IHI[1] Model for Improvement

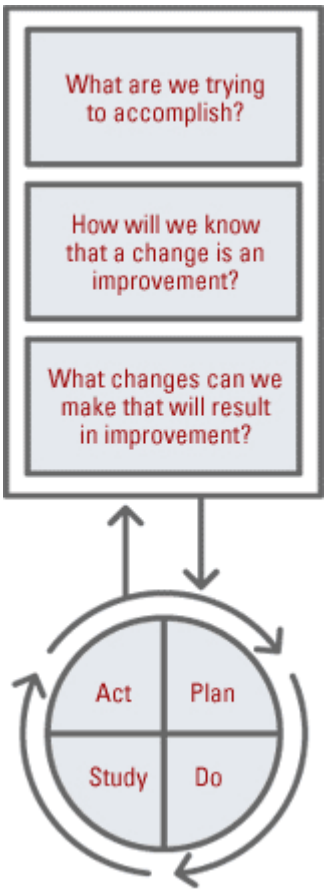
The Model for Improvement,* developed by Associates in Process Improvement, is a simple yet powerful tool for accelerating improvement. The model is not meant to replace change models that organizations may already be using, but rather to accelerate improvement. This model has been used very successfully by hundreds of health care organizations in many countries to improve many different health care processes and outcomes.

The model has two parts:

- Three fundamental questions, which can be addressed in any order.
- The Plan-Do-Study-Act (PDSA) cycle** to test changes in real work settings. The PDSA cycle guides the test of a change to determine if the change is an improvement.

Forming the Team

Including the right people on a process improvement team is critical to a successful improvement effort. Teams vary in size and composition. Each organization builds teams to suit its own needs.



Setting Aims

Improvement requires setting aims. The aim should be time-specific and measurable; it should also define the specific population of patients or other system that will be affected.

Establishing Measures

Teams use quantitative measures to determine if a specific change actually leads to an improvement.

Selecting Changes

Ideas for change may come from the insights of those who work in the system, from change concepts or other creative thinking techniques, or by borrowing from the experience of others who have successfully improved.

Testing Changes

The Plan-Do-Study-Act (PDSA) cycle is shorthand for testing a change in the real work setting — by planning it, trying it, observing the results, and acting on what is learned. This is the scientific method adapted for action-oriented learning.

1 www.ihi.org

Implementing Changes

After testing a change on a small scale, learning from each test, and refining the change through several PDSA cycles, the team may implement the change on a broader scale — for example, for an entire pilot population or on an entire unit.

Spreading Changes

After successful implementation of a change or package of changes for a pilot population or an entire unit, the team can spread the changes to other parts of the organization or in other organizations.

Forming the Team

Including the right people on an improvement team is critical to a successful improvement effort. Teams vary in size and composition. Each organization builds teams to suit its own needs.

First, review the aim.

Second, consider the system that relates to that aim: What system will be affected by the improvement efforts?

Third, be sure that the team includes members familiar with all the different parts of the process — managers and administrators as well as those who work in the process, including physicians, pharmacists, nurses, and front-line workers.

Finally, each team needs an executive sponsor who takes responsibility for the success of the project.

Examples of Effective Teams

Effective teams include members representing three different kinds of expertise within the organization: system leadership, technical expertise, and day-to-day leadership. There may be one or more individuals on the team with each kind of expertise, or one individual may have expertise in more than one area, but all three areas should be represented in order to drive improvement successfully.

Clinical Leader

Teams need someone with enough authority in the organization to test and implement a change that has been suggested and to deal with issues that arise. The team's clinical leader understands both the clinical implications of proposed changes and the consequences such a change might trigger in other parts of the system.

Technical Expertise

A technical expert is someone who knows the subject intimately and who understands the processes of care. An expert on improvement methods can provide additional technical support by helping the team determine what to measure, assisting in design of simple, effective measurement tools, and providing guidance on collection, interpretation, and display of data.

Day-to-Day Leadership

A day-to-day leader is the driver of the project, assuring that tests are implemented and overseeing data collection. It is important that this person understands not only the details of the system, but also the various effects of making change(s) in the

system. This person also needs to be able to work effectively with the physician champion(s).

Project Sponsor

In addition to the working members listed above, a successful improvement team needs a sponsor, someone with executive authority who can provide liaison with other areas of the organization, serve as a link to senior management and the strategic aims of the organization, provide resources and overcome barriers on behalf of the team, and provide accountability for the team members. The Sponsor is not a day-to-day participant in team meetings and testing, but should review the team's progress on a regular basis.

