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Tips and Tools for Learning Improvement

MAY 2017

The ***TIPS AND TOOLS FOR LEARNING IMPROVEMENT*** series was authored by Kim Ethier Stover, Silvia Holschneider, and Simon Hiltebeitel of University Research Co., LLC (URC) and produced by the United States Agency for International Development (USAID) Applying Science to Strengthen and Improve Systems (ASSIST) Project, funded by the American people through USAID's Bureau for Global Health, Office of Health Systems. The project is managed by URC under the terms of Cooperative Agreement Number AID-OAA-A-12-00101. For more information on the work of the USAID ASSIST Project, please visit www.usaidassist.org or write assist-info@urc-chs.com.

The *Tips and Tools for Learning Improvement* is a set of competency-based materials developed by the USAID ASSIST Project to support targeted skill-building in key improvement competencies among health care providers, health care managers, Ministry of Health counterparts, and public health professionals who are new to improvement.

The materials can be used by an individual interested in improvement or can be used by improvement professionals as teaching tools during trainings or coaching visits to target and develop a specific skill. They are designed to complement improvement online courses and in-person trainings.

Each handout in the series is a self-contained, self-directed lesson with numerous competency-based exercises, so that learners can practice the basic steps of improvement. An answer key is provided for each section, with additional information and commentary where appropriate.

The topics in this series include:

- **Aims for Improvement** – Learn to identify a good improvement aim and practice developing an aim.
- **Improvement Teams** – Learn to choose members of an improvement team and practice creating a team.
- **Flowcharts** – Learn to use flowchart symbols and create and analyze a flowchart.
- **Developing Changes** – Learn to develop and changes that address the root problems identified by improvement teams during the process of improving health care.
- **Plan-Do-Study-Act (PDSA)** – Learn to conduct a PDSA cycle and practice each part of the cycle.
- **Measurement for Improvement** – Learn to develop and define measures for improvement.
- **Measurement - Time Series Chart** – Learn to create and plot data on a time series chart.
- **Measurement - Variation vs. Improvement** – Learn to calculate the median and analyze a time series chart.

Each handout and answer key was drafted in consultation with an instructional design consultant and then reviewed by other improvement experts. The materials were then tested by both ASSIST headquarters and field staff who were relatively new to improvement.

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The *Tips and Tools for Learning Improvement* handouts and answer keys are available on the ASSIST website: https://www.usaidassist.org/resources/tips-and-tools-improvement-series

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Aim Statements

What is an aim statement?

To do improvement, you need to set aims. Without a clear aim statement, your organization will have a difficult time coming to consensus about what needs to be done to improve, allocating people and resources needed to accomplish the aim, and measuring whether improvement has occurred.

A good aim statement answers the following questions:

- What outcome or process needs to be improved? *Must be able to measure.*
- For whom will it improve? *Specify the population.*
- How much will it improve? *Set a target.*
- When will it improve? *Determine a timeframe.*
- What tool, method, resource or system will we use to make the change?

How to develop an improvement aim

Start to develop an improvement aim by thinking about what you are wanting to accomplish. Aims often talk about improvement in terms of an increase or decrease in a certain area. For example:

- Reduce the number of maternal deaths in my health care facility.
- Increase the number of children vaccinated in my health care facility.

Then, work on creating an aim statement that is as specific as possible and can be measured. The main questions that the aim statement should address include:

- **What?** – What is the outcome or process you are trying to change? This may be an increase or a decrease in a particular clinical or organizational factor. Examples include "to increase the percent of women receiving oxytocin within 3 minutes of delivery," "to increase the number of children under 5 years with up to date vaccines in my health care facility."
- **For whom?** – What is the target population or group for whom we are trying to improve care? This can encompass the population served by a facility or a geographic location and/or a target population. For example, an answer to "for whom" might be "All pregnant women in Rural Health Center A" or "Children under the age of 5 in the catchment of Hospital Z."
- **How much?** – Provide clear measurable targets for the amount of improvement you expect to see (e.g., percentage increase)
- **By when?** – Provide a clearly defined timeframe for how much improvement you expect to see and by when. Setting a timeframe helps motivate the teams to keep up momentum for the improvement. The timeframe should be realistic, but not allow a team to put off making improvements. Based on the topic, your timeframe might be "by next week" or "within 6 months."
- **Guidance** on how the aim will be achieved should be provided, when known. For example, what tool, method or resource will be used to make the change (e.g., implementation of existing norms according to guidelines, etc.)? Providing this information is helpful, but may not be available for every area you are trying to improve. It is not one of the essential components of an aim statement, but a helpful one.

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Examples of strong aim statements

Below are examples of strong and not strong aim statements

Not strong aim statement	Strong aim statement
We will have more pregnant women attend antenatal care.	Health Center X will improve the percentage of women attending ANC during their 1st trimester from 25% to 80% in the next 12 months.
We will increase HIV-positive patients screened for TB.	We will improve the percentage of HIV-positive patients who are screened for TB from 20% to 60% in 10 health care facilities in 3 provinces in the next 12 months.

Exercise 1: Recognizing a strong aim statement

For each topic area, check the box next to the strongest aim statement.

Topic area	Aim statement 1	Aim statement 2	Aim statement 3
Maternal Health	☐ Our clinic will improve the number of women coming in for antenatal care visits before the end of this year.	☐ Within 8 months, our clinic will increase the percent of women coming in for 4 antenatal care clinics to 90%	☐ Our clinic will improve the percent of women coming in for 4 antenatal care visits within 8 months.
Child Health	☐ In our clinic, we will increase the percent of children diagnosed with malaria and receiving treatment to 100% within 6 months.	☐ In our clinic, 100% of children diagnosed with malaria will receive treatment in a timely manner before October.	☐ In our clinic, health care providers will give malaria treatment to all children every time they come in for a check-up between now and October.
Family Planning	☐ We will increase the number of women and partners who receive family planning counseling after delivery to 100 per month within 6 months.	☐ In our clinic, we will decrease the unmet need for family planning among post-partum women by having providers counsel all post-partum women in family planning.	☐ In our clinic, we will increase the percent of women and partners receiving post-partum counseling on family planning before discharge to 75% with 10 months.

Exercise 2: Identifying missing elements

For the following aim statements, identify which criteria for a good aim is missing:

Remember, a strong aim statement clearly spells out:

- **What?** The outcome you are trying to change
- **For whom?** The target group for whom you are improving care
- **How much?** How much improvement you expect to see
- **By when?** A time frame by when you expect to see the improvement

Statement	What is missing?
Increase the percentage of women who received post-partum family planning counseling at the health center before their discharge from maternity by September 2016.	☐ Outcome ☐ Target group ☐ How much ☐ By when
Increase from 50% to 80% screening for anemia according to the antenatal care standards by September 2016.	☐ Outcome ☐ Target group ☐ How much ☐ By when
Increase by 20% the proportion of pregnant women with severe pre-eclampsia or eclampsia receiving the 1st dose of $MgSO_4$ before transfer to reduce the mortality associated with eclampsia.	☐ Outcome ☐ Target group ☐ How much ☐ By when
Improve by 50% health of children under five by September 2016.	☐ Outcome ☐ Target group ☐ How much ☐ By when

Exercise 3: Developing an aim statement

Case scenario

The head of Rural Health Center 3, Dr. Samson, was informed by his district manager that the health center needed to address poor nutritional status of HIV-positive clients attending the ART clinic. Dr. Samson was aware that his clinic had a number of challenges to overcome: an already overstretched care team, members of the team who did not appreciate the importance of good nutrition in HIV care, and high patient load. The improvement team put together by Dr. Samson decided that the first process they should improve is to assess and categorize the nutritional status of all HIV clients using middle-upper arm circumference (MUAC) measurement. This would enable providers to identify malnourished clients and be able to treat and support them, which would lead to their improved nutritional status. They hoped to achieve full coverage of all HIV clients within 6 months.

Develop an aim statement for Dr. Samson's project by answering the questions below:

Instructions

Fill in the blanks below and then use the resulting information to form an aim statement.

Where will your change be implemented: (A) _____

(A location such as a town, clinic, or office)

What process are we trying to change: (B) _____

(Should be a tangible result, such as a decrease or increase in something that matters in health care)

By what amount are we trying to change it: (C) _____

(Should be a percentage or some other numerical value)

When do you expect to see this this result happen: (D) _____

(An amount of time or by a certain date)

What will you do/use to achieve this result: (E) _____

(What intervention, method, tool, or resource will you employ to make the change?)

Complete the aim statement for Dr. Samson's improvement project:

In (A) _____ we will (B) _____

by (C) _____ within/by (D) _____

through (E) _____ .

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Answer Key | Aim Statements

Exercise 1: Recognizing a strong aim statement

Topic area	Aim statement 1	Aim statement 2	Aim statement 3
Maternal Health	☐ Our clinic will improve the number of women coming in for antenatal care visits before the end of this year.	☑ Within 8 months, our clinic will increase the percent of women coming in for 4 antenatal care clinics to 90%	☐ Our clinic will improve the percent of women coming in for 4 antenatal care visits within 8 months.
Child Health	☑ In our clinic, we will increase the percent of children diagnosed with malaria and receiving treatment to 100% within 6 months.	☐ In our clinic, 100% of children diagnosed with malaria will receive treatment in a timely manner before October.	☐ In our clinic, health care providers will give malaria treatment to all children every time they come in for a check-up between now and October.
Family Planning	☐ We will increase the number of women and partners who receive family planning counseling after delivery to 100 per month within 6 months.	☐ In our clinic, we will decrease the unmet need for family planning among post-partum women by having providers counsel all post-partum women in family planning.	☑ In our clinic, we will increase the percent of women and partners receiving post-partum counseling on family planning before discharge to 75% with 10 months.

Exercise 2: Identifying missing elements

Statement	What is missing?
Increase the percentage of women who received post-partum family planning counseling at the health center before their discharge from maternity by September 2016.	☐ Outcome ☐ Target group ☑ How much ☐ By when
Increase from 50% to 80% screening for anemia according to the antenatal care standards by September 2016.	☐ Outcome ☑ Target group ☐ How much ☐ By when
Increase by 20% the proportion of pregnant women with severe PE or eclampsia receiving the 1st dose of $MgSO_4$ before transfer to reduce the mortality associated with eclampsia.	☐ Outcome ☐ Target group ☐ How much ☑ By when
Improve by 50% health of children under five by Sept. 2016.	☑ Outcome ☐ Target group ☐ How much ☐ By when

Exercise 3: Developing an aim statement

Where will your change be implemented: (A) Rural Health Center 3

What process are we trying to change: (B) all clients assessed and categorized for nutritional status

By what amount are we trying to change it: (C) 100%

When do you expect to see this this result happen: (D) in 6 months

What will you do/use to achieve this result: (E) using MUAC measurement

In (A) Rural Health Center 3 we will (B) increase the percent of HIV patients assessed and categorized for nutritional status

by (C) 100% within/by (D) 6 months

through (E) MUAC measurement .

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Improvement Teams

Why are teams important for health care improvement?

There are many different types of people and steps involved in providing health care. For example, key players in health care processes can range from the patient, the receptionist, the nurse, the doctor, the pharmacist, and people in the community (**Figure 1**). Given the opportunity, these people can best identify problems in health care processes and come up with ideas to resolve them.

Improvement teams consist of representatives of every part of a health care process being improved. This representation ensures that each team member understands and buys into the improvement effort.

For example, if a facility wanted to improve nutrition counseling for HIV patients, they would look at the process of care and identify the person responsible for each step. In this case, the team may consist of a patient, receptionist, expert patient, nurse, clinician, pharmacist and community members.

How to form and run an improvement team

Selecting team members:

- **Team members should be chosen by leadership to represent each step in the process.** If there are multiple people who complete one step, such as several nurses, they should be represented by one or two people on the team. Health care teams often benefit from including both patient and community representatives. There may be some influential people who need to be on the team to give it credibility, such as village elders in a community setting or a representative of management in a hospital setting.
- **A team is usually composed of 7 to 12 members.** A team too small may not have adequate representation of the health care process to be improved. A team too large may have trouble focusing, listening to all voices, and making progress.

Figure 1: Teamwork
Steps and participants in a patient visit to the clinic

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The team as a whole has the following responsibilities:

- Review the current performance in relation to the aim
- Conducting problem analysis
- Developing and testing ideas to change their current processes
- Collecting and analyzing data to see if their changes are leading to improvement
- Making changes based on the information collected
- Keeping their leaders and co-workers informed of the improvement activities.

Specific roles on the team can differ depending on whether the team is a facility-level or community-level team. All teams should select a team leader, who does not have to be the most senior member of the team. Other roles that can be useful include secretary, note-taker, data point person to collect and plot data, and timekeeper, for example.

Teams should meet regularly, at minimum once a month. Teams should have more frequent, short, ad hoc meetings to review the results, including data, of rapid improvement cycles (see the ***Tips and Tools for Learning Improvement*** "Plan-Do-Study-Act" handout) and decide next steps. Longer meetings should be held once or twice a month to do analysis of new areas, develop changes or discuss and resolve challenges.

Exercise 1: Understanding an improvement team

Please answer the following questions:

1. The role of improvement teams is to _____ *(check all that apply)*

   ____ A. Review performance ____ C. Test changes ____ E. All of the above

   ____ B. Develop changes ____ D. Collect and analyze data

2. The numbers of people on an improvement team should be *(choose one)*

   ____ A. 15-20 ____ B. 4-6 ____ C. 7-12 ____ D. As many people as possible

3. Improvement teams should never include patients *(true or false)*

   ____ A. True

   ____ B. False

4. An improvement team should meet

   ____ A. Ad hoc – whenever the team feels it is necessary ____ B. Monthly ____ C. Twice a year ____ D. Once a year

Exercise 2: Determining appropriate team members

Imagine you are a consultant to provide advice to different health centers on forming improvement team. Each health center has already developed their improvement aims. For each aim, circle the person who is least appropriate to participate in that health center's improvement team for that specific aim. (Note that for a different aim, those people may be appropriate.)

1. **Health Center A:** Aim: In our clinic, we want to increase the percent of women receiving oxytocin (drug to prevent postpartum hemorrhage) within one minute after delivery to 95% within 9 months.
   A. Midwife
   B. Mother or women's group representative
   C. Nurse
   D. Pharmacist
   E. Nursing assistant
   F. Pharmacy assistant
   G. Community health worker

2. **Health Center B:** Aim: In our clinic, we will increase the percentage of TB patients completing treatment to 90% within 10 months.
   A. Directly observed therapy (DOTS) supporter
   B. TB patient or representative of support group
   C. Midwife
   D. Pharmacist
   E. Clinical officer or clinician
   F. TB Nurse
   G. Community representative

3. **Health Center C:** One district has central (referral) laboratory where all CD4 laboratory tests are done. In our district, we will reduce turnaround time (tests returned to the facility) for CD4 tests from 1 week to 2 days within 4 weeks.
   A. Facility laboratory technician
   B. Central laboratory assistant/secretary
   C. Central laboratory technician
   D. Central laboratory procurement and stores manager (responsible for reagents)
   E. Driver
   F. HIV patient
   G. District laboratory advisor

Exercise 3: Creating an improvement team

Case study

A Ministry of Health wants to improve uptake of post-partum family planning in their hospitals. One district hospital has taken up this aim: In District Hospital 2, we will increase the percentage of women leaving the facility with the post-partum family planning method of their choice from 11% to 60% within 7 months. The hospital realizes that it will need support from the community in addition to the work of the hospital staff.

Brainstorm and list 7 possible types of people who should be invited to be part of the improvement team:

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

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Answer Key | Improvement Teams

Exercise 1: Understanding an improvement team

1. E. All of the above
2. C. 7-12
3. B. False
4. B. Monthly

Exercise 2: Determining appropriate team members

1. **Health Center A:** Aim: In our clinic, we want to increase the percent of women receiving oxytocin (drug to prevent postpartum hemorrhage) within one minute after delivery to 95% within 9 months.

   G. **Community health worker – not included;** in this case, the CHW is unlikely to be present at and/or playing a role in the provision of AMTSL. However, in cases where the CHW is key to getting women into the facility, they may play an important role.

2. **Health Center B:** Aim: In our clinic, we will increase the percentage of TB patients completing treatment to 90% within 10 months.

   C. **Midwife – not included;** unlikely that a midwife will have a direct role in this process.

3. **Health Center C:** One district has central (referral) laboratory where all CD4 laboratory tests are done. In our district, we will reduce turnaround time (tests returned to the facility) for CD4 tests from 1 week to 2 days within 4 weeks.

   F. **HIV patient – not included;** in this case, this is a process between health facilities. While it affects patients in that they would like their results sooner, they are not directly involved this process.

Exercise 3: Creating an improvement team

There is not one correct list of 7 people. However, there is a pool of people that should be considered for a team of this nature. Uptake of family planning is often influenced by what happens in the community as much as by what counseling takes place in the facility. Therefore, a team looking to influence this may want to consider a mix of facility and community staff. A list of 7 people may be pulled from the following types of people:

Clinician
Nurse
Nursing assistant
Midwife
Representatives of pregnant/ post-partum women
Representatives of fathers
Pharmacist or pharmacy assistant
Supply manager
Representatives of women's groups in the community
Community health worker
Representatives of men's groups
Family planning counselor (possibly volunteer)
Community leader (formal or informal)

Note: This list is not exhaustive. You may have included someone who is key to this process in your facility and community not on this list.

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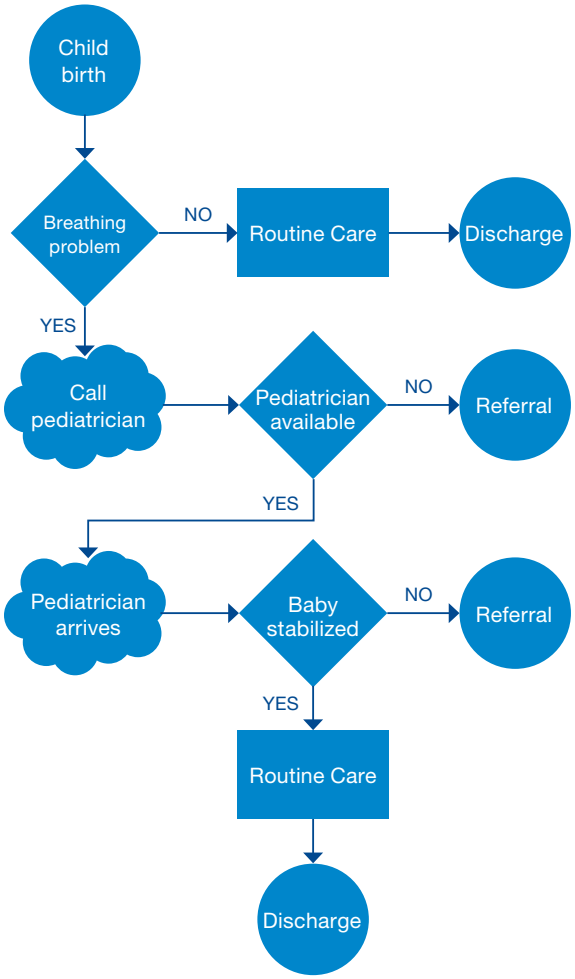
Flowcharts

Figure 1. Example of a flowchart



Part 1. What is a flowchart?

A flowchart is a diagram that uses shapes to represent the sequence of steps or activities in a work process (see **Figure 1**).

There are several different types of processes in healthcare that can be explained through flowcharting. They include the processes by which:

1. Clinical decisions are made
2. Information is transmitted between different people
3. Materials (drugs, supplies, food) are passed through the organization
4. Patients move through the medical facility as they receive care

Most processes are actually multiple flow processes whereby patients, materials, information, and others are involved simultaneously in the same process of care.

Why are flowcharts important for improvement?

