the follow-up appointment on the back of the clinic’s business card	Laura	T	T																		

Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

# Template: Project Planning Form

<b>Team:</b>	<b>Project:</b>
--------------	-----------------

Driver – list the drivers you'll be working on	Process Measure	Goal
1.		
2.		
3.		
4.		
5.		
6.		

Driver Number (from above)	Change Idea	Tasks to Prepare for Tests	PDSA	Person Responsible	Timeline (T = Test; I = Implement; S = Spread)																	
					Week																	
					1	2	3	4	5	6	7	8	9	10	11	12	13	14				



## QI Essentials Toolkit:

# Run Chart & Control Chart

A **run chart** is a graph of data over time. It is a simple and effective tool to help you determine whether the changes you are making are leading to improvement.

Run charts help improvement teams formulate aims by depicting how well (or poorly) a process is performing, understand the value of a particular change, and begin to distinguish between common and special causes of variation.

Common-cause variation is the natural or expected variation inherent in a process. Special-cause variation arises because of specific circumstances that are not inherent in the process.

A **control chart**, which includes an upper control limit (UCL) and a lower control limit (LCL), goes further to help teams distinguish between common and special causes of variation within a process. Use a control chart when you have more than 15 data points and want more insight into your data.

Control charts help improvement teams identify special-cause variation in a process, identify early signs of success in an improvement project, and monitor a process to ensure it is holding the gains from a quality improvement effort.

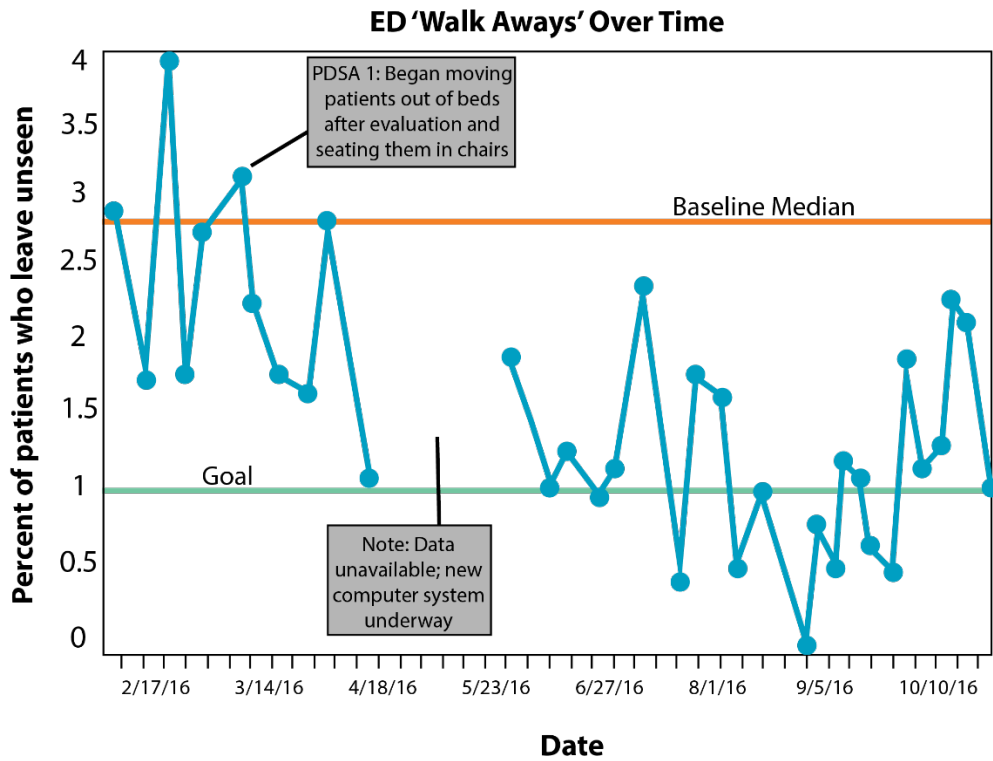
**IHI's QI Essentials Toolkit** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

- Cause and Effect Diagram
- Driver Diagram
- Failure Modes and Effects Analysis (FMEA)
- Flowchart
- Histogram
- Pareto Chart
- PDSA Worksheet
- Project Planning Form
- **Run Chart & Control Chart**
- Scatter Diagram