Example 1: Improving Care in Office Practices

Aim: We will improve care for all our patients with chronic disease by making improvements in our clinic that impact the six dimensions of quality, as outlined in the Institute of Medicine report, *Crossing the Quality Chasm: A New Health System for the 21st Century*.

Team:

- Technical Expert: ____, MD, Physician at downtown clinic
- Day-to-Day Leader: ____, RN, Manager of downtown primary care clinic
- Additional Team Members: Patient educator, medical assistant, clerk/scheduler, laboratory manager, quality expert
- Sponsor: _____, MD, Medical Director for primary care practices

Example 2: Improving Patient Safety

Aim: Reduce adverse drug events (ADEs) on all medical and surgical units by 75 percent within 11 months.

Team:

- Clinical Leader: ___, MD, Chair, Pharmacy and Therapeutics Committee, Patient Safety Officer
- Technical Expertise: ____, RPh, Director, Clinical Pharmacist
- Day-to-Day Leadership: ____, RN, Manager, Medical/Surgical Nursing
- Additional Team Members: Risk Manager, Quality Improvement Specialist, Staff Nurse, Staff Education, and Information Technology
- Sponsor: ___, MD, Chief Medical Officer

Example 3: Improving Critical Care

Aim: Redesign the leadership and care systems of our Medical Intensive Care Unit (MICU) in order to reduce harm and improve outcomes for patients.

Team:

- Clinical Leader: ____, MD, Medical Director, Medical Intensive Care Unit (MICU)
- Technical Expertise: ____, MD, Intensivist
- Day-to-Day Leadership: ____, RN, MICU Manager
- Additional Team Members: Respiratory Therapy, Quality Improvement Specialist, Staff Nurse, Clinical Pharmacist, Clinical Nurse Specialist
- Sponsor: _____, MD, Chief Operating Officer

Example 4: Improving Flow

Aim: Ensure that patients receive timely access to appropriate care in our hospital and move through the system efficiently.

Emergency Department Team:

- Clinical Leader: Medical Director or Physician
- Technical Expertise: Director or Nurse Manager
- Day-to-Day Leadership: Front-line nurse
- Two "continuity staff" with a cross-organizational view of flow (e.g., Operations Engineer or vice president with management responsibilities across departments/services, who will be assigned to this work over time)

Intensive Care Unit Team:

- Clinical Leader: Intensivist or Medical Director
- Technical Expertise: Director or Nurse Manager
- Day-to-Day Leadership: Front-line nurse
- Two "continuity staff" with a cross-organizational view of flow, e.g., Operations Engineer or vice president with management responsibilities across departments/services, who will be assigned to this work over time

Operating Room Team:

- Clinical Leader: Surgeon or Anesthesiologist
- Technical Expertise: Director or Manager of Surgical Services
- Day-to-Day Leadership: Operating Room (OR) Nurse (circulating or scrub nurse)
- Surgery Technician
- One "continuity staff" with a cross-organizational view of flow, e.g., Operations Engineer or vice president with management responsibilities across departments/services, who will be assigned to this work over time

Project Sponsor:

Chief Executive Officer

Setting Aims

Improvement requires setting aims. An organization will not improve without a clear and firm intention to do so. The aim should be time-specific and measurable; it should also define the specific population of patients that will be affected. Agreeing on the aim is crucial; so is allocating the people and resources necessary to accomplish the aim.

In 1999, the Institute of Medicine (IOM) in Washington, DC, USA, released *To Err Is Human: Building a Safer Health System*, a report that brought much public attention to the crisis of patient safety in the United States. In 2001, the IOM issued a second report, *Crossing the Quality Chasm: A New Health System for the 21st Century*, which outlines six overarching "Aims for Improvement" for health care:

- **Safe:** Avoid injuries to patients from the care that is intended to help them.
- **Effective:** Match care to science; avoid overuse of ineffective care and underuse of effective care.
- **Patient-Centered:** Honor the individual and respect choice.
- **Timely:** Reduce waiting for both patients and those who give care.
- **Efficient:** Reduce waste.
- **Equitable:** Close racial and ethnic gaps in health status.

Many organizations use the six IOM aims to help them develop their aims.

Tips for Setting Aims

1. State the aim clearly. Achieving agreement on the aim of a project is critical for maintaining progress. Teams make better progress when they are very specific about their aims. Make sure that the aim statement describes the system to be improved, and the patient population. In addition, ensure that the aim gives guidance on the approaches to improvement.

2. Include numerical goals that require fundamental change to the system. Teams are more successful when they have unambiguous, focused aims. Setting numerical goals clarifies the aim, helps to create tension for change, directs measurement, and focuses initial changes. For example, the aim "Reduce operating room time" is not as effective as "Reduce operating room time by 50% within 12 months." Including numerical goals not only clarifies the aim but also helps team members begin to think about what their measures of improvement will be, what initial changes they might make, and what level of support they will need.