Flowcharts are a powerful quality improvement tool as they help improvement teams to:

- Understand the sequence of activities and processes that make up a task
- Look at relationships between activities and decisions
- Identify opportunities to fix bottlenecks, add missing steps, clarify unclear steps or responsibility and eliminate unnecessary work

For example, In **Figure 1**, we see a flowchart from a team in India. Staff in a district hospital were worried about the high number of babies who died or needed to be referred due to

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asphyxia. They wanted to provide better care to these babies. To decide how to go about this they used a flow chart to identify where things were going wrong.

The process of drawing the flowchart allowed the team to understand that there were unclear steps, marked by clouds on the flowchart, that needed to be addressed in order to provide better care. They were able to understand that most referrals happened when the pediatrician was not available and that there were significant delays in stabilizing the baby while they waited for the pediatrician to be called and to come to the bedside. The team was then able to develop changes to address these problems.

Figure 2 shows the basic symbols used in creating a flow-chart for improvement.

Figure 3 shows how to use question symbols with 'yes' and 'no' arrows.

Figure 2. Basic symbols for improvement flowcharts

Start and end points in the process (e.g., make a cup of tea)

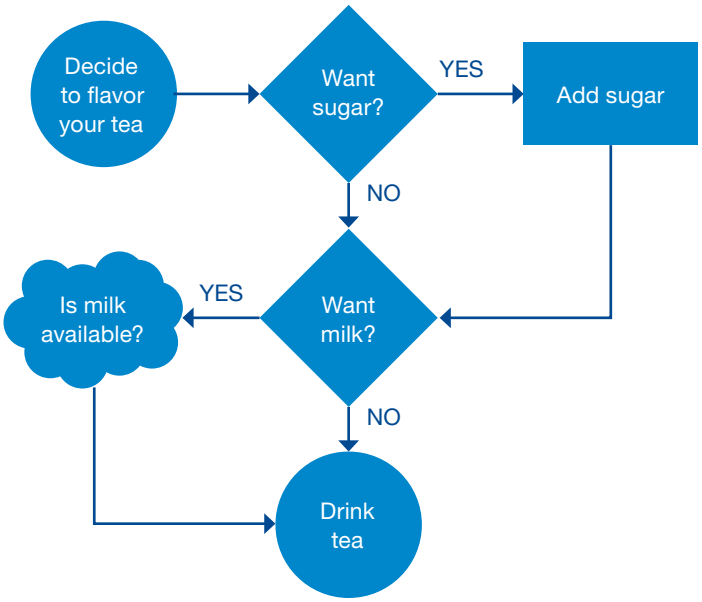
Activity or step (e.g., add sugar)

Decision to be made (YES or NO); diamond needs to contains a YES/NO question with two arrows coming out—one if the answer is YES and one if the answer is NO (e.g., Do you want sugar?)

Direction of flow between steps

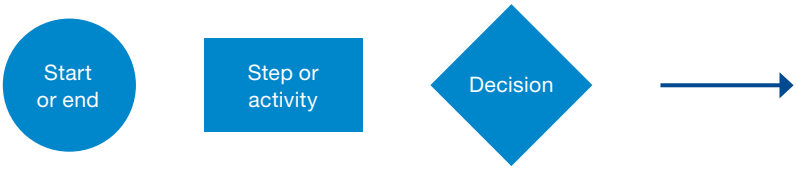
A step that is currently uncertain; this can be used in place of a box or coming out of it to indicate a problem (i.e. is milk available?)

Figure 3. An example of how to use question symbols in a flowchart



Exercise 1. Practice using symbols

Practice using these symbols using the steps below by following the steps for making a cup of tea. Use the appropriate symbol for each part of the process.



Tips: Remember a step or activity only has one arrow going out of it. A decision diamond should be a yes/no question with one arrow out for “yes” and one arrow out for “no”.

A. Flowchart of how to make a cup of tea

First, determine which symbol from above you should use for each of the points of the process and put them in the blank space.

Time for tea	
Gather supplies (heat source, water, pot, tea bag, cup spoon, sugar)	
Boil water	
Prepare cup with tea bag	

Pour boiling water over tea bag	
Remove tea bag	
Want sugar?	
Add sugar	
Drink tea	

B. Flowchart of how to make a cup of tea

Next, try putting those symbols into a flowchart here by adding the arrows. Remember a step or activity only has one arrow going out of it. A decision diamond should be a yes/no question with one arrow out for “yes” and one arrow out for “no”.

Part 2. Translating a process into a flowchart

Once you understand the basics components of a flowchart, the next step is to practice using a flowchart to visualize a process. Don't worry if you don't get it right the first time! This can be trickier than it sounds.

The following basic steps can be followed when drawing a flowchart based on a process:

1. **Form an improvement team of people who all have a role to play in the process you are trying to improve.** Each one of them will have insight into different steps in the process. In the India example in **Figure 1,** it would be the midwife, nurse, pediatrician and possibly other medical assistants involved in delivery and care of newborns.

2. **Determine and agree on the beginning and end points of the process to be flowcharted.**
   - What is the beginning of this process?
   - What is the end of the process?

   When deciding on a beginning and end, think about your aim and what triggers the key process in your aim to begin. The end is often the output that you are looking for. In the example above, the team wanted to understand what happens to newborns between childbirth (beginning) and discharge home (end) or referral to another facility (end) in relation to breathing difficulties.

3. **Identify the elements of the flowchart by asking:**
   - What is the next step or activity? Who does it?
   - Are there any decisions that need to be made? A decision point may be things like a diagnosis one way or the other, whether a resource is available, etc.

   Sometimes it can be helpful to list out the steps and decisions on paper before drawing the flowchart. This allows you to identify the steps and note any disagreements about the order of the steps or what is done during each step. For any steps that are unclear or have disagreement around them, make sure to use a cloud so that you know you need to come back and clarify that step.

   HINT: If you are developing a flowchart to identify weaknesses in your processes, the steps and decision points you put into the flowchart should reflect the true process (what is actually done, not what should be done according to a guideline or standard operating procedure). For example, a Ministry of Health guideline may require that you take every pregnant woman's blood pressure at every visit. However, a facility may have three exam rooms but only one with a blood pressure cuff, so only women being examined in the room with the blood pressure cuff actually get checked. Creating a flowchart that shows every woman being checked based on the guideline does not reflect the actual situation and is not helpful when you are trying to improve a process. If the real situation is that only some women get their blood pressure taken or if staff disagree on what happens, then you would use a cloud for that step to indicate there is a problem there.

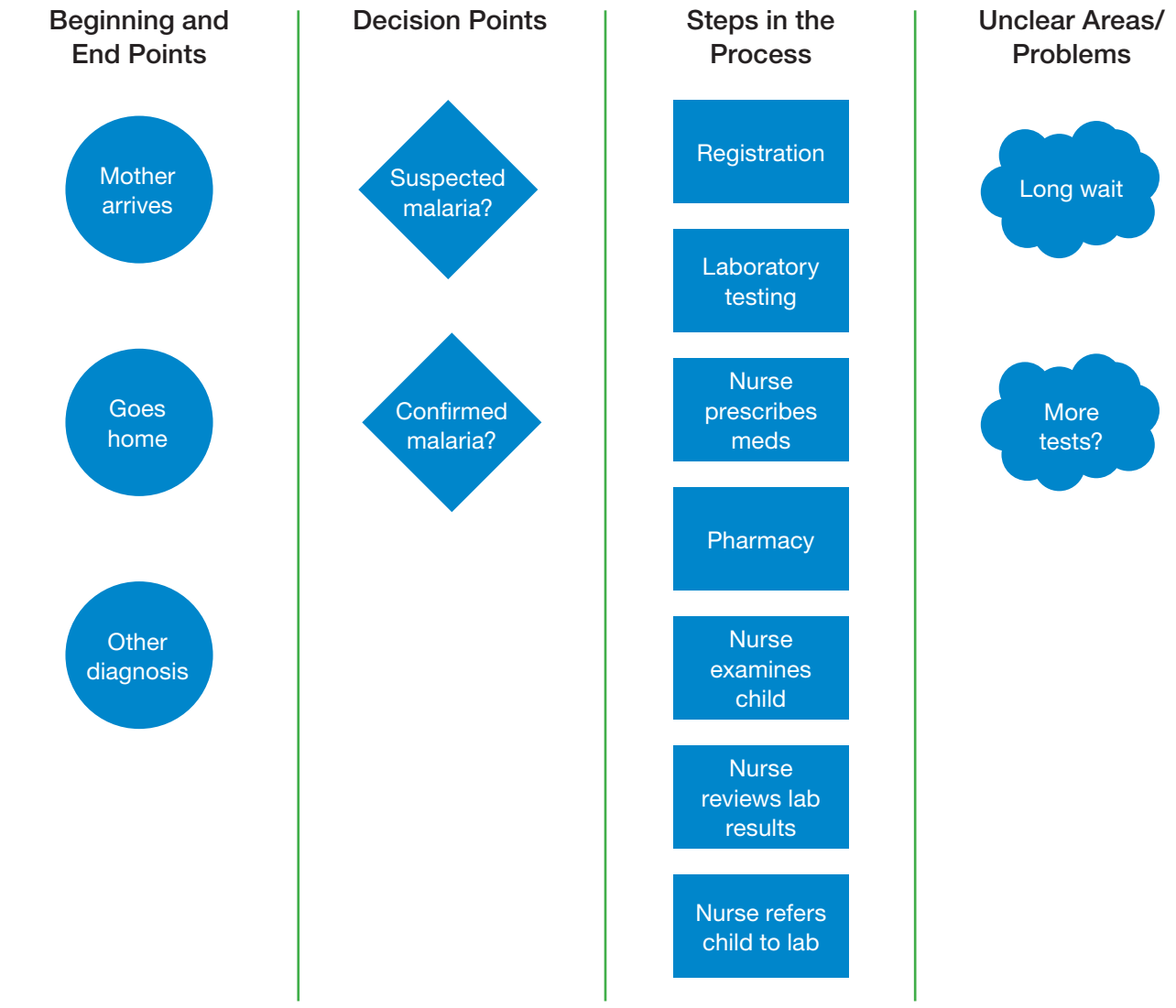
4. **Within a few days, review the flowchart with the group with fresh eyes to see if everyone is satisfied with the result.** Ask others involved in the process if they feel it reflects what they do and revise accordingly.

Exercise 2. Turn a description of a process into a flowchart

Read the case below so that you can create a flowchart.

A mother arrives at the health center with a two year-old child who has a high fever and is sweating. The mother goes to the registration desk to retrieve the child's record. After a short wait, the nurse calls the child back for examination. The nurse examines the child and suspects malaria. The nurse refers the mother to the laboratory. There is only one person working at the laboratory, so the line is long. The laboratory technician eventually does the test and hands the mother the results to bring back to the nurse. The nurse's role is to inform the mother if the child has malaria or not and if the child does not have malaria, more tests may need to be done. The child has malaria. The nurse prescribes treatment. The mother goes to the pharmacy to pick up the treatment and goes home.

The flowchart symbols that you need to complete this exercise are listed below. On the next blank page, create a flowchart that reflects the process of the mother taking her child to the hospital. Draw the flowchart symbols in the correct order to develop a flowchart which reflects the story. You will need to add arrows between the steps and the "yes" and "no" for any decision point.



Draw your flowchart here.

Part 3. Interpreting a flowchart for improvement

Once your improvement team has created a flowchart that reflects the real situation at your health facility, the team will want to do a simple analysis to determine possible areas where changes can be made that will lead to improvement. You can ask yourselves the following questions:

- Are there any steps or group of steps that are redundant?
- Are there extra steps that involve fixing mistakes from earlier steps (a rework loop)? For example, if you find a rapid HIV test is consistently done incorrectly the first time; a second test would be required.
- Does every step add value to the process? Is there any unnecessary work that could be eliminated?
- What complexities or additional problems do the clouds reflect? Is there confusion among providers or an unclear step? What is the cause of this problem?
- Are there any possible problems in the transitions from one person to the next? What could or does go wrong?
- Is the flow logical? Are there fuzzy areas or places where the process leads off to nowhere? Are there parallel tracks? Is there a rationale for those?

This discussion should generate a list of possible areas for improvement in the process. In the earlier example of the team from India, the team realized that they needed to clarify a procedure for calling the pediatrician, addressing what to do if the pediatrician wasn't available and what to do while they waited for the pediatrician to arrive. The next steps of prioritizing and developing changes based on the flowchart analysis are covered in the ***Tips and Tools for Learning Improvement*** "Developing Changes" handout.

Exercise 3. Interpreting a flowchart

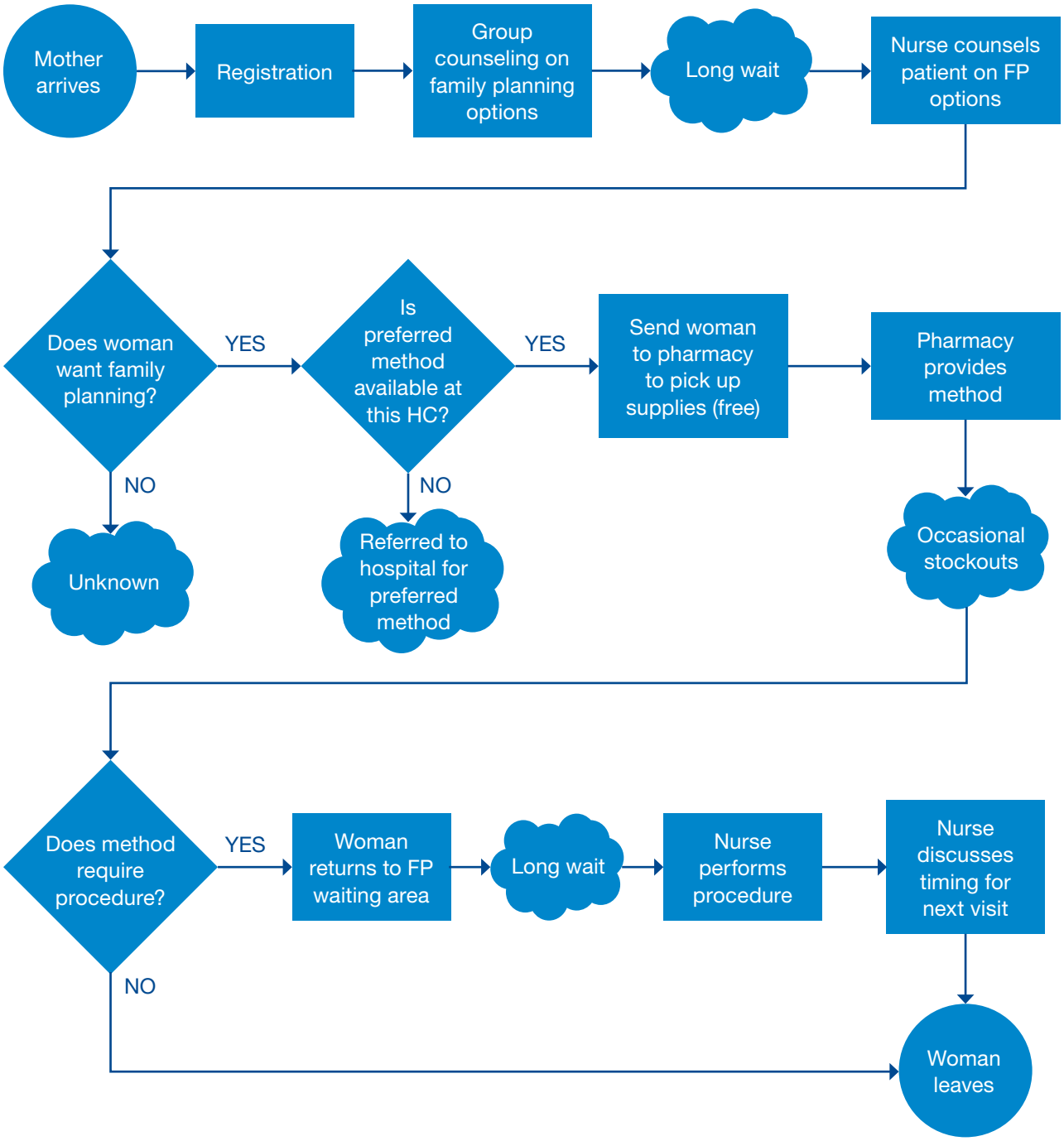
A team in a rural health center wants to increase the number of HIV patients lost to follow-up who are brought back to care. The team sat down and created a flowchart of their process for tracking patients and getting them back to care. Review their flowchart and answer the questions below.

Statements about flowchart	True	False
This flowchart shows the information flow between the nurse and the CHW.		
This flowchart shows what happens if the patient doesn't return to care after the reminder call.		
This flowchart shows how the CHW addresses the patient's needs.		
This flowchart shows the process for reminding patients about appointments.		
This flowchart shows how lost to follow-up patients are returned to the clinic.		
This flowchart shows whether there are any unclear steps, problems or bottlenecks in this process.		
This flowchart has enough information to understand problems in the process and develop changes to improve the process.		
This flowchart would better address the aim if it included more information about what happens after the reminder phone call is made.		

Exercise 4. Analyzing a flowchart

Review the following flowchart and answer the questions on the following page.

This team is reviewing their process for providing family planning (FP) services to women in the health center (HC). They want to make the services as easy to use as possible for women seeking services.



Exercise 4. Questions

1. Do you see any areas where the staff are doing double work?

2. Do you see any areas where there is opportunity for more efficiency?

3. What parts of the process might patients be unhappy with?

4. What steps or clouds might need to have their own flowchart to understand the process within that step or further areas for root cause analysis?

5. Which problem(s) would you want to address in your improvement work and why?

Tips and Tools for Learning Improvement

Answer Key | Flowcharts

Exercise 1. Practice using symbols

A. Flowchart of how to make a cup of tea

Time for tea	
Gather supplies (heat source, water, pot, tea bag, cup spoon, sugar)	
Boil water	
Prepare cup with tea bag	
Pour boiling water over tea bag	
Remove tea bag	
Want sugar?	