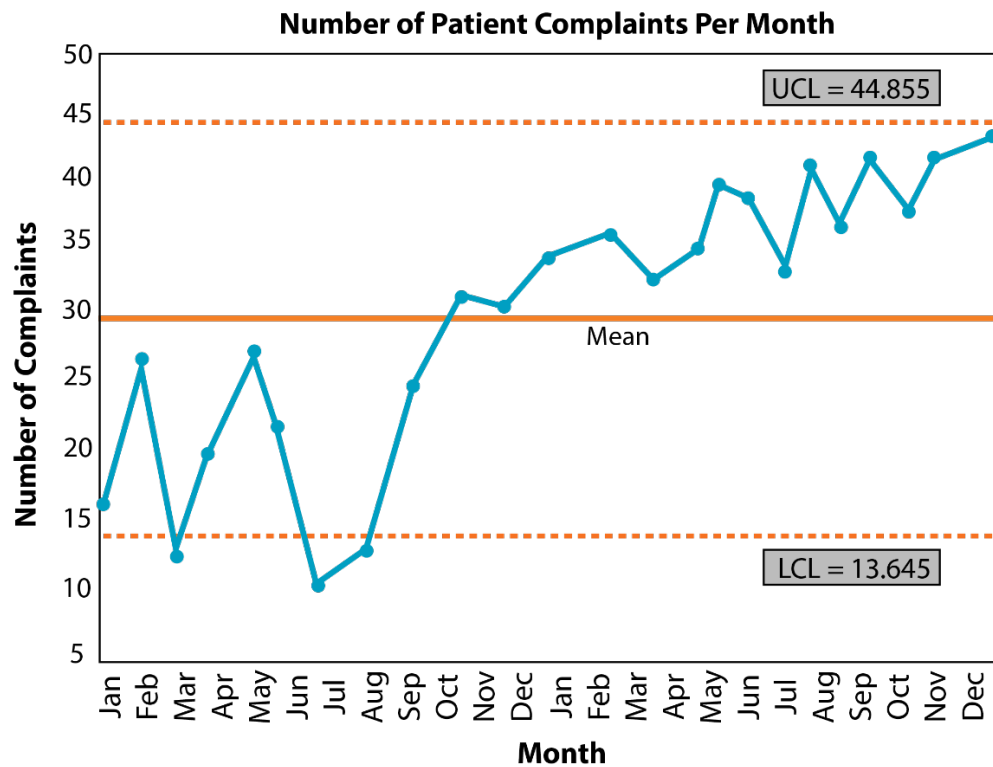
# Instructions

- 1) Obtain a set of data points in their natural time sequence.
- 2) Draw the vertical and horizontal axes, leaving room on all sides to title and label the graph.
- 3) Label the vertical (Y) axis with the name of the value being measured (e.g., Percent of Births by C-section, Number of Days to Third Next Available Appointment, etc.).
- 4) Label the horizontal (X) axis with the unit of time or sequence in which the numbers were collected (e.g., April, May, June, etc., or Quarter 1, Quarter 2, etc.).
- 5) Determine the scale of the vertical axis. The scale should extend from a number 20 percent larger than the largest value to a number 20 percent smaller than the smallest value. Label the axis in equal intervals between these two numbers.
- 6) Plot the data values in the sequence in which they occurred.
- 7) Draw lines to connect the data points on the graph.
- 8) Calculate the median (the data point half way between the highest and the lowest data point) of the plotted numbers and draw the line on the graph.
  - Note: For a control chart, complete these two steps:
    - a) Instead of calculating the median, calculate the mean or control limit (the average) of the plotted numbers and draw the line on the graph.
    - b) Calculate and then draw upper and lower control limits that correspond to  $\pm 3$  sigma limits from the mean. (We recommend doing this in Microsoft Excel or another software program.)
- 9) Title the chart, and note the goal line and the sample size.
- 10) Annotate the chart, indicating when tests of change were initiated, so that it is easy to see the effect of changes on the measure. Also indicate any external events that may have affected the performance of the process.