3. Set stretch goals. A "stretch" goal is one to reach for within a certain time. Setting stretch goals such as "Reduce operating room time by 50% within 12 months" communicates immediately and clearly that maintaining the status quo is not an option. Effective leaders make it clear that the goal cannot be met by tweaking the existing system. Once this is clear, people begin to look for ways to overcome barriers and achieve the stretch goals.

4. Avoid aim drift. Once the aim has been set, the team needs to be careful not to back away from it deliberately or "drift" away from it unconsciously. The initial stretch goal "Reduce operating room time by 50% within 12 months" can slip almost imperceptibly to "Reduce operating room time by 40%" or "by 20%." To avoid drifting away from the aim, repeat the aim continually. Start each team meeting with an explicit statement of aim, for example, "Remember, we're here to reduce operating room time by 50% within 12 months," and then review progress quantitatively over time.

5. Be prepared to refocus the aim. Every team needs to recognize when to refocus its aim. If the team's overall aim is at a system level (for example, "Reduce adverse drug events in critical care by 30% within 12 months"), team members may find that focusing for a time on a smaller part of the system (for example, "Reduce adverse drug events for critical care patients on the cardiac service by 30% within 12 months") will help them achieve the desired system-level goal. Note: Don't confuse aim drift, or backing away from a stretch goal (which usually isn't a good tactic), with consciously deciding to work on a smaller part of the system (which often is a good tactic).

Examples of Effective Aim Statements

For Patient Safety

- Reduce adverse drug events (ADEs) in critical care by 75 percent within 1 year.
- Improve medication reconciliation at transition points by 75 percent within 1 year.
- Reduce high-hazard ADEs by 75 percent within 1 year. For example, reduction of 75 percent in one of the following:
    - Overdoses from benzodiazepines and narcotics
    - Percentage of patients with incidence of bleeding in patients being treated with anticoagulant medications
    - Percentage of patients on insulin with any blood sugar <50
- Increase the number of surgical cases between cases with a surgical site infection by 50 percent within 1 year.
- Achieve > 95 percent compliance with on-time prophylactic antibiotic administration within 1 year.

For Clinic Access

- Reduce waiting time to see a urologist by 50 percent within 9 months.
- Offer all patients same-day access to their primary care physician within 9 months.
- Reduce waiting time to see a physician to less than 15 minutes within 9 months.

For Flow (all goals to be achieved within 9 months)

- Transfer every patient from the Emergency Department to an inpatient bed within 1 hour of the decision to admit.
- Transfer every patient from the Post-Anesthesia Care Unit (PACU) to an inpatient bed within 1 hour from the time patient is deemed ready to move from the PACU.
- Transfer every patient from the Intensive Care Unit (ICU) to an inpatient bed within 4 hours from the time the patient is deemed ready to move from the ICU.
- Transfer every patient from the inpatient facility to a long-term care facility within 24 hours after the patient is deemed ready to transfer.

For Critical Care

- Reduce ICU mortality by 20 percent within 9 months.
- Reduce incidence of ventilator-associated pneumonia by 25 percent.
- Reduce average ventilator days by 2 to 4 days per discharge.
- Reduce adverse drug events (ADEs) per ICU day by 75 percent (or absolute number of less than 0.10 ADE per ICU day).
- Reduce incidence of oversedation or too lengthy sedation by 40 percent.
- Reduce complications of ICU stay by 40 percent:
    - Development of deep vein thrombosis
    - Gastrointestinal bleeding from stress ulcers
    - Line infections
- Reduce the average length of stay for Medical ICU patients by 50 percent within 9 months.

Establishing Measures

Measurement is a critical part of testing and implementing changes; measures tell a team whether the changes they are making actually lead to improvement. Measurement for improvement should not be confused with measurement for research. This difference is outlined in the table below.