Add sugar	
Drink tea	

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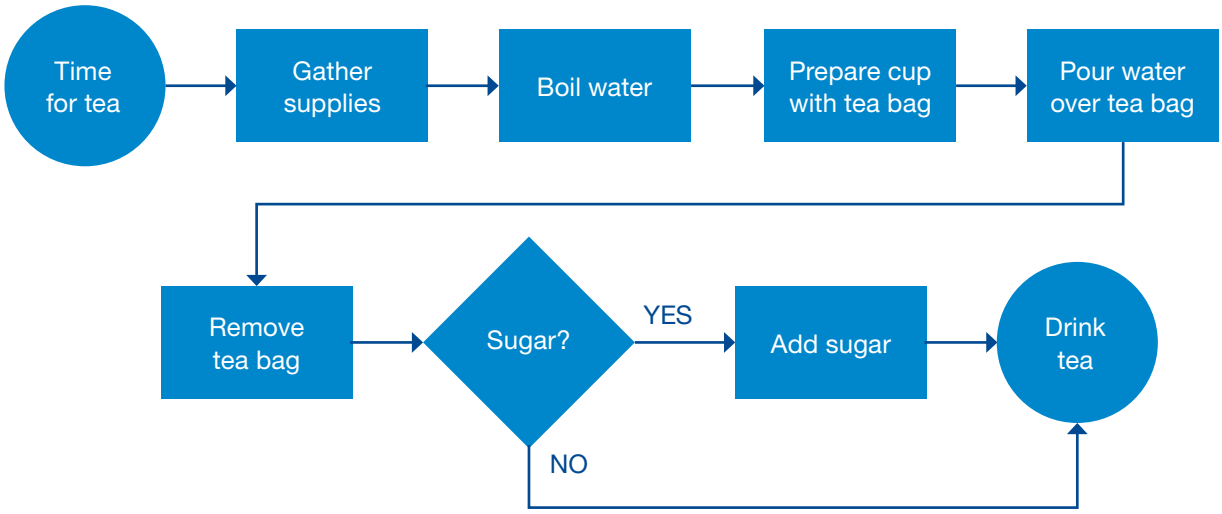
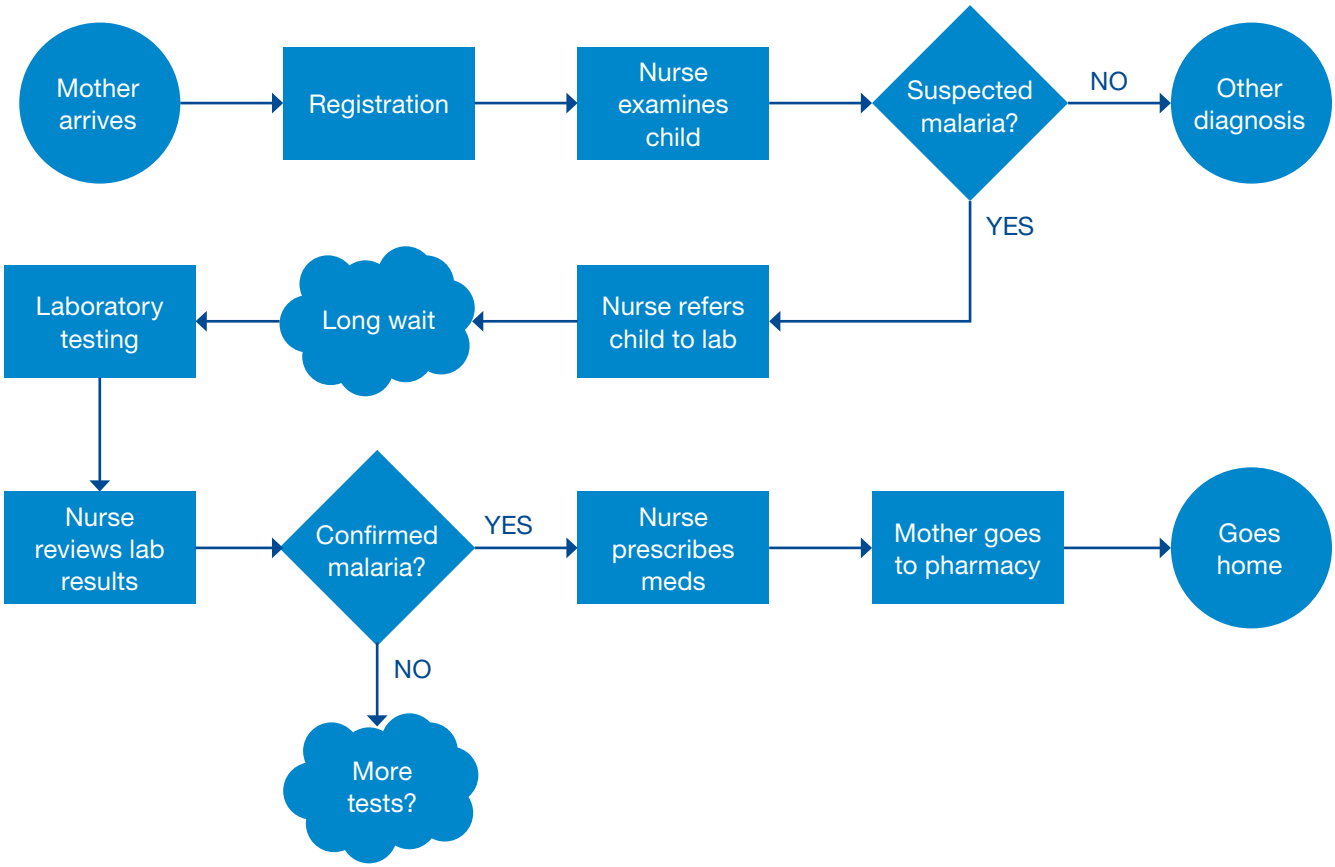
B. Flowchart of how to make a cup of tea



Exercise 2. Turning a description of a process into a flowchart



Exercise 3. Interpreting a flowchart

Statements about flowchart	True	False
This flowchart shows the information flow between the nurse and the CHW.	X	
This flowchart shows what happens if the patient doesn't return to care after the reminder call.		X
This flowchart shows how the CHW addresses the patient's needs.		X
This flowchart shows the process for reminding patients about appointments.	X	
This flowchart shows how lost to follow-up patients are returned to the clinic.		X
This flowchart shows whether there are any unclear steps, problems or bottlenecks in this process.		X
This flowchart has enough information to understand problems in the process and develop changes to improve the process.		X
This flowchart would better address the aim if it included more information about what happens after the reminder phone call is made.	X	

Exercise 4. Analyzing a flowchart

Note: These answers may not be the only possible answers, but will give you some ideas to think about.

1. Do you see any areas where the staff are doing double work?
   - Woman counseled twice on same FP information
2. Do you see areas where there is opportunity for more efficiency?
   - Reduce counseling burden
   - Eliminate need for patient to go to pharmacy
3. What parts of the process might patients be unhappy with?
   - Long waits
   - Counseling twice wastes patient's time
   - Sending patient to the pharmacy
4. What steps or clouds might need to have their own flowchart to understand the process within that step or further areas for root cause analysis?
   - Supply chain for family planning supplies
   - Referral system for family planning methods not provided at this clinic

5. Which problem would you start with and why? Several possible options might include:
    - Long waits – This may be a good place to start as it is a straightforward problem for a new team. Reducing wait times can often be done quickly and motivate new teams.
    - Duplicate counseling – Finding a way to reduce double work will free up time of the nurse or counselor to be doing other work. This will be motivational for staff as they feel that they are using their time more efficiently. Patients will be happy to not get information twice (unless they request it).
    - Trip to the pharmacy – The team can try to eliminate the need for the patient to spend time going to the pharmacy and waiting a second time for the provider. This will be a more efficient use of time for the patient and make them more satisfied with their care. You may also have some patient attrition if women decide not to spend the time going to the pharmacy and coming back.
    - Stock-outs of key pharmaceuticals – For a more advanced team, they may choose to tackle this problem first. This will help reduce their percent of unmet need for family planning by ensuring that women who want a method are able to get it in a timely manner at one visit. Dealing with supply chain may involve actors and processes outside of the facility, so this may not be a good choice as a first area for improvement for a new team.

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Tips and Tools for Learning Improvement

Developing Changes

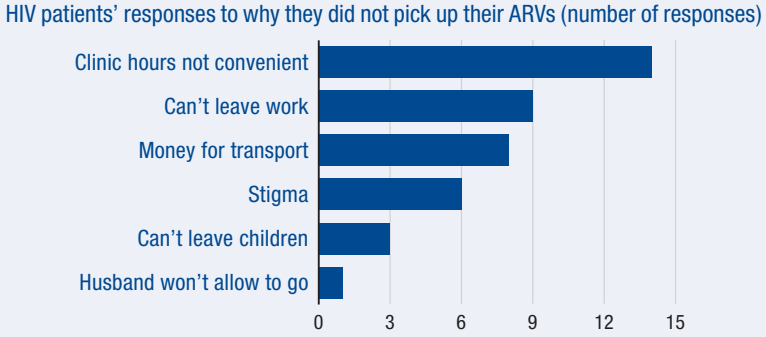
What are changes in improvement?

Making improvement requires change. Changes are any possible solutions to problems identified by improvement teams during the process of improving health care. Changes are usually interventions that alter the process of care in some way. For example, a clinic may have a problem that oxytocin, which must be refrigerated, cannot be given to a woman who delivers at night because it is stored in the pharmacy refrigerator and the pharmacy is locked at night. Change ideas to address this problem may be to either give a nurse a key to open the pharmacy when needed or to find a way to keep the medication cool in the labor ward overnight. It is important to remember that not every solution or change will lead to improvement. However, improvement cannot happen without change. A few examples of categories of common changes[1] include finding ways to:

- Solve customer problems (see Figure 1).
- Eliminate mistakes through reminders, double checks, or checklists.
- Standardize processes (e.g., reporting, clinical processes, laboratory).
- Eliminate waste and duplicated work.

An improvement team at a rural health clinic was trying to determine how to improve HIV patients' timely pick up of antiretrovirals (ARVs) to support adherence to their treatment regimen. The team started by asking 41 patients who had not picked up their medication or did so late why they did not do so. This was a simple exercise that gave them valuable information, but did not take a lot of time or money. The team put the answers into a Pareto chart – a bar chart that displays data in ascending or descending order of frequency to show the popularity of each category.

Figure 1: Example of developing changes



To develop change ideas, the team first looked at the data to try to understand what the most common problem was: the clinic hours were not convenient. This problem was also related to patients not being able to leave work or children. The team therefore hypothesized that changing clinic hours would improve patients' ability to pick up their ARVs on time. They developed a few change ideas: to provide easier access to medications, open clinic on Sunday; have clinic stay open late a few days per week; have clinic open early a few days per week; and assign someone to deliver medications to the patients at home who do not come into the clinic. Since the clinic did not have enough staff to do all of these things, the team decided they would start by testing the change idea to open the clinic on Saturday for a few hours to hand out medications.

[1] Langley GJ, Moen RD, Nolan KM, Nolan TW, Norman CL, Provost LP. 2009. *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance Second Edition.* San Francisco, CA: Jossey-Bass.

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- Improve organization of care and work or patient flow including minimizing hand-offs between providers, eliminating bottlenecks, move steps closer together, and task shifting.
- Reduce wait times, laboratory turn-around times, and other delays in providing care

How do you develop changes?

Changes should be developed based on data, knowledge, and beliefs about likely causes of problems. Before developing changes, it is important to do a simple analysis of the current situation using existing data, root cause analysis ("fishbone diagram" or "why why why"), process analysis ("flowchart"), client and provider interviews, or other techniques to better understand the problem and its causes. See Figure 1 for an example of using interviews and a Pareto chart to guide actions for improvement. After analyzing the current situation, the team chooses one problem or cause of the problem and develops change ideas to address it. Ideas for changes could come from a variety of sources including evidence in the literature, a new guideline, learning from others, brainstorming (see Figure 2), creative thinking from the team, and innovative uses of technology.

When you are part of an improvement team developing changes, you need to think about:

- Something you have never done before
- Something you can do tomorrow
- Something that worked elsewhere
- Something that addresses identified gaps

Teams should avoid:

- More of the same: more people, more money, more time, more requests
- Adding inspection or punishment for not improving
- Trying to develop one perfect change; most improvement takes testing and refining multiple changes to reach the goal

A lot of teams will start addressing problems by developing changes such as writing a directive, creating awareness or providing some education. While it is critical that providers have competency in the clinical areas they cover, awareness creation and short trainings do not usually solve problems caused by broken processes.

Figure 2: How to brainstorm

Step 1. Write down the topic

Step 2. Review the rules of brainstorming:

- Do not discuss ideas during the brainstorming
- Do not criticize any idea
- Be unconventional: every idea is acceptable
- Build on the ideas of others
- Quantity of ideas counts

Step 3. Gather ideas. Make sure everyone has a chance to speak.

Step 4. Write down all ideas.

Step 5. Review, clarify, and combine related ideas.

Step 6. Agree on ways to judge ideas, such as voting or prioritization matrices.

How do you prioritize changes?

Once a team has developed changes based on their best knowledge and understanding of the root cause of the problem, they need to determine which change to test first. After prioritizing one change, the team will conduct a Plan-Do-Study-Act (PDSA) cycle to see if that change results in improvement [See the ***Tips and Tools for Learning Improvement:*** "Plan-Do-Study-Act" handout]. There are several things to consider when prioritizing a change, including:

- **Development of the team:** If it is a new team, they should focus on starting with a simple change that will give them a chance to practice the PDSA cycle. Testing a simple change and seeing results quickly will help motivate the team.
- **Most relevant:** The team should look again at the analysis and discuss which change will be most relevant and likely to address the cause of the problem.
- **Sequence:** Some of the ideas may need to be done in sequence. For example, in trying to improve pregnant women's attendance at antenatal care, the team may need to start with a change that helps identify pregnant women and then move on to a change that will encourage registration at the clinic.

If the teams are having trouble coming to a decision on which change to test first, they can try using one of these methods:

- Majority or straight voting: This method is where each participant has one vote. Voting is most useful when the improvement options are straightforward or time is limited. It encourages equal participation of all team members by equalizing decision making between dominant and quiet participants.
- Multi-voting: This allows participants to vote more than once and is useful when the group wants to pick more than one item to improve or when the list of items is very long and needs to be reduced to two or more. This voting method increases the likelihood that everyone will have at least one of the items for which they voted on the reduced list.
- Prioritization matrix: A multiple criteria or prioritization matrix is a tool for evaluating options based on a set of explicit criteria the group has determined is important for making an appropriate, acceptable decision. Matrices work best when options are more complex or when multiple criteria should be considered in determining priorities or making a decision. Criteria can be weighted and ranked to help in the decision-making process. Although the prioritization matrix is the method most likely to result in consensus, at times it can be time-consuming and complex. Examples of criteria might be impact, cost, difficulty of implementation, evidence from others who have tried it, or potential risk.
- Rank ordering: Each team member ranks all the proposed ideas. The team agrees to average the rankings and select the alternative with the highest score.
- Decision made by expert on the team: The team may include someone who knows more about the issue, and the other members may turn to this person to make the decision. This approach would be used rarely and probably most often in cases involving clinical decisions.

Exercise 1: Choosing a problem and first step

The national treatment guidelines and policy in one country recommend that the diagnosis for all patients suspected of severe malaria should be confirmed with microscopy. An improvement team in one hospital conducted a baseline assessment which revealed that only 14.5% of the suspected malaria cases in children under five years of age were confirmed with microscopy. The facility had good levels of drugs and commodities. The health workers had been trained in malaria case management only a few months prior to the assessment. Still, almost 85% of suspected cases of severe malaria were treated presumptively and/or based on the malaria rapid diagnostic test (mRDT) result, contrary to the national guidelines. The improvement team decided to carry out a problem analysis using a fishbone diagram to determine the root causes of low microscopy rates in pediatric patients suspected of severe malaria. Some of the root causes found included:

- Clinicians were ordering an mRDT test for suspected cases of severe malaria instead of microscopy as per guidelines.
- Samples for blood smear for malaria parasites for microscopy were not collected because the health workers felt that the process of taking the samples was too long. They wanted to use the faster method of using the malaria rapid test.
- Those few samples that were collected were delayed in the ward and were poorly collected, thus the laboratory rejected them.
- In the ward, there was no health worker assigned to follow up on the samples and collection of results from the laboratory.
- The laboratory technicians did not prioritize processing and reading of the blood smears for malaria diagnosis. As a result, clinicians and nurses used malaria rapid diagnostic tests or no diagnostic testing as alternatives.

Once the team uncovered these problems, the team members had different reactions. See what each of the three team members below had to say about what the team's first action should be. Which opinion do you think represents the best starting point? Circle one.

Team Member 1	Team Member 2	Team Member 3
"This is unacceptable. The staff were trained in the new guidelines a few months ago, and there is no reason why they should be continuing to rely on mRDT or simply treating on suspicion. We need to review the records and find out who is responsible and tell them that they have to follow the guidelines or else there will be consequences. We can check again in a few weeks to make sure that they have started following the guidelines."	"We really need to ask management to hire more people. The laboratory needs someone who can focus on microscopy and diagnosing malaria. We should make sure that there is a microscope purchased and dedicated to malaria diagnosis since it is so common. It would also help to hire someone to be responsible for taking smears to the lab and then waiting for the results and bringing them back to the clinician or nurse. This would mean samples don't get lost."	"This analysis shows a lack of clarification in the process of taking samples and testing by the lab. It would probably help for us to clarify the process. I think I heard about another hospital that had a similar problem but was able to solve it. Maybe we could talk to their team to get ideas. Let's choose one of these problems to start with and think of ideas that might help solve the problem. We can brainstorm some ideas of what would work in our ward."

Exercise 2: Matching a problem with a change idea

A neonatal intensive care unit is having a hard time ensuring sterile care while putting in central lines. There are several problems. Draw a line between each problem and the change idea that would best address the problem.

Problems	Change ideas
Staff are unaware of the extent of the problem related to line infections.	Change protocol to allow use of alcohol hand wash instead of soap and water.
Staff do not know the correct steps for sterile technique when putting in a central line.	Create central line tray with all required equipment.
The sink is in another room, and it is hard to reach when emergencies come up.	Collect and display number of line infections weekly.
Supplies for central lines are kept in different places so can't be gathered quickly.	Develop central line protocol. Train staff on the protocol and the importance of adhering to the protocol.

Exercise 3: Determining the best change idea

For the following scenarios, choose which change idea is most likely to address the problem.

Scenario 1

An improvement team in a health clinic has found that oxytocin is not being given to women immediately following the delivery of the placenta per the protocol. When the team did an analysis of the situation, they realized that oxytocin was not being given because it meant that the attending midwife had to leave the mother and baby to go to the nurses' station to get the drug. At the nurses' station, she would need to take the oxytocin from the refrigerator and fill a syringe. Very often the mother seemed fine and was not showing signs of hemorrhaging, so the midwife did not bother to go get the oxytocin.

Which of these changes most directly addresses the problems in the process described above? (Check one):

☐ Head of the health center writes policy that oxytocin should be given

☐ Head of the health center trains staff on importance of oxytocin

☐ Midwife preloads syringe with oxytocin and keeps it on a cold pack by the bedside for each delivery

Scenario 2

In a maternity ward in one hospital, health care providers are concerned because many of the newborn babies are becoming hypothermic. The improvement team aims to reduce the incidence of hypothermia among newborns. A few team members observe 10 births over two days to determine the process that is currently being used to keep

newborns from becoming hypothermic and if there are any problems with it. The team found that providers are clamping cords of newborns before drying and wrapping them, which results in anemia and hypothermia in babies.

Which of these changes most directly addresses the problems in the process described above? (Check one):

☐ Put up poster informing nurses to wrap babies before other procedures

☐ Re-organize equipment so that cord clamp is kept under the towels for wrapping newborns

☐ Have nurse in charge observe deliveries and give performance reviews

Scenario 3

A busy HIV clinic improvement team is working on improving the nutritional status of their HIV patients. A first step in improving their health is to know which patients are malnourished. Previously, providers had been assessing patients for malnutrition only when a patient looked malnourished. They did not have a consistent way of assessing patients. The team had previously tested creating a place, down the hall from the registration desk, where a volunteer could measure height and weight and then record the information. The registration officer reminded the patients to have their height and weight taken, but more than half of the patients skipped that step and went straight to the waiting area.

Which of these changes most directly addresses the problems in the process described above? (Check one):

☐ Tell patients to not skip the station

☐ Do not give drugs to patients who have skipped the station

☐ Move the place for assessing height and weight right next to the registration desk

Exercise 4: Prioritizing a change idea

Read the scenario below and decide which team member you agree with.

An experienced improvement team, made up of patients and providers at a district health center, is trying to decide between different change ideas that can address the problem of adherence among HIV patients. After doing a root cause analysis, they learned that some patients' reasons for not returning monthly for their ARVs include the time it takes to come to the facility, not being able to leave work or children, the cost of transport, and/or HIV-related stigma. The team has learned of possible solutions from other health centers doing similar work. They are now trying to decide between three possible changes to address these concerns:

- Provide medications for 3 months at a time to stable patients.
- Have a community health worker deliver medications to patients who have trouble reaching the facility.
- Use peer supporters who can collect medications for patients who live near them and pass the medications on to those patients.

The team had a lot of discussions around these changes and is having trouble reaching consensus. Some people on the team are worried about the implications on community health worker time; others are thinking about patient convenience; and some members are concerned about pharmacy rules and procedures.

All of these changes could address the problems that patients have to varying degrees. They have decided that it is time to use a prioritization tool. Members of the team have different opinions on prioritizing the problem to start with. Circle the team member who you agree with.

Team Member 1	Team Member 2	Team Member 3
"We are having a lot of trouble figuring out what to do. I think we should just ask the head of the facility to make a decision. He hasn't been part of these discussions, so he will have fresh eyes on the situation."	"We all seem to have different opinions on what is best to do. Let's just vote on it and everyone can accept that the idea with the highest vote wins. It isn't hard to choose between these three."	"These all have implications for health worker time, patient acceptance, management support, pharmacy supply chain planning, and other resources. I think we should use a prioritization matrix to weigh the options and determine which is most likely to be successful for everyone involved."