## Example: Run Chart

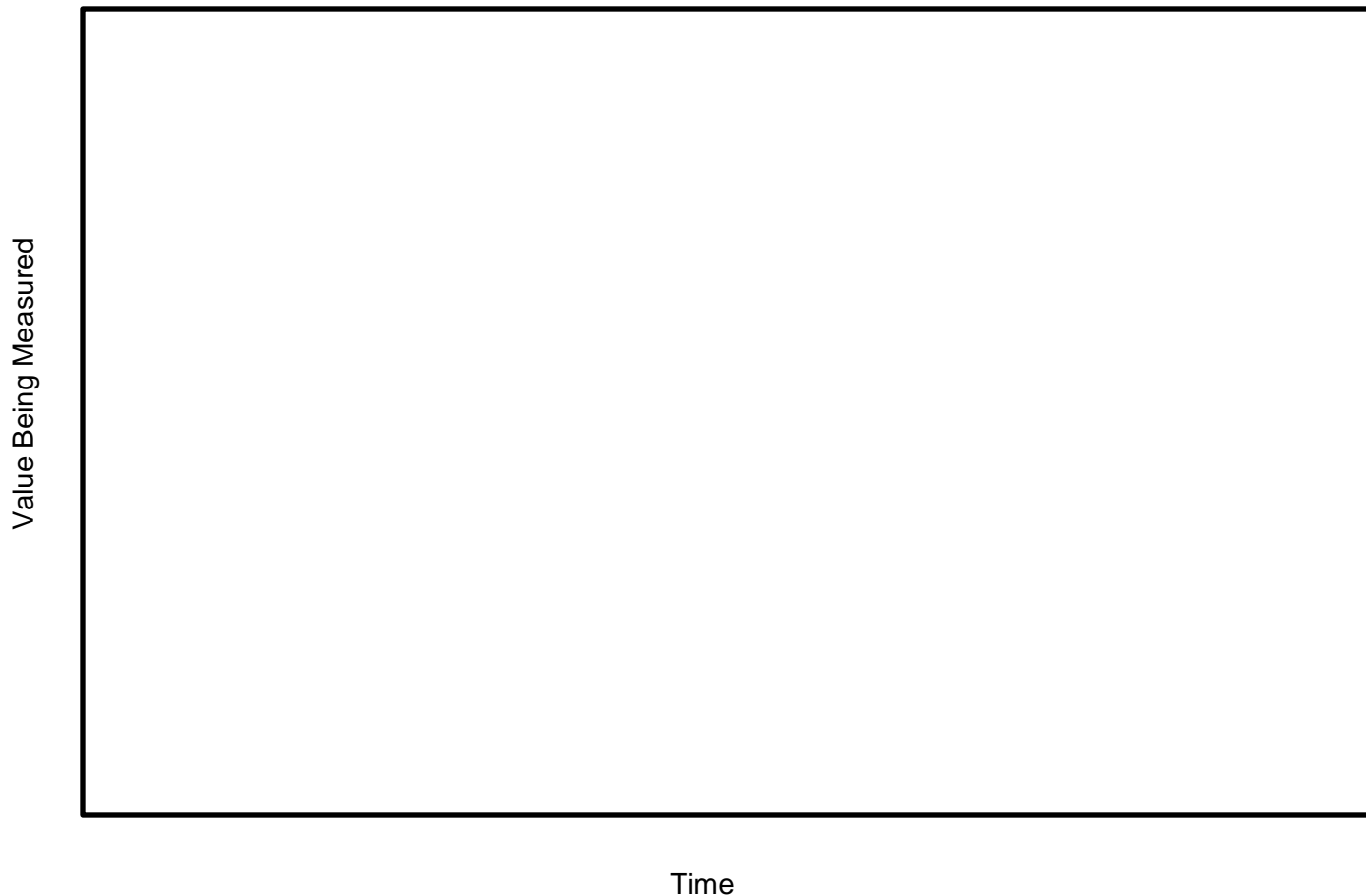


## Example: Control Chart



Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

## Template: Run Chart or Control Chart





## QI Essentials Toolkit:

# Scatter Diagram

A scatter diagram — also known as a “scatter plot” — is a graphic representation of the relationship between two variables. Teams use scatter diagrams to help them identify cause-and-effect relationships between two variables. For example, after brainstorming multiple causes and effects using a fishbone (cause and effect) diagram, your team might use a scatter diagram to determine whether a particular cause and effect are related.