	Measurement for Research	Measurement for Learning and Process Improvement
Purpose	To discover new knowledge	To bring new knowledge into daily practice
Tests	One large "blind" test	Many sequential, observable tests
Biases	Control for as many biases as possible	Stabilize the biases from test to test
Data	Gather as much data as possible, "just in case"	Gather "just enough" data to learn and complete another cycle
Duration	Can take long periods of time to obtain results	"Small tests of significant changes" accelerates the rate of improvement

Tips for Effective Measures

1. **Plot data over time.**
   Improvement requires change, and change is, by definition, a temporal phenomenon. Much information about a system and how to improve it can be obtained by plotting data over time, such as data on length of stay, volume, patient satisfaction — and then observing trends and other patterns. Tracking a few key measures over time is the single most powerful tool a team can use.
2. **Seek usefulness, not perfection.**
   Remember, measurement is not the goal; improvement is the goal. In order to move forward to the next step, a team needs just enough data to know whether changes are leading to improvement.
3. **Use sampling.**
   Sampling is a simple, efficient way to help a team understand how a system is performing. In cardiac surgery, the patient volume is typically low enough to allow tracking of key measures for all patients. However, sampling can save time and resources while accurately tracking performance. For example, instead of monitoring the time from catheterization to cardiac surgery continuously, measure a random sample of 10 to 20 cardiac surgery patients per month.
4. **Integrate measurement into the daily routine.**
   Useful data are often easy to obtain without relying on information systems. Don’t wait two months to receive data on patients’ average length of stay in the hospital from the information systems department. Develop a simple data

collection form, and make collecting the data part of someone's job. Often, a few simple measures will yield all the information you need.

5. **Use qualitative and quantitative data.**
   In addition to collecting quantitative data, be sure to collect qualitative data, which often are easier to access and highly informative. For example, ask the nursing staff how weaning from medications is going or how to improve the sedation protocol. Or, in order to focus your efforts on improving patient and family satisfaction, ask patients and their families about their experience of the cardiac surgery process.

The Whole System Measures, a set of health system performance measures, keyed to the six dimensions of quality outlined by the Institute of Medicine in the *Crossing the Quality Chasm* report — safe, effective, patient-centered, timely, efficient, and equitable — that can be used to evaluate the overall performance of a health system.

Three Types of Measures

Use a balanced set of measures for all improvement efforts: outcomes measures, process measures, and balancing measures.

Outcome Measures

How does the system impact the values of patients, their health and wellbeing? What are impacts on other stakeholders such as payers, employees, or the community?

- For diabetes: Average hemoglobin A1c level for population of patients with diabetes
- For access: Number of days to 3rd next available appointment
- For critical care: Intensive Care Unit (ICU) percent unadjusted mortality
- For medication systems: Adverse drug events per 1,000 doses

Process Measures

Are the parts/steps in the system performing as planned? Are we on track in our efforts to improve the system?

- For diabetes: Percentage of patients whose hemoglobin A1c level was measured twice in the past year
- For access: Average daily clinician hours available for appointments
- For critical care: Percent of patients with intentional rounding completed on schedule.

Balancing Measures (looking at a system from different directions/dimensions)

Are changes designed to improve one part of the system causing new problems in other parts of the system?

- For reducing time patients spend on a ventilator after surgery: Make sure reintubation rates are not increasing
- For reducing patients' length of stay in the hospital: Make sure readmission rates are not increasing

Sample Measures

See the Measures section of the Knowledge Center for sample measures. IHI's Improvement Map contains standard measures suitable for improvement projects in a wide variety of clinical and administrative topics.

Using Sampling: An Example

Here is how one team used sampling in measuring the time for transfer from Emergency Department (ED) to inpatient bed.

Rapid movement from the Emergency Department (ED) after a decision to admit the patient is critical flow for entry to the entire system for emergent patient care. It represents the ability of patients with various illnesses to get into the system through the most common admission route.

Sampling approach: The measurement will consist of 6 weekly data collections of 25 patients each. The patients can be sampled in several ways:

- 5 patients per day for 5 days of the week. The patients must be consecutive and at least one day must be a weekend day.

  or

  - *25 consecutive patients regardless of any specific day, except that it must include some weekend admissions.*

    or

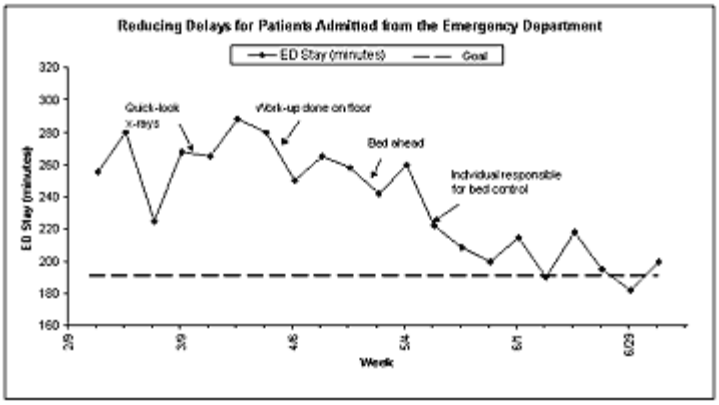
  - *If there are fewer than 25 admissions for a week, the total admissions for the week should be included in the sample.*

The time is measured from the decision to admit to the physical appearance of the patient into the inpatient room. The destination cannot be a "holding area" but must be a "real inpatient bed." The sample collection should be done in real time, so a data collection process needs to be worked out by members of the team to achieve this goal. The collections must be done weekly and summarized as the percentage of patients in the sample that achieved the goal for that week. Six weeks of data needs to be collected and six data points placed on a run chart.