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Tips and Tools for Learning Improvement

Answer Key | Developing Changes

Exercise 1: Choosing a problem and first step

Team Member 1	Team Member 2	Team Member 3
"This is unacceptable. The staff were trained in the new guidelines a few months ago, and there is no reason why they should be continuing to rely on mRDT or simply treating on suspicion. We need to review the records and find out who is responsible and tell them that they have to follow the guidelines or else there will be consequences. We can check again in a few weeks to make sure that they have started following the guidelines."	"We really need to ask management to hire more people. The laboratory needs someone who can focus on microscopy and diagnosing malaria. We should make sure that there is a microscope purchased and dedicated to malaria diagnosis since it is so common. It would also help to hire someone to be responsible for taking smears to the lab and then waiting for the results and bringing them back to the clinician or nurse. This would mean samples don't get lost."	"This analysis shows a lack of clarification in the process of taking samples and testing by the lab. It would probably help for us to clarify the process. I think I heard about another hospital that had a similar problem but was able to solve it. Maybe we could talk to their team to get ideas. Let's choose one of these problems to start with and think of ideas that might help solve the problem. We can brainstorm some ideas of what would work in our ward."
Punishing individuals in a system does not address the underlying problem in the process. Telling people to work more, better, faster, etc. does not usually lead to any sustained change or improvement.	*It is important that the facility has all of the resources that it needs to complete its tasks. However, simply hiring more people or buying more equipment will not likely solve the problem in this case, which is a lack of clarity on the process by which samples are collected, sent to the lab, analyzed, and the results returned to the provider. Once the team has clarified and improved the process, then they will be able to better determine if more staff or equipment are needed.*	*This is the best approach to the problem described. The problem here is a lack of clarity in the process of collecting samples, sending them to the laboratory, analyzing them, and sending the results back to the provider. If they develop and test changes to improve each step in the process, they will achieve more sustainable results. Before developing changes, some root cause analysis or flowcharting will help them better understand the problem.*

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Exercise 2: Matching a problem with a change idea

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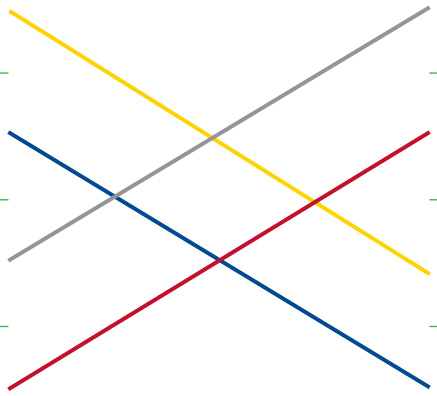

Exercise 3: Determining the best change idea

For the following scenarios, choose which change idea is most likely to address the problem.

Scenario 1

☐ Head of the health center writes policy that oxytocin should be given

☐ Head of the health center trains staff on importance of oxytocin

✓ Midwife preloads syringe with oxytocin and keeps it on a cold pack by the bedside for each delivery

Scenario 2

☐ Put up poster informing nurses to wrap babies before other procedures

✓ Re-organize equipment so that cord clamp is kept under the towels for wrapping newborns

☐ Have nurse in charge observe deliveries and give performance reviews

Scenario 3

☐ Tell patients to not skip the station

☐ Do not give drugs to patients who have skipped the station

✓ Move the place for assessing height and weight right next to the registration desk

Exercise 4: Prioritizing a change idea

Team Member 1	Team Member 2	Team Member 3
"We are having a lot of trouble figuring out what to do. I think we should just ask the head of the facility to make a decision. He hasn't been part of these discussions, so he will have fresh eyes on the situation."	"We all seem to have different opinions on what is best to do. Let's just vote on it and everyone can accept that the idea with the highest vote wins. It isn't hard to choose between these three.	"These all have implications for health worker time, patient acceptance, management support, pharmacy supply chain planning, and other resources. I think we should use a prioritization matrix to weight the options and determine what is most likely to be successful for everyone involved."
If the facility head has not been involved in the discussions of the problem or solutions, that person may not be informed enough to make the decision. While sometimes it is appropriate to have an expert on the team make a decision, there is no evidence to show that the facility head is the expert in this situation.	*The team could take a vote, but that may not be the best option in this case as each of these changes has implications on resources, patient acceptance, rules and regulations, etc. A vote may result in deciding on the most popular change, but it may not address all of the concerns of the team members.*	*This is the best answer for this situation. When the problem and solutions are both complex, a priority matrix allows you to analyze the solutions to determine what your best option is. All of these are big changes to the current process, and thinking through carefully which idea best addresses the problem(s) will result in a more appropriate change.*

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Tips and Tools for Learning Improvement

Plan-Do-Study-Act

What is a Plan-Do-Study-Act cycle?

A plan-do-study-act cycle (PDSA) is a simple process used to test out and adapt ideas or solutions, often called "changes", for your unique setting. The method helps you to learn quickly through testing your planned changes on a small scale and adapting the changes as you learn from the test to address a problem. It is a process we all do multiple times a day in trying something out, tweaking the idea and trying it again until we get the result we are looking for, like finding the shortest route to get to work or adapting a recipe.

Why is a Plan-Do-Study-Act cycle important?

By trying out an idea with a quick test on a small scale, a person or team can determine whether it will lead to improvement in their problem area and determine any potential side effects that need to be mitigated before making a permanent change. Testing the change out with staff involved in the process can help reduce resistance to change that often occurs in health facilities.

How to conduct a PDSA cycle

PLAN: Plan what you will do

Implementing a small-scale test still requires careful planning, including being clear about what needs to be done, who needs to do it, how and when they will do it, and what they predict will happen. The prediction or hypothesis about how this change will affect care helps the team think through what they expect to change and why. The team connects the problem they are trying to solve with the solution they are proposing and why they think it will work.

Testing on a small scale

Testing on a small-scale means trying out the change idea on a couple of patients or for a specific, short time period, such as one shift. Teams should ask themselves "what is the smallest scale I can try this out on?" and then do that test as soon as possible. This will give the teams immediate feedback on the idea: what works, what doesn't work, and what problems or barriers need to be fixed. As they find a solution to any barriers encountered, teams can test the idea again on a larger scale. For example, perhaps they test an idea to reorganize patient flow with 5 patients the next day. If that works well, they can move to trying it with all patients for one shift, then for one week, and eventually make it a permanent part of the facility's operation.

Figure 1: Steps in a Plan-Do-Study-Act cycle

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How will we know that a change is an improvement: Measures for a project vs. measures for a test

Remember that for a PDSA cycle, you need to collect a small amount of data to tell you whether the change made a positive impact on the process in question. This data is to support the PDSA cycle, should be short-term and process-focused, and may include qualitative data. These may not be the same measures that tell you whether you reached your aim.

To determine if a change idea works, you might consider the following types of measures for the test period:

- Time taken for a specific task or step.
- Number or percent of patients receiving service (per change idea).
- Ask providers how it went.
- Ask patients how it went.
- Review whether there were any unintended consequences (positive or negative).

In addition, the team needs to think about what information and data they will need to learn from this test. Team members should ask themselves how they will know if this test worked. For example, will they use quantitative data (e.g., how many patients did this work for, how long did it take) or qualitative information (e.g., team members' observations about processes – what was successful, what wasn't successful), or both? It is important to note that the measures that reflect whether a small test worked may not be the same as the measure which tells you whether you are meeting your aim. For example, a monthly measure of the entire population of HIV patients won't be affected by a test with 5 patients, so there needs to be a simple way of knowing whether the test on 5 patients worked.

DO: Carry out the intervention on a small scale

To test the proposed solution, a team needs to carry out the planned activities and record what happened. Team members need to communicate progress to all those involved in the test. They need to document what worked and what did not work during the testing process; this information is important to assess the solution.

STUDY: Study the results

During this step, the team will decide whether the solution they tested had the desired results. Here, the team needs to ask, "What did we learn from this test?"

A team should ask itself:

- Did we meet the criteria for success? Did the solution have the desired results? What did team members think of the change?
- What aspects of the test went well? What aspects were difficult?
- Did the solution create problems for others or other processes that we did not anticipate?
- What kind of resistance did we encounter?
- Was our prediction correct?

ACT: Act on the study results

Based on what was learned from the study results, the team can decide what action to take. Not every solution that is tested is then adopted. Sometimes, a solution needs to be reassessed, modified, or abandoned altogether. The team should ask itself:

- Did the change tested show promise? If not, they may need to abandon the change idea and test another change.
- Does it need to be modified to work even better? If so, they need to adapt it and run the PDSA again on a small scale at first.
- Did it work very well? If so, they will need to test it at a larger scale across a wider range of conditions (different hours of the day, more patients or different types of patients, other staff members involved) before they can be ready to adopt it. This testing method helps to increase our degree of belief that the change is an effective one.

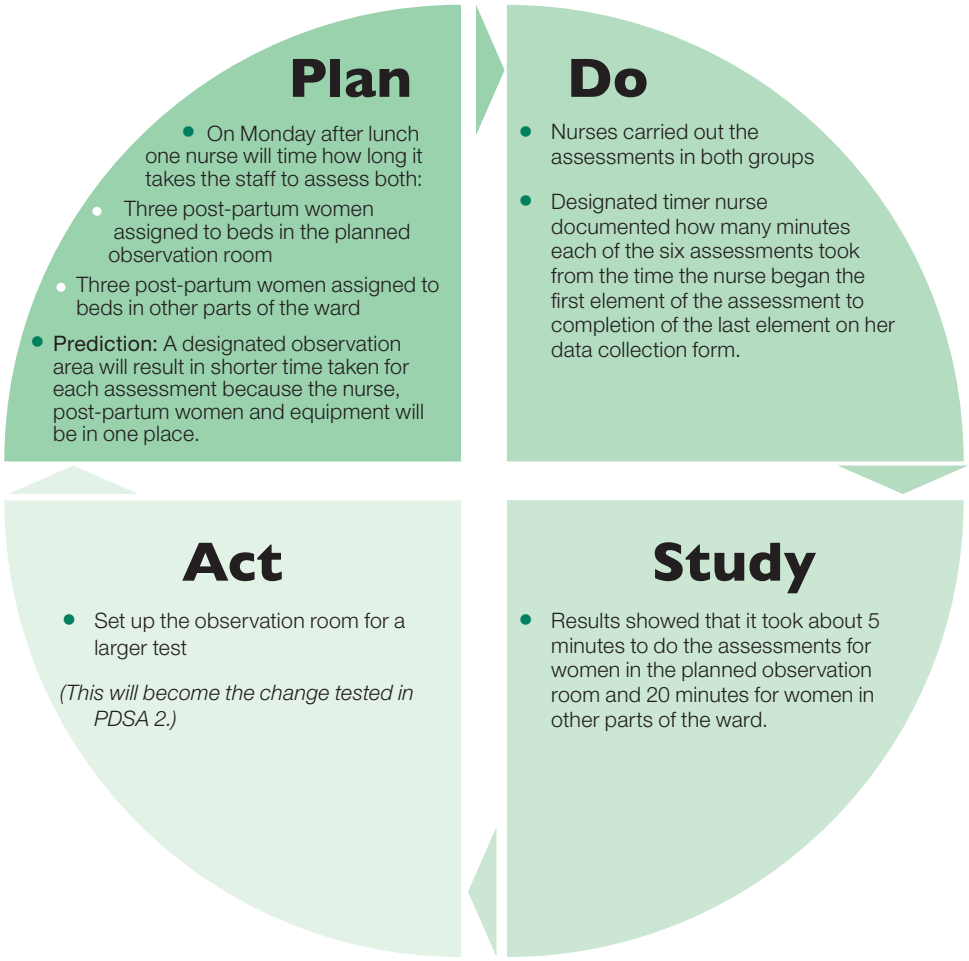
Example

An improvement team at a hospital in India decided to increase the frequency of post-partum assessments (structured clinical checks with women who have just given birth) to comply with the Government guideline to assess 11 times within 48 hours. They were hoping to catch and treat women with danger signs to prevent maternal deaths. The team's aim was: "Within 2 months, we will increase the number of times each woman post-delivery is assessed to at least 6 times within 48 hours." Their discussion prompted some extra attention to be given to assessments. The team met and discussed the fact that assessments for post-partum women were increasing in frequency, but the number of women being identified with complications was not increasing. They thought that the reason was that staff workload prevented them from doing the assessment carefully. They wondered if they could find ways of making the assessment more efficient so it would take less time and could be done properly.

The team decided that reorganizing the hospital maternity ward could make the assessments more efficient. Reorganizing a ward is a large change. The team wasn't completely sure that this would work to improve assessment frequency so they decided to test it first. Their ward had three rooms. Their change idea was to turn one room into an area for observing postpartum mothers for the first 24 hours. Before they made this a permanent part of their entire ward, they planned to test the idea.

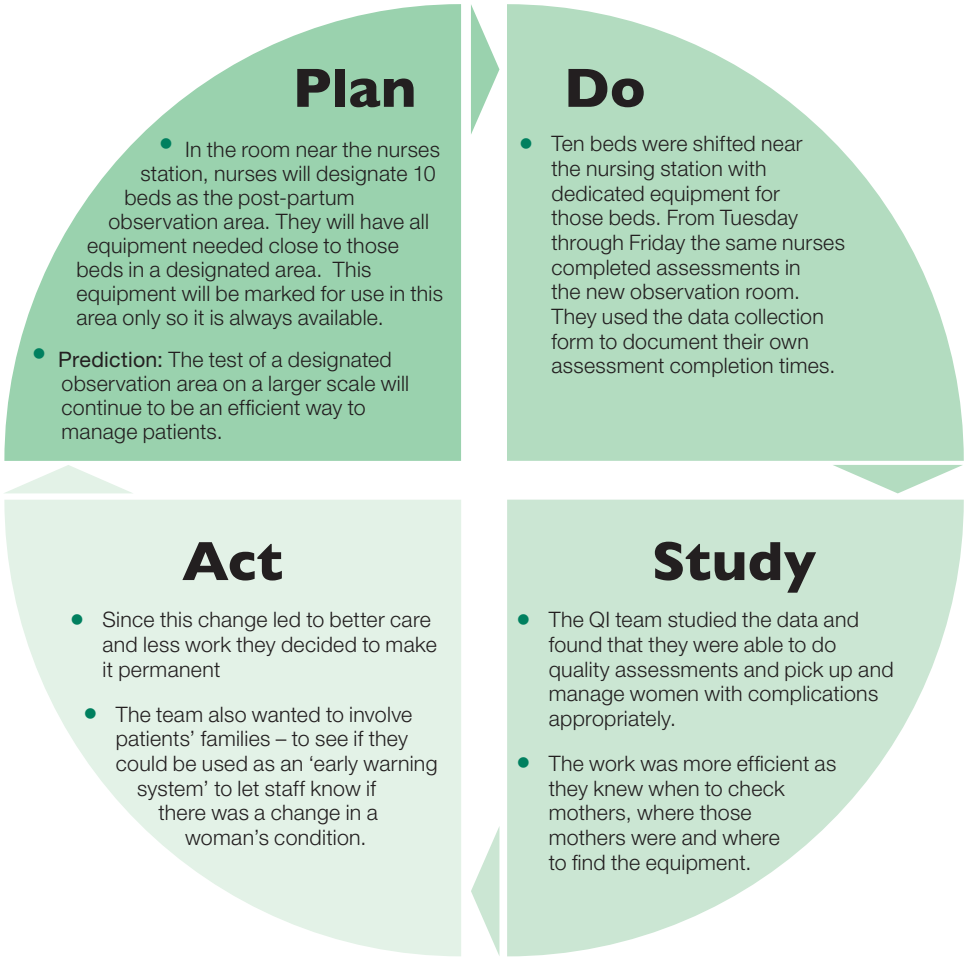
PDSA 1:

Compare the time to complete the post-partum assessment of three women in the planned observation room near the nurses' station to that of three post-partum women in other parts of the ward.



PDSA 2:

Test the observation area on a larger scale with 10 beds.



Result:

After the reorganization of the ward, five post-partum women were identified with danger signs, two of which were picked up by relatives. All were identified early, managed appropriately, and discharged within a week.

Exercise 1: Developing a plan

Please read the case below and help the team develop a plan.

An improvement team at a large hospital wanted to improve the care they were providing for HIV/TB co-infected patients. One of the problems they found was that patients with HIV and suspected TB are referred to the TB clinic in the same hospital but often do not go to the TB clinic to complete their referrals. The improvement team set an aim to increase the percent of completed referrals to the TB clinic of patients with HIV and suspected TB to 100% within 6 months. The team decided to test the following change:

- Any HIV patient who is suspected by the HIV clinic staff to have TB will be escorted from one clinic to the other to assure linkages to care.

The HIV clinic sees on average 100 patients per day and there are long waits to see the clinicians.

*The team needs to create a plan for this first PDSA cycle. Help them out by circling the best option of the three for the plan. Remember: The idea is for a **rapid test** on a **small scale.** Make a note of why you choose the option.*

Plan component	Option 1	Option 2	Option 3	Reasons for choice
Who will be responsible for escorting patients?	Physician or clinical officer	Nurse	Volunteer	
Test scale or period: for how many patients or how long will we test the change?	The next 100 HIV patients with suspected TB	The next 5 HIV patients with suspected TB	All HIV patients with suspected TB for the next month for the whole clinic	
How will we know if the test was successful (learning from the test)?	The team will ask the head of the HIV clinic and the head of the TB clinic if it worked	All patients found to be co-infected are escorted to the other clinic; the staff, volunteer and patient found it helpful.	The team will review whether there is a change in the percent of completed referrals of HIV patients with suspected TB to the TB clinic for all patients in one month	
When should we first review the results of the test?	At the regular meeting of the team at the end of the month	Once per hour during the test period	A quick, informal meeting when the test is complete	
Who will collect information for review?	Volunteer alone	Volunteer and staff members from HIV and TB clinics	Facility leadership	
What is your prediction about what will happen?	(Write in your prediction here)			

Exercise 2: Reviewing study and act steps

Please read the case below and help the team study their test and act on it.

The hospital improvement team enacted their plan to improve referral from the HIV clinic to the TB clinic for HIV patients with suspected TB. The plan was for the volunteer to escort the next 5 HIV patients with suspected TB to the TB clinic and get them registered. They met their 5-patient test number in one day. The team enacted this test and met the next day to discuss what happened.

As their study step, the team reflected on what they learned from their test:

- The clinical officer and nurse identified 5 HIV patients with suspected TB during the afternoon following the meeting.
- Only 4 of the 5 patients were escorted by the volunteer to the TB clinic.
- The last patient identified was found at 4:30 pm after the volunteer had left for the day so he wasn't escorted.
- The volunteer did not know what to do with the patient once in the clinic. The first few times he just walked them to the waiting area. One time he told the registration desk it was a referral. One time he asked for the person to skip the line and be seen right away.

Part 1

The team then needed to decide if this was a good or bad change. Three team members disagree on whether this was a successful change or not. Choose the team member that best reflects your analysis of the situation.

Team Member 1	Team Member 2	Team Member 3
"This change was not successful. The volunteer didn't escort everyone. This change relied on one volunteer and when he left it dropped. He didn't know what to do when he got there. We don't know whether they were registered or seen at the TB clinic. I would recommend we test something completely different."	"This was a successful change because we know that the HIV patients are making it to the clinic. However, we need to make modifications to refine the change, address some of the problems, and test it again."	"This was a great change. Most people made it to the clinic, and that's much better than our current rate of completion for referrals. I suggest that we implement this for all patients starting tomorrow. We don't need further testing because we know it works."