A scatter diagram graphs one variable on the X-axis and the other variable on the Y-axis. If the two variables are related, the data points will fall along a diagonal line or curve — that is, values for variable X will be associated with values for variable Y. This could show either a positive correlation (values for both variables increase or decrease) or a negative correlation (values for one variable increase while those for the other decrease).

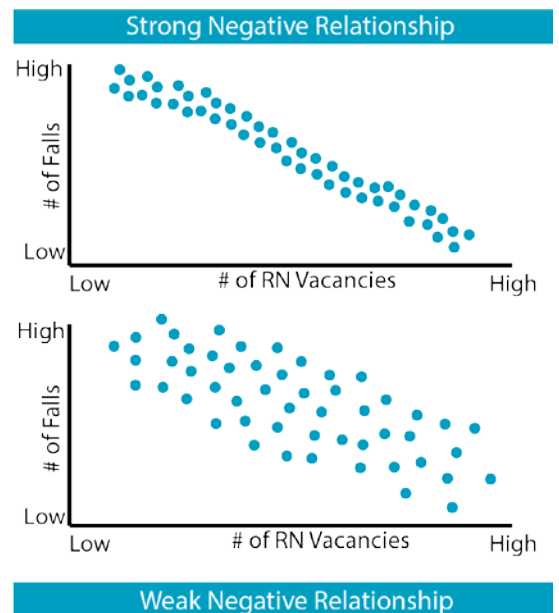
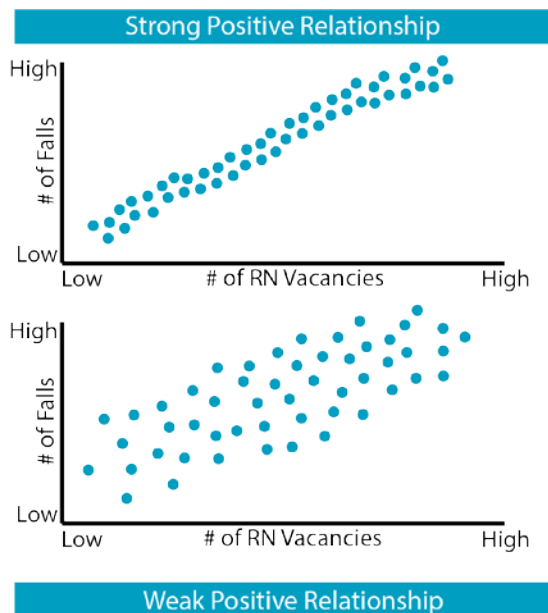
Note: A scatter diagram shows a correlation between two variables; it does not prove causation.

***IHI's QI Essentials Toolkit*** includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

- Cause and Effect Diagram
- Driver Diagram
- Failure Modes and Effects Analysis (FMEA)
- Flowchart
- Histogram
- Pareto Chart
- PDSA Worksheet
- Project Planning Form
- Run Chart & Control Chart
- **Scatter Diagram**

# Instructions

- 1) Gather the data for your two variables. On the data collection sheet, put each data pair in their respective columns. Ensure the data remain paired.
- 2) Decide which factor you will plot on which axis. Put the suspected cause on the horizontal (X) axis, and the suspected effect on the vertical (Y) axis.
- 3) Draw and label the axes clearly.
  - Make the axes roughly the same length, creating a square plotting area.
  - Label each axis with increasing values from left to right, and from bottom to top.
  - Label each axis to match the full range of values for that factor. In other words, make the lowest numerical label slightly less than the lowest data value, and the highest label slightly greater than the highest value. The data should fill the whole plotting area.
- 4) Plot the X and Y data pairs on the diagram; place a point on the graph where the two values intersect.
- 5) Include a title at the top of the diagram and provide necessary annotations to describe what it shows.
- 6) Study the pattern that the plotted data points create to identify what you have learned and decide on your next steps. If there is an association between the two variables, the pattern will resemble an elliptical shape or a straight line.
  - If the points for both values are increasing (line slants from lower left to upper right): The correlation is positive.
  - If one variable increases while the other decreases (line slants from upper left to lower right): The correlation is negative.
  - If the points form a circular shape: There is little or no correlation.