Part 2

Answer the following questions below:

Which of the following improvements is NOT a good next step?	☐ Clarify what happens when the volunteer reaches the TB clinic with a patient ☐ Have the nurse escort patients instead of the volunteer ☐ Create a coverage schedule so there is always a volunteer available to escort patients
Which of the following is the best idea for the scale of the next test of having a schedule of volunteers to escort patients?	☐ Testing the new schedule of volunteers for 6 months ☐ Test on 200 patients ☐ Test a new schedule of volunteers for one full clinic day

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Tips and Tools for Learning Improvement

Answer Key | PDSA

Exercise 1: Developing a plan

Plan component	Option 1	Option 2	Option 3	Reasons for choice(s)
Who will be responsible for escorting patients?	Physician or clinical officer	Nurse	**Volunteer**	*This task does not require clinical skills. A volunteer doing the escorting is the least likely to disrupt the clinic functioning.*
At what scale or how long will we test the change?[1]	The next 100 HIV patients with suspected TB	**The next 5 HIV patients with suspected TB**	All HIV patients with suspected TB for the next month for the whole clinic	*Starting with the next 5 patients gives you a small sample to get an understanding of where there may be complications or problems.*
How will we know if the test was successful (learning from the test)?	The team will ask the head of the HIV clinic and the head of the TB clinic if it worked	**All patients found to be co-infected are escorted to the other clinic; the staff, volunteer and patient found it helpful**	The team will review whether there is a change in the percent of completed referrals of HIV patients with suspected TB to the TB clinic for all patients in one month	*The best initial way to determine learning from this test would be whether all patients were escorted and whether staff, volunteers and patients found it useful. This lays a foundation for determining if it should be tested further.*
When should we first review the results of the test?	At the regular meeting of the team at the end of the month	Once per hour during the test period	**A quick, informal meeting when the test is complete**	*For this change, the best thing to do is to try it out and have a quick, informal meeting of the team to see how it went. When testing a change, it can be helpful to see what you can do right away that you can learn from to determine if it is worthwhile. If you wait until a formal team meeting that might be held once per month, you might forget the details of what happened and/or you have missed out on time to make simple adjustments and test again. Meeting every hour is unnecessary as there may not even be a relevant patient in that timeframe.*

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Plan component	Option 1	Option 2	Option 3	Reasons for choice(s)
Who will collect information for review?	Volunteer alone	**Volunteer and staff members from HIV and TB clinics**	Facility leadership	*The best option is the volunteer and staff together as they jointly can determine whether the change was beneficial for everyone involved. For a PDSA cycle, members of the team or people involved in the process should collect the quantitative and qualitative information that they need to determine if their test worked.*
What is your prediction about what will happen?	*While there may be a few variations of predictions, generally the team would predict that by escorting patients from one clinic to the other, the patients are less likely to leave and will be connected to care and that a personal escort will encourage patients to go right away.*			

Exercise 2: Reviewing study and act steps

Part 1

Team Member 1	Team Member 2	Team Member 3
"This change was not successful. The volunteer didn't escort everyone. This change relied on one volunteer and when he left it dropped. He didn't know what to do when he got there. We don't know whether they were registered or seen at the TB clinic. I would recommend we test something completely different."	"This was a successful change because we know that the HIV patients are making it to the clinic. However, we need to make modifications to refine the change, address some of the problems, and test it again."	"This was a great change. Most people made it to the clinic, and that's much better than our current rate of completion for referrals. I suggest that we implement this for all patients starting tomorrow. We don't need further testing because we know it works."
Expert response: This team member is correct that there are problems that need to be fixed. However, there seems to be some promise in the change so it is worth fixing the problems and testing again.	*Expert response: This is the best option. The purpose of the PDSA is to test a change to see if it works. They tested this change, and while it has some problems, it also has potential. It is worth fixing those problems and doing a quick test again, perhaps with a few more patients, to see what happens. Doing these quick tests means that they don't spend time implementing flaws. They can refine the promising change and know it works before implementing across the facility.*	*Expert response: While this is a promising change, there are still a lot of problems and unknowns. Implementing this across the facility with all patients could create more confusion and problems and be detrimental. It needs more testing.*

Part 2

Which of the following improvements is NOT a good next step?	☐ Clarify what happens when the volunteer reaches the TB clinic with a patient ✓ Have the nurse escort patients instead of the volunteer ☐ Create a coverage schedule so there is always a volunteer available to escort patients	*There is nothing in the test that tells us that having the volunteer do this is a bad idea. It is best to keep testing with the volunteer.*
Which of the following is the best idea for the scale of the next test of having a schedule of volunteers to escort patients?	☐ Testing the new schedule of volunteers for 6 months ☐ Test on 200 patients ✓ Test a new schedule of volunteers for one full clinic day	*As one of the problems was a scheduling issue, it would be good to clarify this issue and then test for a full day to see if the new schedule provides adequate coverage.*

Results of the second PDSA: The team decided to test the new schedule for volunteers as well as clarify that the volunteer should escort the patient to the registration desk and let them know this is a referral. They tested this for one day and found it worked well. They plan to test this for a full week to see how this arrangement works on days when the clinics have different hours.

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Tips and Tools for Learning Improvement

Measurement for Improvement

Why is it important to measure improvement?

After developing a good aim statement, one may proceed with defining measure(s) (also called indicators) for improvement. Through good measures you can answer the question: "How do I know that a change is an improvement?"

Meaningful performance measures are essential for your improvement team to analyze current systems and processes, guide improvement efforts, and sustain optimal performance. Measures will tell you performance over time, including whether it is improving, declining or staying the same.

How do you measure improvement?

The rule in improvement is to measure on a regular basis and plot data on a time series chart to see how the changes being tested are affecting performance. To measure improvement, the following types of indicators are usually used: process and outcome.

Process indicator: Measures "processes of care" or the actions of providers during the care of patients. Processes of care may influence either immediate or future health outcomes. For example, to make sure that HIV-positive patients on antiretroviral therapy (ART) have good clinical status, we may want to make sure that all ART patients are screened for tuberculosis (TB) during their ART appointments, that they receive nutrition counseling or support, or that they are adhering to their ART regimen. An example of a process indicator could be: % of patients on ART who were screened for TB per protocol at their last ART appointment.

Outcome indicator: Measures how a system is performing with respect to the health or social status of a defined population or individual. For example, if we are trying to make sure that newborns remain infection free by improving safe and clean deliveries, a way we can measure that would be: % of newborns with sepsis on the 7th day of life.

How do you develop measures?

To develop measures, you need to start by looking at the aim statement you developed for your improvement work and determine what measure(s) would tell you whether you have reached that aim. Developing aim statements are covered in the ***Tips and Tools for Learning Improvement*** handout "Aim Statements". The example below describes how an aim statement leads to a process and outcome measure.

Example: Developing a measure

A health facility has problems with a high rate of post-partum hemorrhage, which it believes results from not all women receiving timely oxytocin (a uterotonic known to reduce post-partum hemorrhage). To address this gap, the improvement team developed the following improvement aim: Increase the percentage of women receiving oxytocin immediately after birth from 59% to 95% within 6 months.

Process indicator example: Percentage of women who were treated with oxytocin immediately after delivery of the baby at the health facility.

Outcome indicator example: Percentage of women with postpartum hemorrhage at the health facility.

Source: Improving Care of Mothers and Babies: A Guide for Improvement Teams. American Academy of Pediatrics and University Research Co., LLC. 2016

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Numerator ⟶ Group who receive service out of those eligible

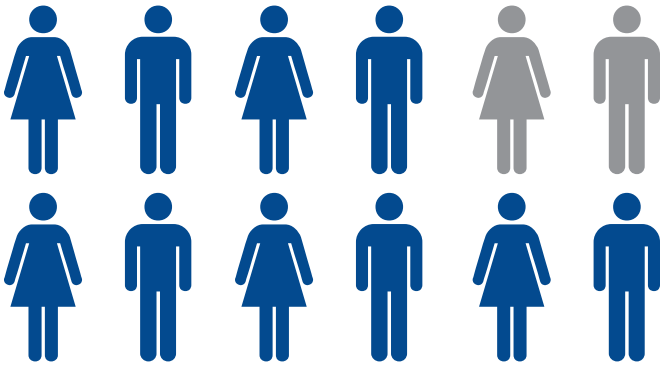
Denominator ⟶ Group who are eligible for service

Example of numerator and denominator

Percentage of children who have received all recommended vaccines

Numerator – # of children who have received all recommended vaccines by age 5 (blue kids)

Denominator - total # of children (all blue and grey kids)



For each indicator, you will need to define the denominator, numerator, and data sources. For example:

- The **denominator** represents the number of people who were eligible for a particular service during a defined period of time
- The **numerator** represents those who actually received the appropriate service in that same period of time
- **Data sources** could be patient registers, medical records, interviews, direct observations of a process of care, etc.

In addition, you will need to decide **who will collect the data and how often the data will be collected** (e.g., daily, weekly, monthly, quarterly). You should then do a test collection of the indicator to determine how easily the data can be accessed and whether there are any uncertainties (i.e., who is or isn't included in a denominator). For example, you may need to clarify whether stillbirths are included in the denominator of a newborn care indicator.

It is important to not overwhelm teams with too much data collection. Indicators should be limited to only the key information that is needed. Collecting too much data can easily overwhelm a new improvement team and slow down action. Indicators might be collected with different frequency over time—more frequently early in an improvement effort to make sure improvement is occurring and then less frequently later to monitor whether the desired performance is maintained.

Example: Defining a measure

To continue the example from above, please see how the process indicator was measured.

Process indicator: Describe what you are measuring.	Percentage of women who were treated with oxytocin immediately after delivery of the baby at the health care facility
Numerator: Who actually received the service?	Number of women who were treated with oxytocin immediately after delivery of the baby at the health care facility
Denominator: Who should receive the service which you are focusing on?	Number of women giving birth at the health care facility
Data source: Where are you getting your data from?	Delivery register
Frequency: How often will data be collected?	Weekly during period of testing changes, followed by monthly to monitor that improvement is sustained
Responsible person: Individual who will ensure that the data is collected and maintained.	Nurses-in-charge

When an indicator is expressed as a percentage, you would divide the numerator by the denominator and multiply by 100.

$$\frac{\text{Numerator}}{\text{Denominator}} \times 100 = \text{Percentage}$$

Exercise 1: Understanding measures

True or False

1. An outcome indicator measures how a system is performing with respect to the health or social status of a defined population or individual.

   A. True

   B. False

2. A process indicator measures the long-term results of what we are trying to improve.

   A. True

   B. False

Exercise 2: Defining a measure

For the following indicators, please fill in the numerator and denominator

Indicator	Numerator	Denominator
% of pregnant women tested for HIV during ANC visits daily		
% of circumcised males experiencing at least one moderate or severe adverse event during or in three days following surgery per week		
% of vulnerable children as defined by PEPFAR in village 1 sleeping under bed nets the previous night		
% of babies born in the facility who received skin-to-skin care		

Exercise 3: Creating a measure

A health team in Uganda decided that their overall goal was to improve the nutritional status of HIV positive patients. The first step in improving the nutritional status of HIV positive patients was to integrate regular monitoring of nutritional status into HIV services to better understand who is moderately or severely malnourished. The previous practice was ad hoc, with staff addressing nutrition issues only if the patients looked thin. The improvement aim the health center improvement team adopted for this process was: "Improve the nutritional status of HIV clients by assessing nutritional status using mid-upper arm circumference (MUAC) of 90% of HIV clients within 6 months." The team will have the registration officer and patient volunteer test out different options for assessing nutritional status using MUAC, and the data clerk will help aggregate the information from patient records.

Please fill out the table below:

Process indicator: Describe what you are measuring.	
Numerator: Who actually received the service?	
Denominator: Who should receive the service which you are focusing on?	
Data source: Where are you getting your data from?	
Frequency: How often will data be collected?	
Responsible person: Individual who will ensure that the data is collected and maintained.	

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Answer Key | Measurement for Improvement

Exercise 1: Understanding measures

True or False

1. An outcome indicator measures how a system is performing with respect to the health or social status of a defined population or individual.

   A. True

   B. False

2. A process indicator measures the long-term results of what we are trying to improve.

   A. True

   B. False

Exercise 2: Defining a measure

Indicator	Numerator	Denominator
% of pregnant women tested for HIV during ANC visits daily	*Number of pregnant women tested for HIV during ANC visits for a given day*	*Number of pregnant women who came in for ANC visits for a given day*
% of circumcised males experiencing at least one moderate or severe adverse event during or in three days following surgery per week	*Number of males circumcised in the health care facility who experience at least one moderate or severe adverse event in three days following surgery (based on week of surgery, not date of adverse event)*	*Number of males circumcised in the health care facility each week*
% of vulnerable children as defined by PEPFAR in village 1 sleeping under bed nets the previous night	*Number of vulnerable children as defined by PEPFAR in village 1 sleeping under bed nets the previous night*	*Number of vulnerable children as defined by PEPFAR monitored in village 1*
% of babies born in the facility who received skin-to-skin care	*Number of babies who received skin-to-skin care for the first hour after birth in the facility*	*Number of live births in the facility*

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Exercise 3: Creating a measure

Process indicator: Describe what you are measuring.	*% of HIV-positive clients assessed for malnutrition using MUAC*
Numerator: Who actually received the service?	*# of HIV-positive clients who had their nutritional status assessed using MUAC in the clinic*
Denominator: Who should receive the service which you are focusing on?	*# of HIV-positive clients seen in the clinic*
Data source: Where are you getting your data from?	*Client records*
Frequency: How often will data be collected?	*Weekly during the improvement process, followed by monthly to monitor sustained performance*
Responsible person: Individual who will ensure that the data is collected and maintained.	*Registration officer, volunteers, and data clerk*

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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).

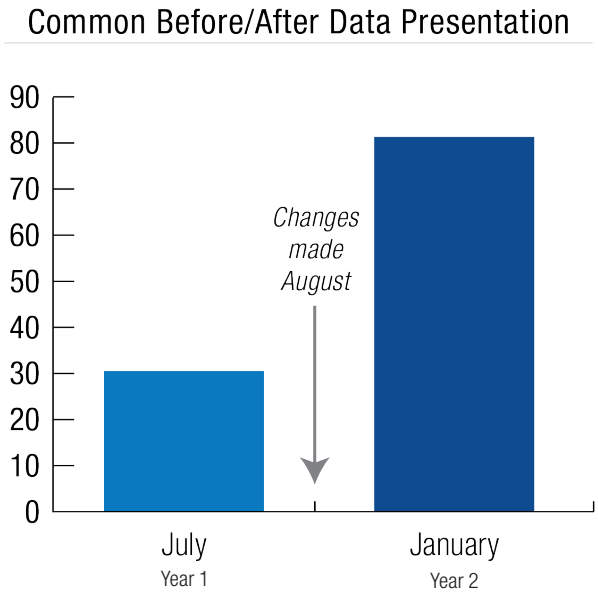
Why is a time series chart important?

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



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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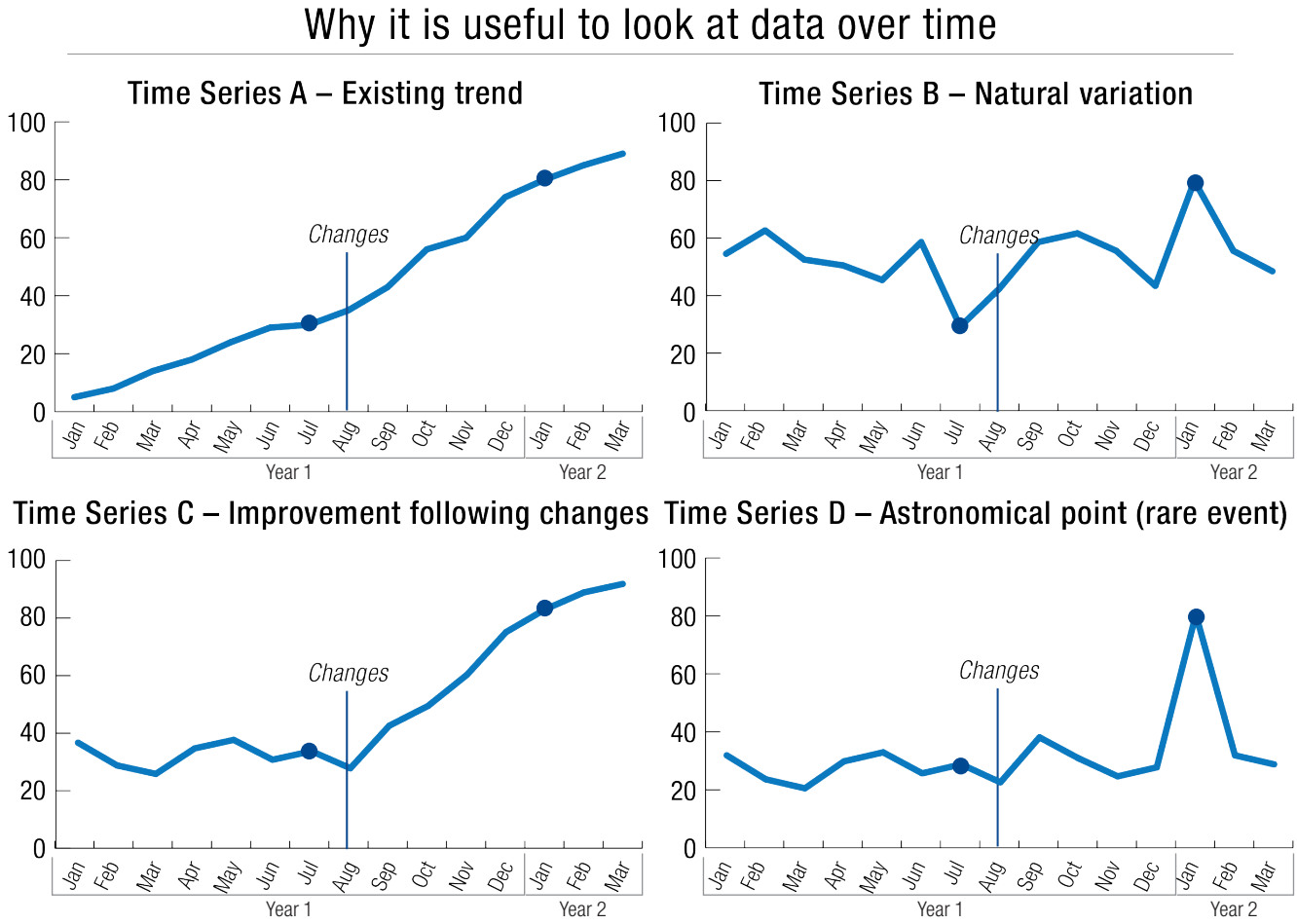
Figure 2. Time series charts tell a story



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.

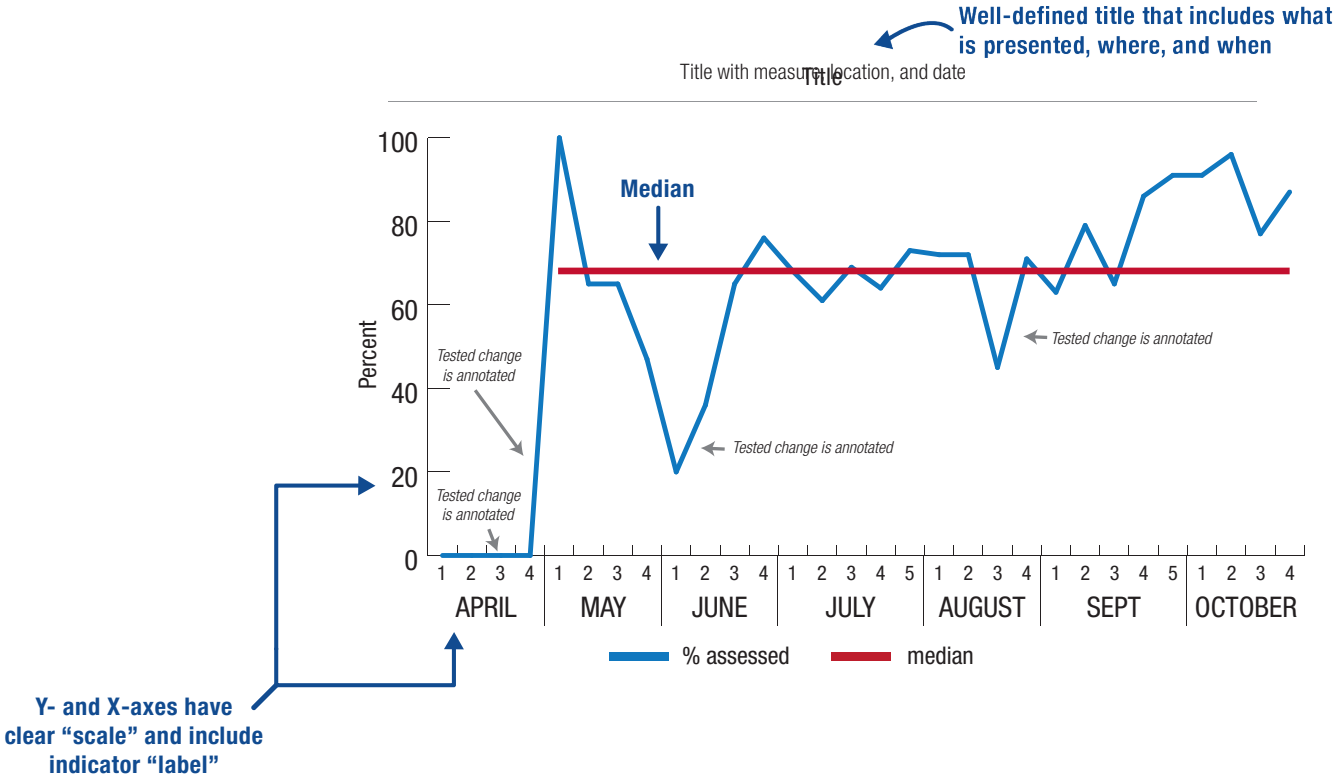
Step 5. Title the graph. Provide a well-defined title that includes what is presented, where, and during what period of time.

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



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:

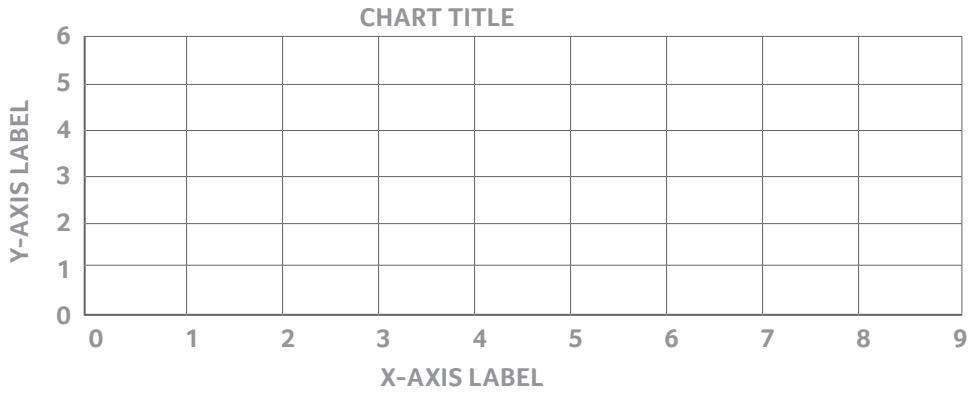
- Title: Numbers of cups of tea consumed each day
- Y-axis label: Number of cups of tea
- X-axis label: Day

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:

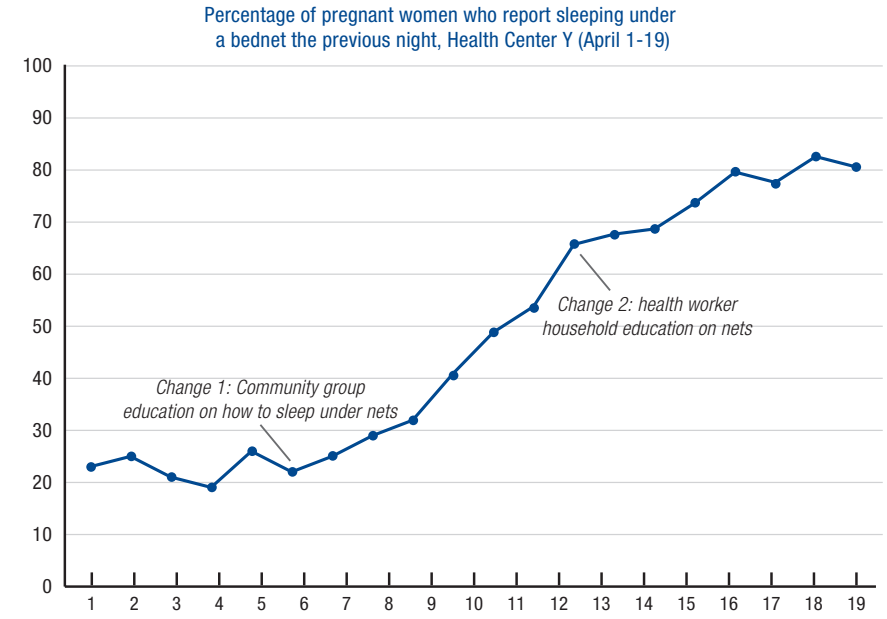
Day	Cups of tea
1	4
2	5
3	4
4	2
5	1
6	2
7	0
8	1



Exercise 2: Identifying parts of a time series chart

Review each chart and determine which component is missing.

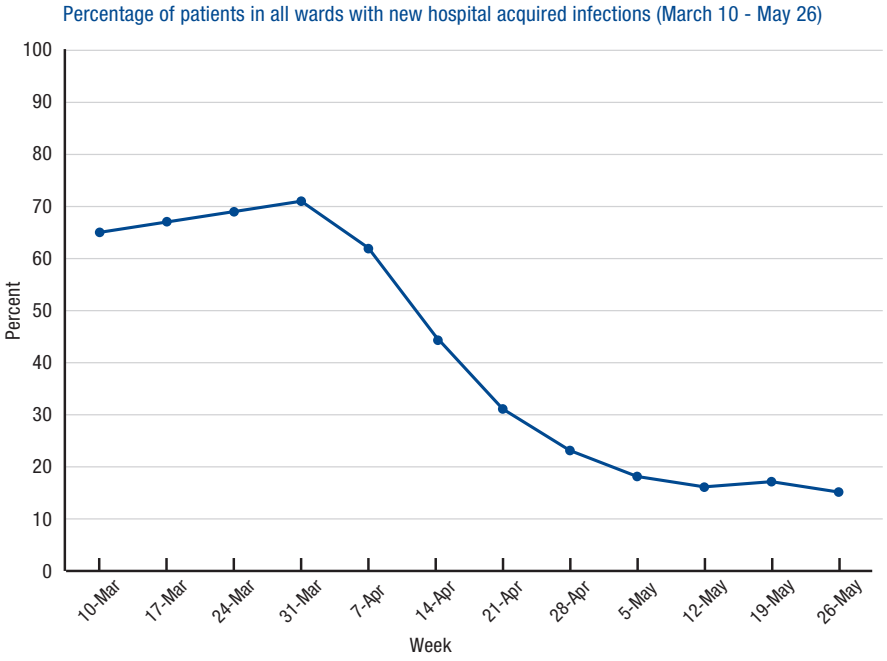
Time Series Chart 1



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

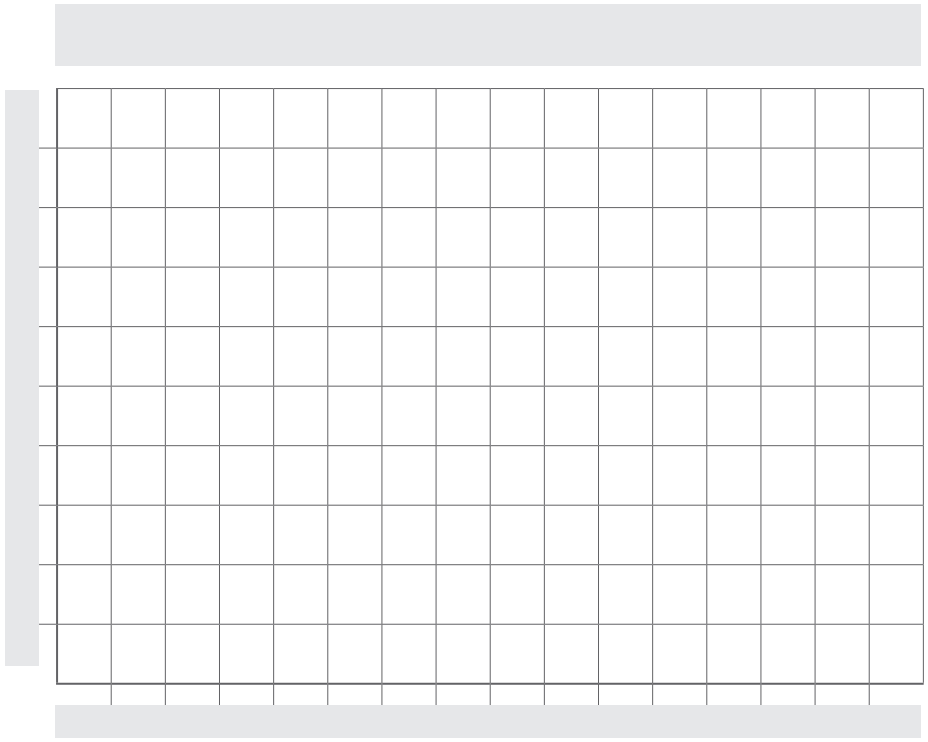
Use the information and blank graph provided below to create a time series chart. Remember:

- 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



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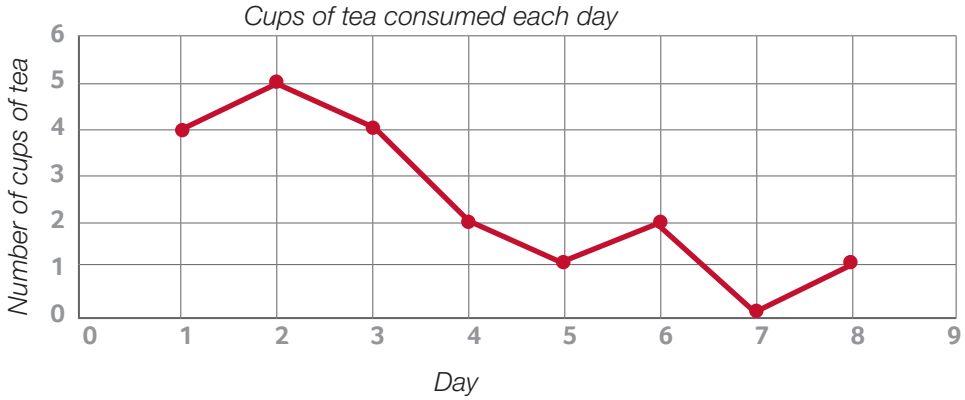
Tips and Tools for Learning Improvement

Answer Key | Measurement – Time Series Chart

Exercise 1: Plotting a time series chart



Exercise 2: Identifying parts of a time series chart

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 1:

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

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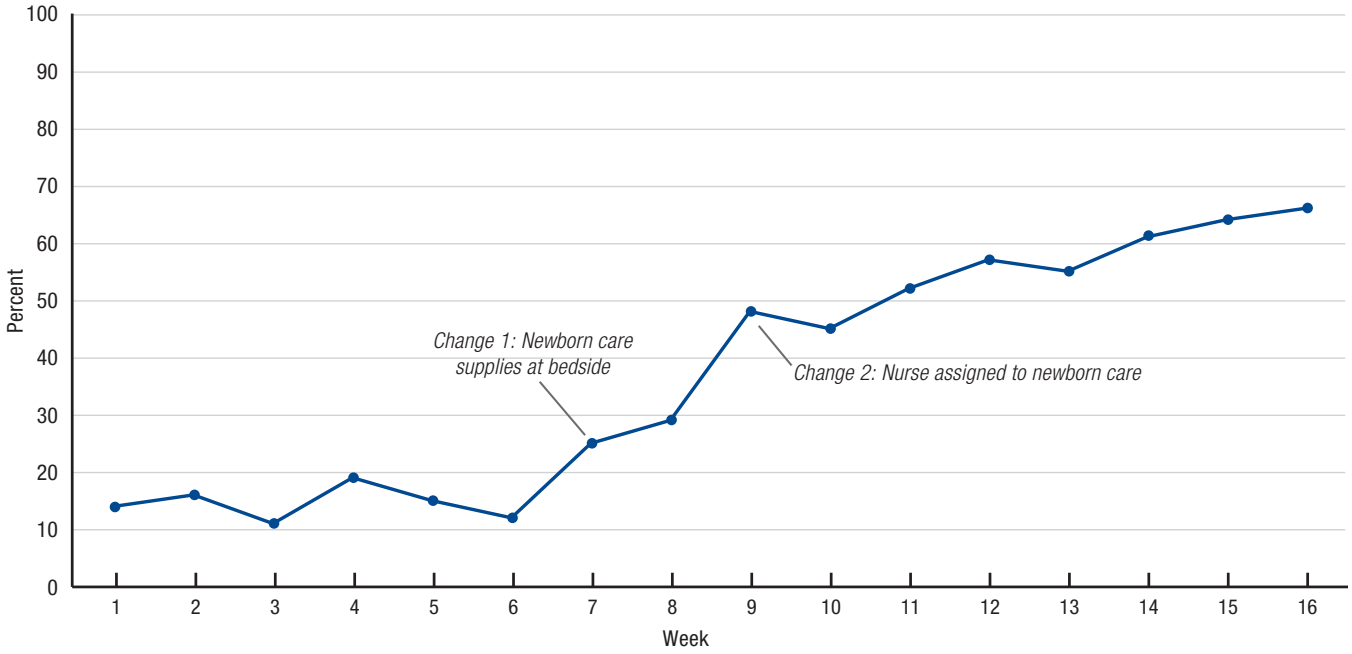
Exercise 3: Creating a time series chart

Percentage of newborns receiving all elements of essential newborn care within one hour per national standards, National Hospital (Weeks 1 to 16)



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Tips and Tools for Learning Improvement

Measurement
Variation vs. Improvement

What are variation and improvement?

Variation is the natural up and down in the performance of a process. For example, if you walk from your house to the market, it may take you 30 minutes on average. However, each time you go, the amount of time it takes varies – 31 minutes one day, 28 minutes another, 33 minutes another, and so forth. Figure 1 shows a time series chart with the variation of the process of walking to the market over a 12-day period. Each up and down in the graph does not represent a change in the process, but rather the variation that is normal for any process. To change the performance of the process significantly, you would need to do something differently, such as run, ride a bike, walk a different route, or drive in a car.

Changes in a process can lead to an improvement or decline in performance, or may not make a difference in performance. Whether an increasing or decreasing value is improvement or a decline in performance depends on the data being tracked. For example, increasing compliance with standards and decreasing morbidity would both reflect improvement. Sometimes, when collecting data over time, it can be obvious that things are improving rapidly. For example, Figure 2 clearly shows a reduction in the percentage of men with infections following voluntary male circumcision, which is an improvement. The improvement team is achieving its goal of reducing the number of men with infections. In cases where the data points continue to move in one direction, it is easy to determine whether improvement has been made.

Figure 1. Variation example: Time to walk to the market daily

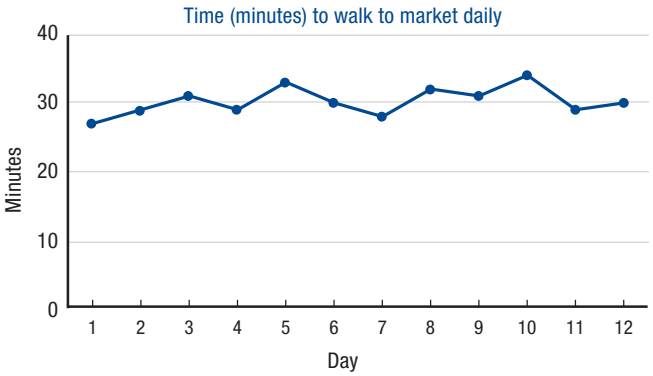
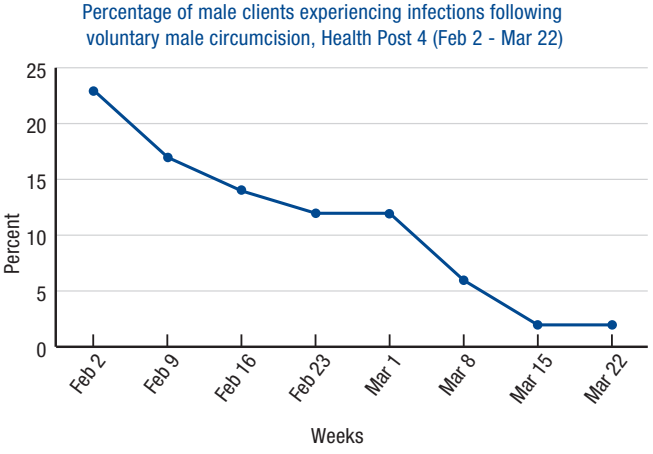


Figure 2. Example of improvement in outcome



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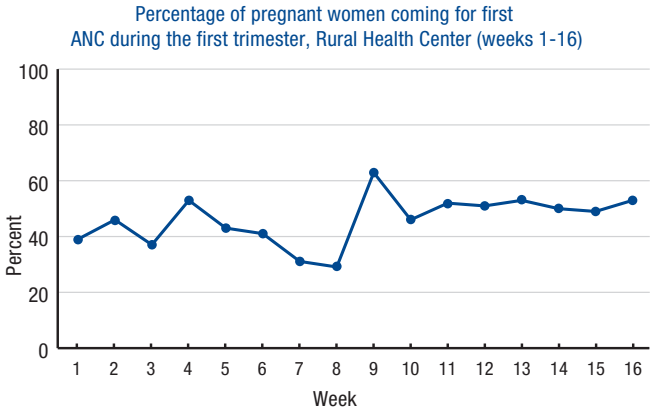
Why is it important to understand variation?

Understanding the difference between variation and improvement is important because a slight increase or decrease between data points can be normal variation and does not necessarily signify improvement or decline in performance.

How do you determine if a time series chart shows improvement?

Figure 3 shows an example of a time series chart that would need more analysis to determine if the process of getting pregnant women to come in for their first antenatal care (ANC) visit had improved. Looking at the chart you could interpret the data as showing that the process is getting worse between weeks 4 and 8 and then is improving in week 9. However, without further analysis you cannot be sure whether the process is declining and improving or simply shows variation in a process. There are simple rules you can use to figure out whether your time series charts show improvement.

Figure 3. Example of a time series chart with unclear performance



Analyzing a time series chart

A run chart is a specific type of time series chart in which a set of rules are applied to analyze the data. The terms run chart and time series chart are often used interchangeably. You need 10 data points before you can apply run chart rules.

When you have at least 10 data points, you can also determine the middle or central value of the data points, called the **median.** See the text box for more information on calculating and plotting the median.

How to calculate and plot the median

1. List the numbers in order from smallest to largest.
2. If there is an odd number of data points in the set, take the number in the middle. For example, the median (or middle value) of the following set of 15 data points is the 8th number, or 11: 3, 4, 6, 7, 9, 10, 10, 11, 13, 14, 17, 17, 18, 20, 22
3. If the data set has an even number of data points, add the middle pair of numbers together and divide by two. For example, the median in the following set of 16 data points is the average of the 8th and 9th numbers, or 12: 3, 4, 6, 7, 9, 10, 10, 11, 13, 14, 17, 17, 18, 20, 22, 24 (median= (11+13)/2)
4. Draw a horizontal line on the time series chart to represent the median.

There are two main types of analysis (called run chart rules) that will tell you whether or not you have improvement: **trend** and **shift.**

Trend: Five consecutive increasing or decreasing points suggest a **trend.** *A trend is continued movement of data in a single direction, either up or down, and means that something has happened (a change) that is causing the process to perform differently, either improving or declining in performance.* You do not need the median to determine a trend.