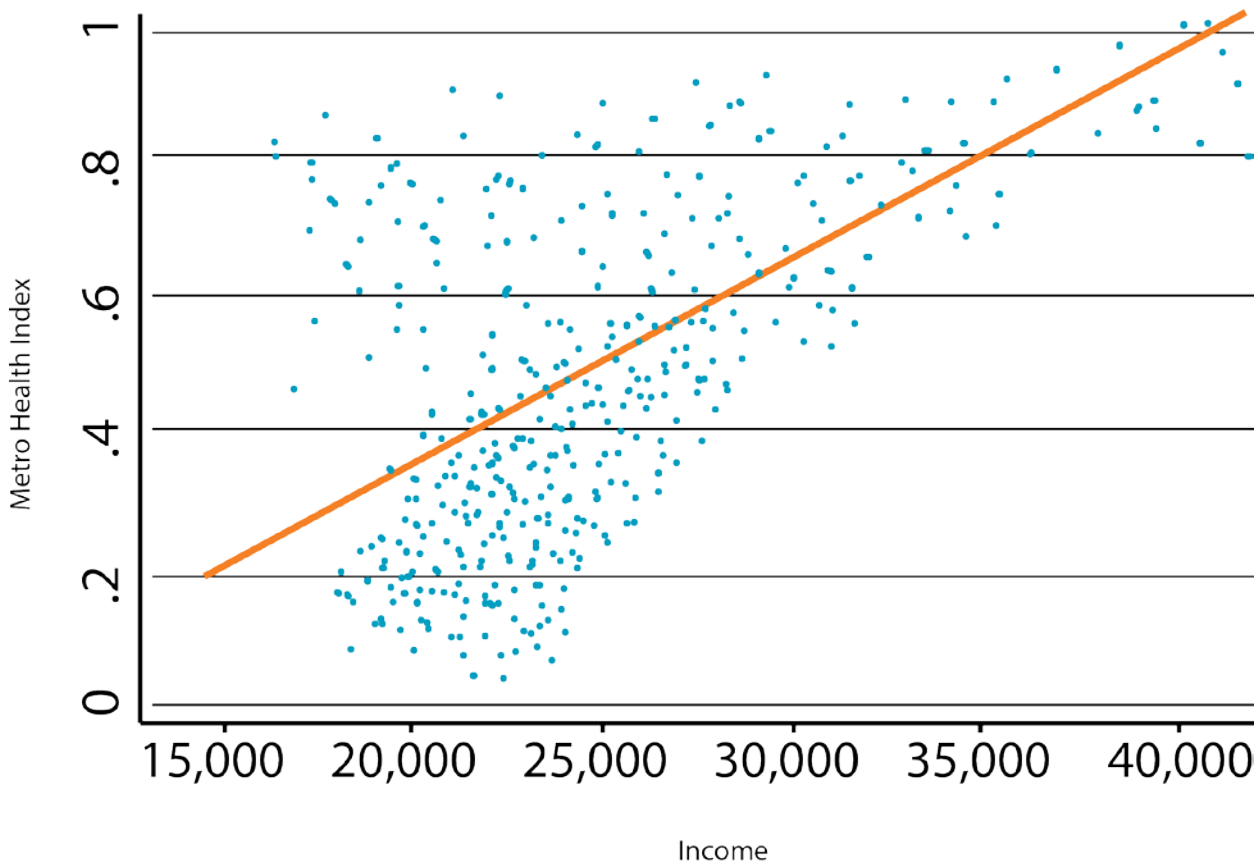


## Example: Scatter Diagram

This example scatter diagram shows the relationship between median income (X-axis) and Metro Health Index, a measure of people who smoke or are obese (Y-axis). The researcher wanted to see if there was correlation between income and health outcomes.

Indeed, the scatter diagram indicates that cities with a lower median income tend to have a lower Metro Health Index (indicating much higher levels of smoking and obesity). As the income level increases, so does the Metro Health Index. The scatter diagram shows a strong **positive correlation** between income and Metro Health Index.

**Correlation Between Median Income (in US \$) and Metro Health Index**



Source: Florida R. "Why Some Cities Are Healthier Than Others." *The Atlantic CityLab*. January 5, 2012.  
<http://www.citylab.com/design/2012/01/why-some-cities-are-healthier-others/365/>

Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

## Template: Data Collection Sheet

Variable 1	Variable 2

## Template: Scatter Diagram