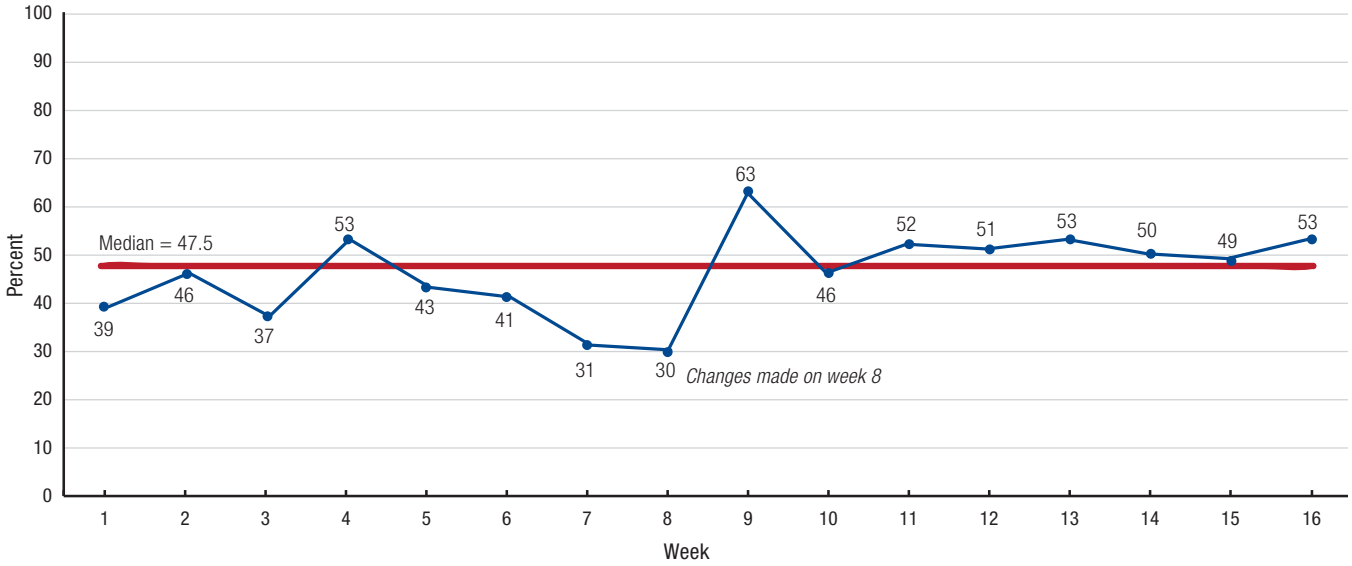
Shift: Six consecutive points above or below the median line suggest a **shift** in the process. *A shift is a pattern that shows that a change has caused the process to either improve or decline.* Before applying the run chart rules for shifts, it is important to calculate and plot the median. The median is the central value in a list of numbers.

In **Figure 4,** the median is 47.5. If we draw the median on the graph, we can see whether this example follows either of these run chart rules.

Let's analyze **Figure 4.** A median is not required to check for a **trend.** We start by comparing each point to the previous point. There are 4 decreasing points in a row from weeks 5 to 8 in the middle of the graph. We start counting the trend at week 5 because that is the first point to go down. Because five points are needed for a trend, the drop from weeks 5 to 8 is not a trend.

Figure 4. Example of run chart with median

Percentage of pregnant women coming for first ANC during first trimester, Rural Health Center (weeks 1-16)



The last six points on the graph are continuously above the median. Six data points above the median means that there has been a **shift** in the performance of the system. These six points do not need to be in increasing or decreasing order. You can have a shift without a trend. For the indicator "Percentage of pregnant women coming for first ANC during the first trimester", we would be looking for the percentage to *increase* in order to show improvement. Since the six points in the shift are above the median, then we can say with confidence that this process has *improved.*

Run chart rules give us tools grounded in mathematics and statistics to determine whether improvement has occurred, but this should make intuitive sense as well. Look at the first seven weeks of data in **Figure 4.** There is a lot of variation, with performance ranging from a low of 31% to a high of 53%. This contrasts with weeks 11 to 16, which indicate a shift has occurred, where performance is consistently between 49% and 53%. Improvement involves both reducing variation and increasing performance.

When analyzing run charts, the size of the denominator and whether the denominator represents a sample or the whole patient population can alter the interpretation. For the sake of simplicity, the rules above assume that the denominator is large enough to interpret and is fairly consistent over time.

Exercise 1: Calculating a median

For this exercise, you should calculate the median using the following steps.

1. Take all data points and order them in numerical order. Make sure to include any repeated numbers.
2. Count the number of data points.
3. Calculate the median.
   a. If the number of data points is an odd number, take the middle number as the median.
   b. If the number of data points is an even number, take the two middle values, add them together and divide them by two to get the average.

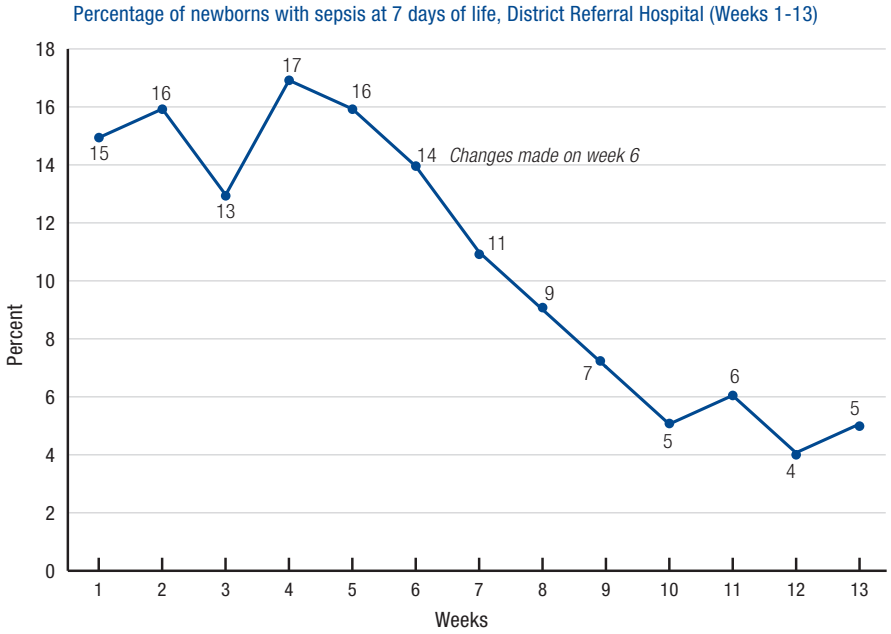
Calculate the median for the data sets below:

Data set	Line up the numbers in numerical order	Median
52, 41, 44, 60, 77, 41, 58		
10, 6, 15, 20, 7, 3		
4, 8, 0, 2, 4, 2, 6, 7		
11, 82, 33, 59, 25, 71		

Exercise 2: Determining variation or improvement

For this exercise, simply look at the charts below to see whether improvement is obvious or if you need to do more analysis. There is a tendency to guess at whether improvement has happened, rather than doing analysis. How accurate are your guesses? In the next exercise, we will analyze the charts further.

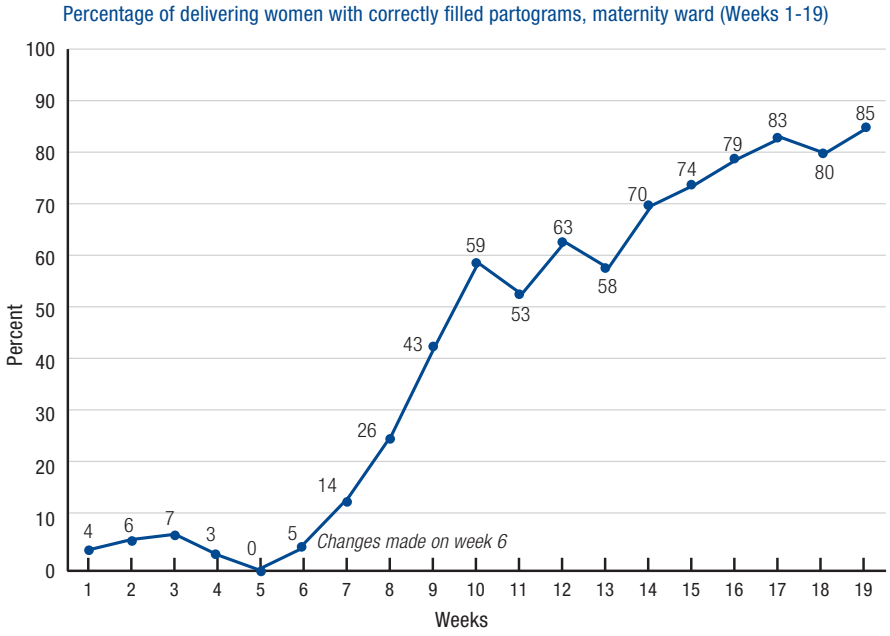
Example 1



What can you tell from this graph? Check the right answer.

- ☐ It shows improvement
- ☐ It does not show improvement
- ☐ I can't tell. I need to do more analysis

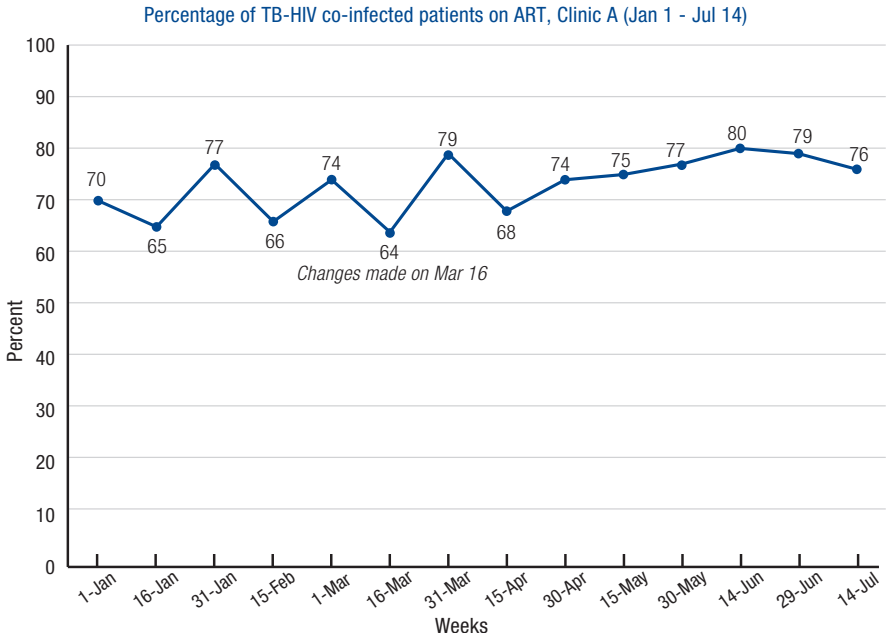
Example 2



What can you tell from this graph? Check the right answer.

- ☐ It shows improvement
- ☐ It does not show improvement
- ☐ I can't tell. I need to do more analysis

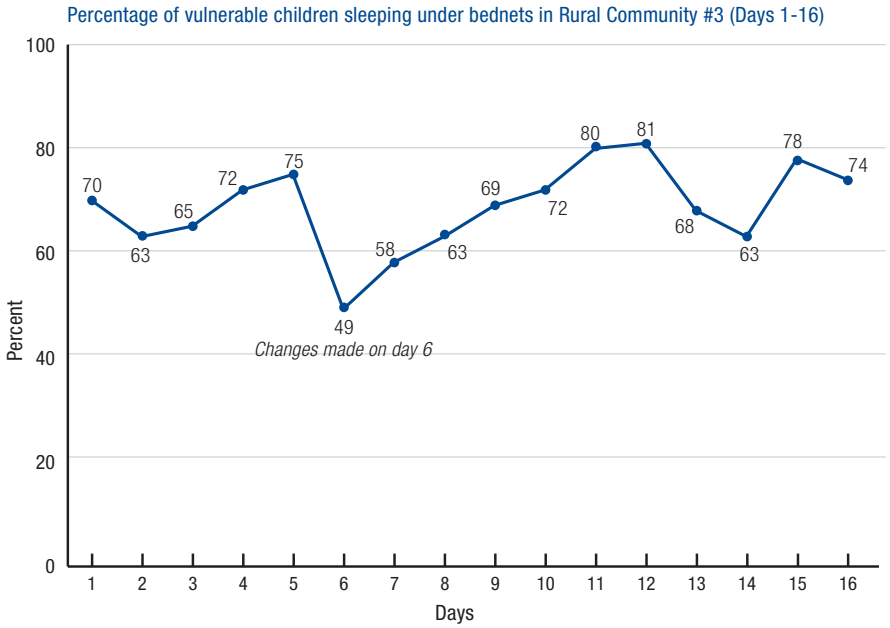
Example 3



What can you tell from this graph? Check the right answer.

- ☐ It shows improvement
- ☐ It does not show improvement
- ☐ I can't tell. I need to do more analysis

Example 4



What can you tell from this graph? Check the right answer.

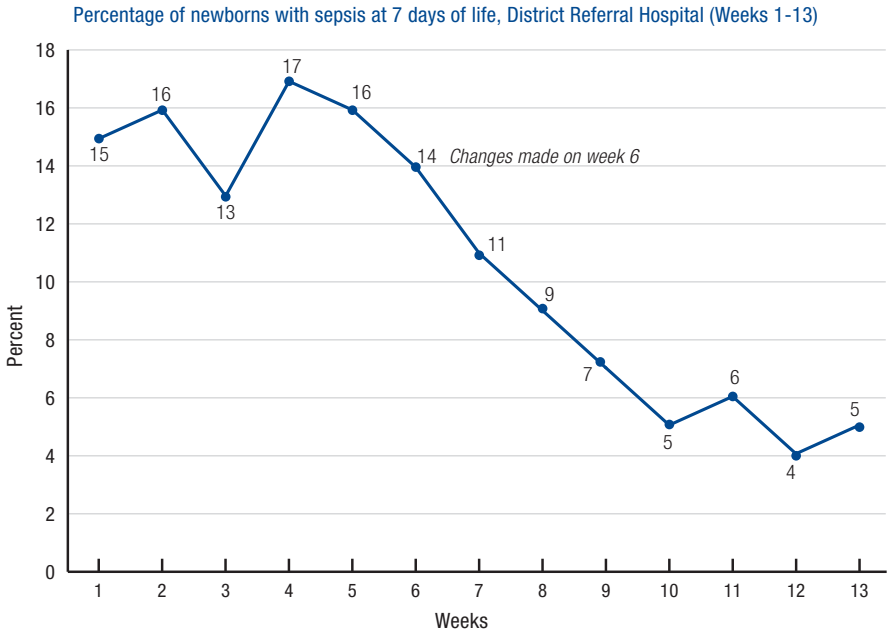
- ☐ It shows improvement
- ☐ It does not show improvement
- ☐ I can't tell. I need to do more analysis

Exercise 3: Practicing run chart rules

For the graphs below, determine if there is improvement or not using the run chart rules. Keep in mind the following tips:

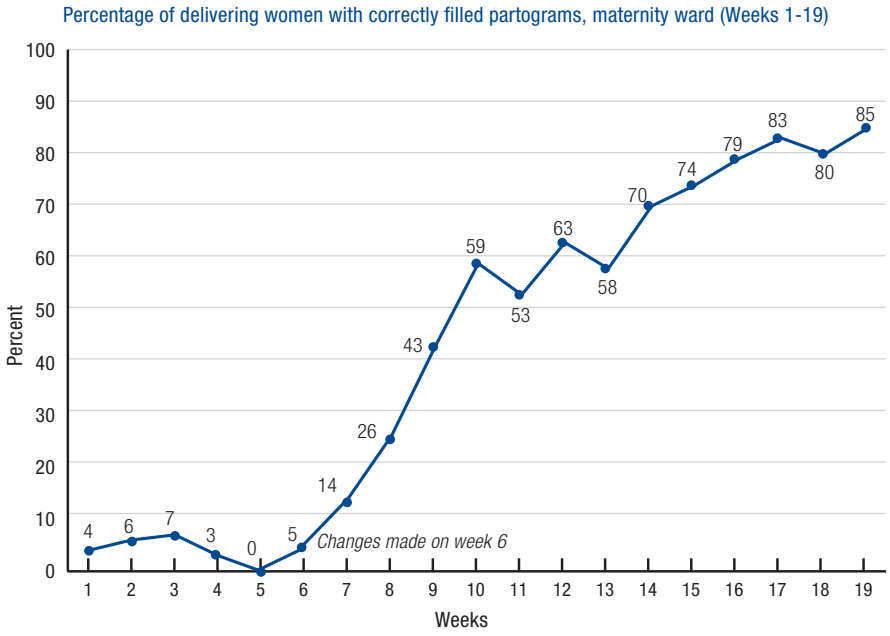
- You need 10 data points before you can apply run chart rules.
- 5 consecutive points up or down in one direction indicate a trend. This may show improvement or decline in performance, depending on the indicator.
- After calculating the median, if there are 6 or more consecutive points above or below the median you have a shift.

Example 1



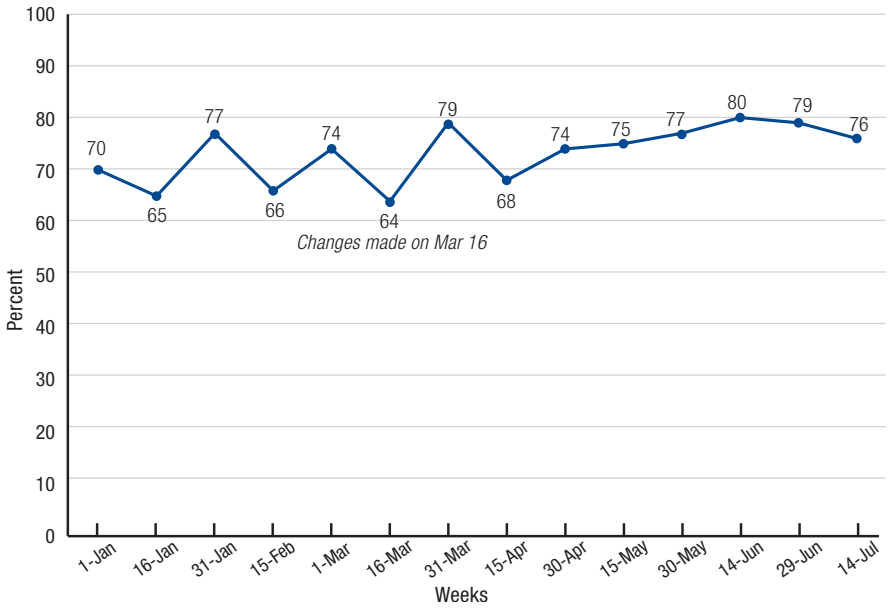
Analysis question	Circle or write in the answer
At least 10 data points?	Yes No
Do at least 5 points continue up or down in the same direction?	Yes No
Is there a trend?	Yes No
What is the median? (write in and draw on graph)	
Are there 6 or more points above or below the median?	Yes No
Is there a shift?	Yes No
Does this graph show improvement?	Yes No

Example 2



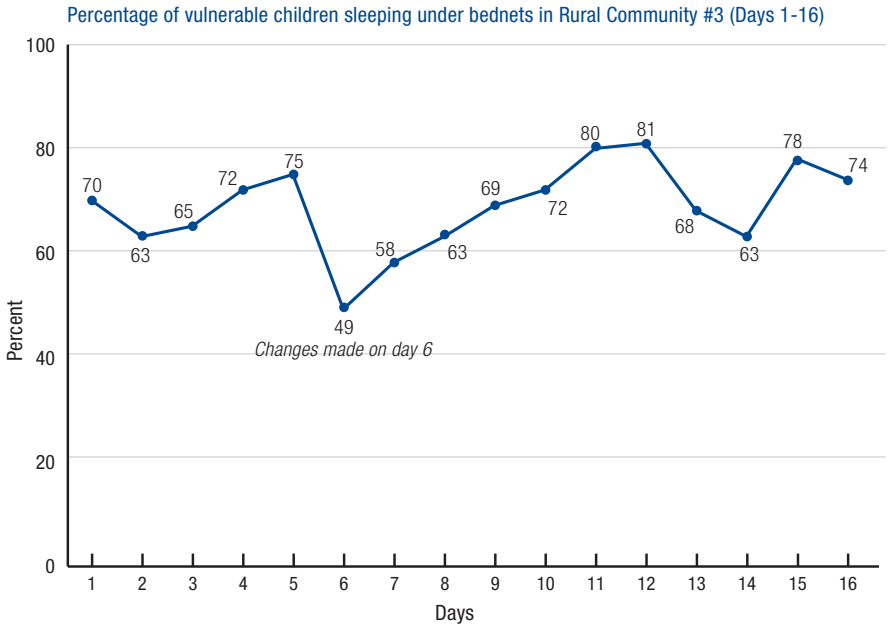
Analysis question	Circle or write in the answer
At least 10 data points?	Yes No
Do at least 5 points continue up or down in the same direction?	Yes No
Is there a trend?	Yes No
What is the median? (write in and draw on graph)	
Are there 6 or more points above or below the median?	Yes No
Is there a shift?	Yes No
Does this graph show improvement?	Yes No

Example 3



Analysis question	Circle or write in the answer
At least 10 data points?	Yes No
Do at least 5 points continue up or down in the same direction?	Yes No
Is there a trend?	Yes No
What is the median? (write in and draw on graph)	
Are there 6 or more points above or below the median?	Yes No
Is there a shift?	Yes No
Does this graph show improvement?	Yes No

Example 4



Analysis question	Circle or write in the answer
At least 10 data points?	Yes No
Do at least 5 points continue up or down in the same direction?	Yes No
Is there a trend?	Yes No
What is the median? (write in and draw on graph)	
Are there 6 or more points above or below the median?	Yes No
Is there a shift?	Yes No
Does this graph show improvement?	Yes No

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Applying Science to Strengthen and Improve Systems

Tips and Tools for Learning Improvement

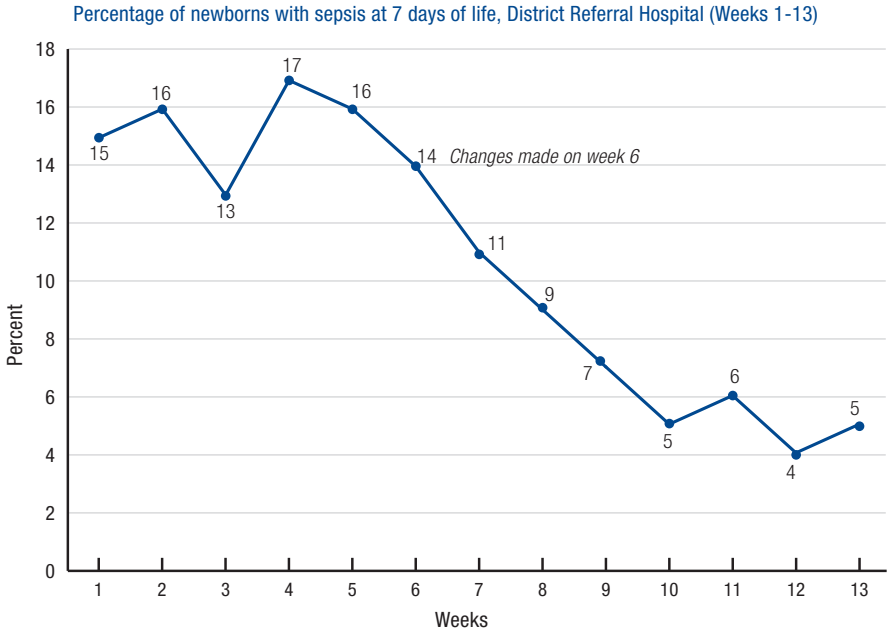
Answer Key | Measurement - Variation vs. Improvement

Exercise 1: Calculating a median

Data set	Line up the numbers in numerical order	Median
52, 41, 44, 60, 77, 41, 58	*41 41 44 52 58 60 77*	*52*
10, 6, 15, 20, 7, 3	*3 6 7 10 15 20*	*8.5*
4, 8, 0, 2, 4, 2, 6, 7	*0 2 2 4 4 6 7 8*	*4*
11, 82, 33, 59, 25, 71	*11 25 33 59 71 82*	*46*

Exercise 2: Determining variation or improvement

Example 1



What can you tell from this graph? Check the right answer.

- ✓ It shows improvement
- ☐ It does not show improvement
- ☐ I can't tell. I need to do more analysis

MAY 2017

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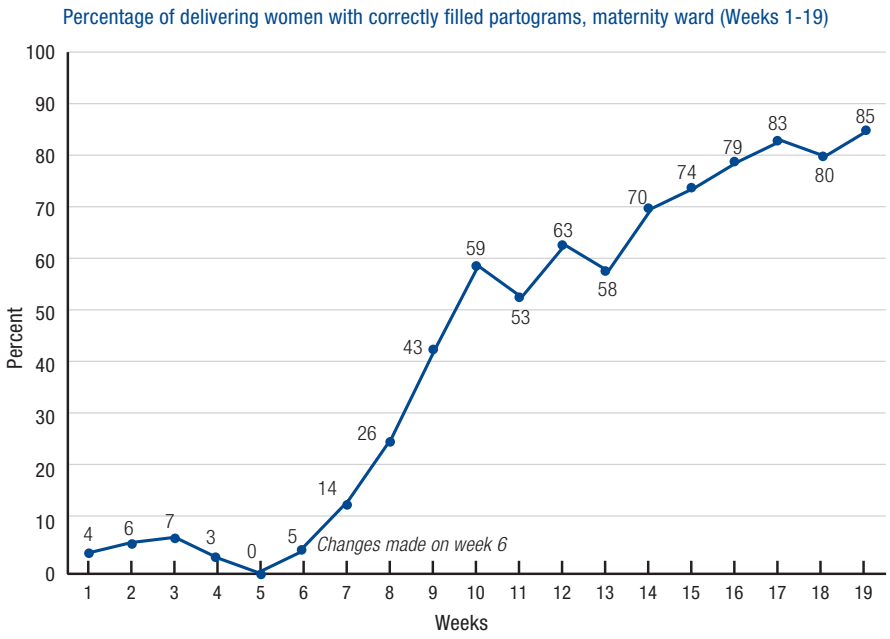
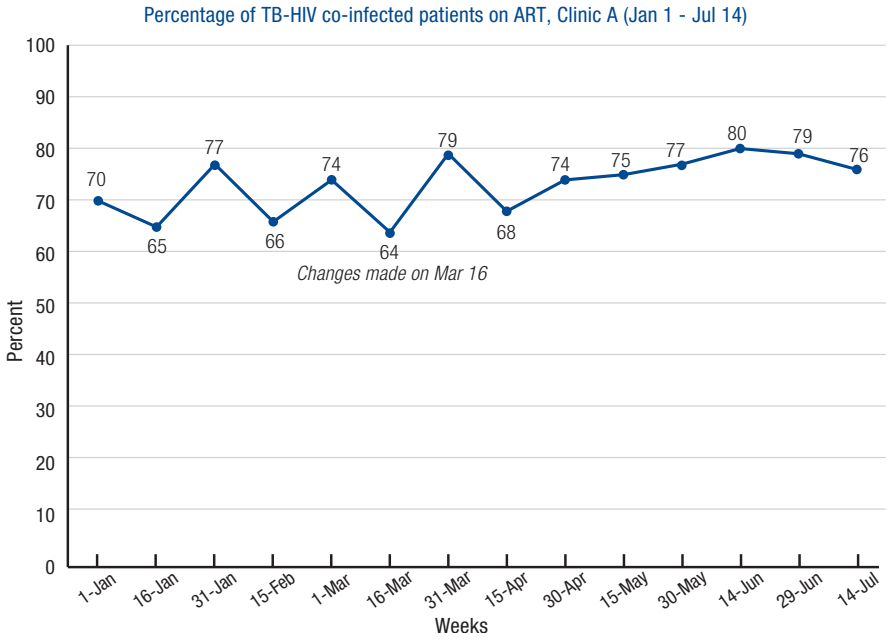
Example 2



What can you tell from this graph? Check the right answer.

- [x] It shows improvement
- [ ] It does not show improvement
- [ ] I can't tell. I need to do more analysis

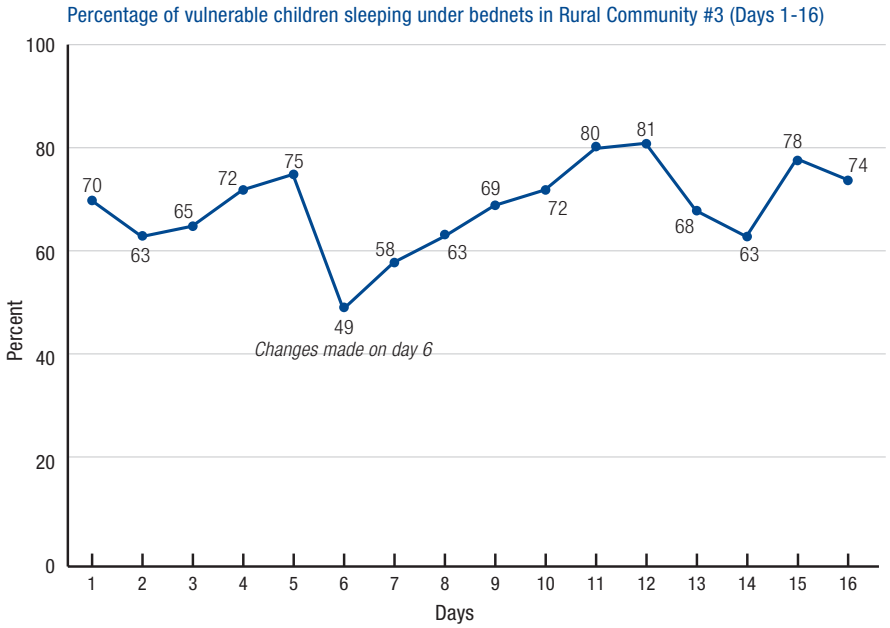
Example 3



What can you tell from this graph? Check the right answer.

- [ ] It shows improvement
- [ ] It does not show improvement
- [x] I can't tell. I need to do more analysis

Example 4

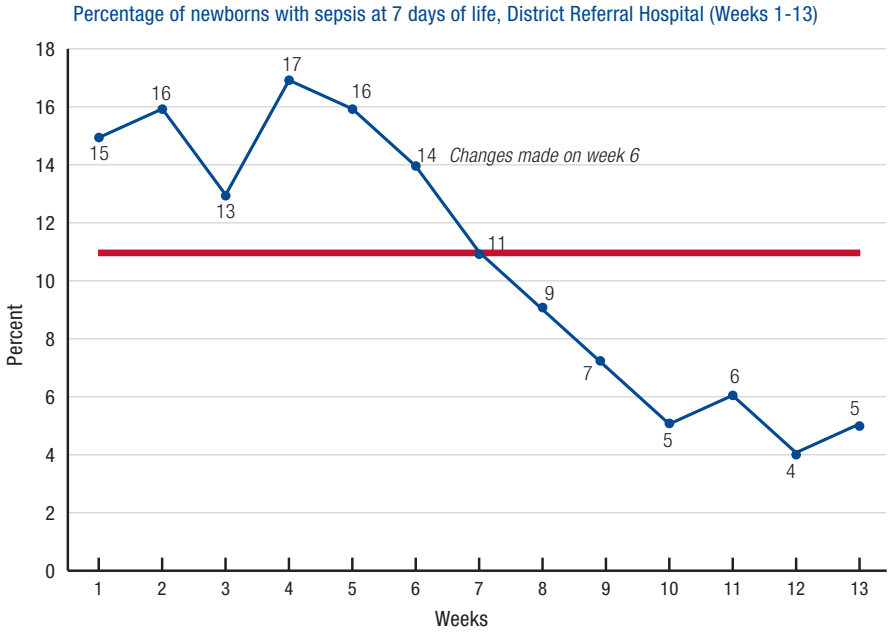


What can you tell from this graph? Check the right answer.

- ☐ It shows improvement
- ☐ It does not show improvement
- ✓ I can't tell. I need to do more analysis

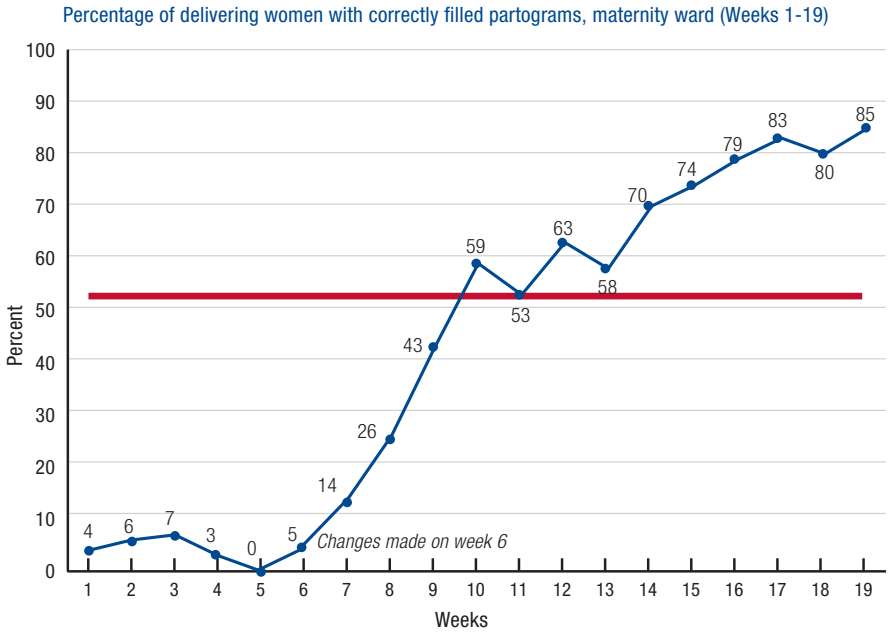
Exercise 3: Practicing run chart rules

Example 1



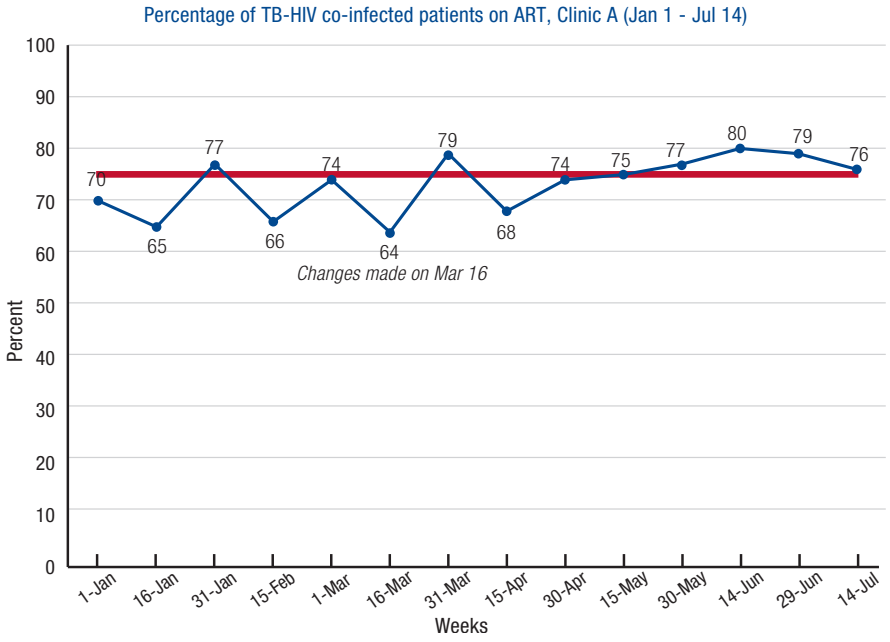
Analysis question	Circle or write in the answer
At least 10 data points?	(Yes) No
Do at least 5 points continue up or down in the same direction?	(Yes) No
Is there a trend?	(Yes) No
What is the median? (write in and draw on graph)	*11*
Are there 6 or more points above or below the median?	(Yes) No
Is there a shift?	(Yes) No
Does this graph show improvement?	(Yes) No

Example 2



Analysis question	Circle or write in the answer
At least 10 data points?	(Yes) No
Do at least 5 points continue up or down in the same direction?	(Yes) No
Is there a trend?	(Yes) No
What is the median? (write in and draw on graph)	*53*
Are there 6 or more points above or below the median?	(Yes) No
Is there a shift?	(Yes) No
Does this graph show improvement?	(Yes) No

Example 3

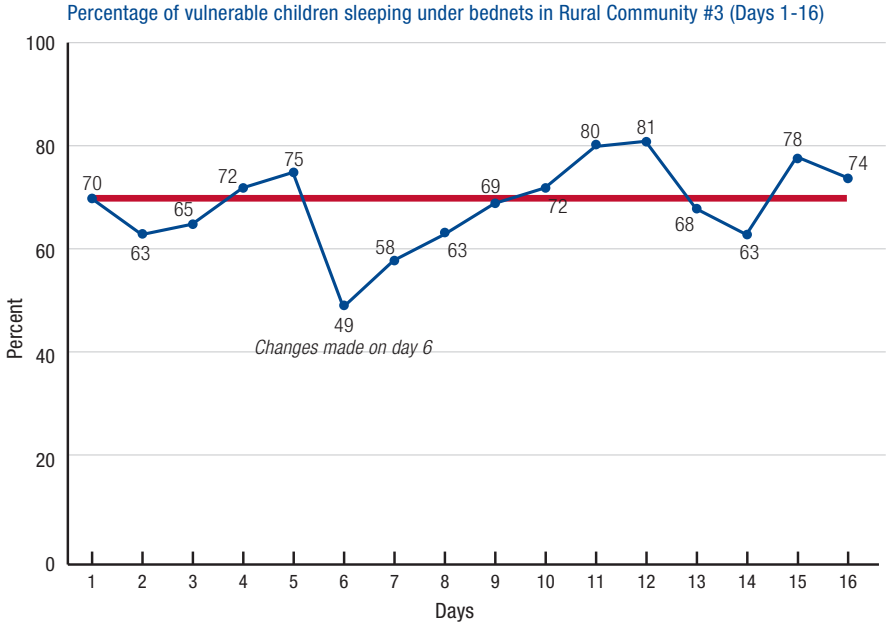


Analysis question	Circle or write in the answer
At least 10 data points?	(Yes) No
Do at least 5 points continue up or down in the same direction?	Yes (No)
Is there a trend?	Yes (No)
What is the median? (write in and draw on graph)	*74.5*
Are there 6 or more points above or below the median?	Yes (No)
Is there a shift?	Yes (No)
Does this graph show improvement?	Yes (No)

There is no trend here. You begin counting with the first data point going up, in this case Apr 30 (74). There are only 4 points.

The data show that there appears to be a change in the right direction towards improved performance. There are currently 5 points above the median. If the next point turns out to be above the median, then we would have a shift and could claim improvement in the process.

Example 4



Analysis question	Circle or write in the answer
At least 10 data points?	(Yes) No
Do at least 5 points continue up or down in the same direction?	(Yes) No
Is there a trend?	(Yes) No
What is the median? (write in and draw on graph)	*69.5*
Are there 6 or more points above or below the median?	Yes (No)
Is there a shift?	Yes (No)
Does this graph show improvement?	(Yes) No *between days 6 and 12*

It is not clear whether improvement will be sustained as the last few points on the graph are dropping. An improvement team would want to watch performance carefully and make note of anything that might be hindering performance.

There are options for more advanced analysis which are not covered here and not expected for the learner to know. For example, you can compare the median for the baseline period (days 1 – 6) with the median after the baseline (days 7 – 16). In this case, the baseline median is 67.5 and the median for the period after changes were made is 70.5 which shows improvement. We may be seeing a new variation pattern at the end of the graph. We would need more data points to understand exactly what is happening.

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