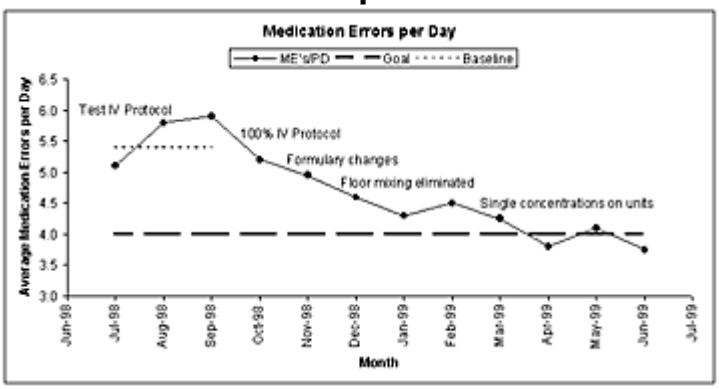
Plotting Data Over Time

Plotting data over time using a run chart is a simple and effective way to determine whether the changes you are making are leading to improvement. Annotate the run chart to show the changes you made. You can use the Improvement Tracker to automatically plot your data over time.

Example 1:



Example 2:



Selecting Changes

While all changes do not lead to improvement, all improvement requires change. The ability to develop, test, and implement changes is essential for any individual, group, or organization that wants to continuously improve. There are many kinds of changes that will lead to improvement, but these specific changes are developed from a limited number of change concepts.

A change concept is a general notion or approach to change that has been found to be useful in developing specific ideas for changes that lead to improvement. Creatively combining these change concepts with knowledge about specific subjects can help generate ideas for tests of change. After generating ideas, run Plan-Do-Study-Act (PDSA) cycles to test a change or group of changes on a small scale to see if they result in improvement. If they do, expand the tests and gradually incorporate larger and larger samples until you are confident that the changes should be adopted more widely.

The change concepts included here were developed by Associates in Process Improvement. See *The Improvement Guide* (Langley GJ, Nolan KM, Nolan TW, Norman CL, Provost LP. San Francisco: Jossey-Bass Publishers, Inc.; 2009) for a list of hundreds of change concepts, as well as examples of how they were applied in process improvement, both inside and outside of health care.

Using Change Concepts for Improvement

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Eliminate Waste

In a broad sense, waste can be considered as any activity or resource in an organization that does not add value to an external customer. Some possible examples of waste are materials that are thrown away, rework of materials and documents, movement of items from one place to another, inventories, time spent waiting in line, people working in processes that are not important to the customer, extra steps or motion in a process, repeating work that has previously been done by others, over-specification of materials and requirements, and more staff than required to match the demand for products and services.

Toyota is famous for focusing improvement on the following "seven wastes":

- Waste of overproduction
- Waste of waiting
- Waste of transportation
- Waste of processing itself
- Waste of inventory (stock)
- Waste of motion
- Waste of producing defective parts or products

Improve Work Flow

Products and services are produced by processes. How does work flow in these processes? What is the plan to get work through a process? Are the various steps in the process arranged and prioritized to obtain quality outcomes at low costs? How can we change the work flow so that the process is less reactive and more planned?

Optimize Inventory

Inventory of all types is a possible source of waste in organizations. Inventory requires capital investment, storage space, and people to handle and keep track of it. In manufacturing organizations, inventory includes raw material waiting to be processed, in-process inventory, and finished goods inventory. For service organizations, the number of skilled workers available is often the key inventory issue. Extra inventory can result in higher costs with no improvement in performance for an organization. How can we reduce costs associated with the maintenance of inventory? Understanding where inventory is stored in a system is the first step in finding opportunities for improvement. The use of inventory pull systems such as "just-in-time" is one philosophy of operating an organization to minimize the waste from inventory.

Change the Work Environment

Changes to the environments in which we work, study, and live can often provide leverage for improvements in performance. Production of products and services takes place in some type of work environment. As we try to improve quality, reduce costs, or increase value of these products and services, technical changes are developed, tested, and implemented. But many of these technical changes do not lead to improvement because the work environment is not ready to accept or

support the changes. Changing the work environment itself can be a high-leverage opportunity for making other changes more effective.

Producer/Customer Interface

To benefit from improvements in quality of products and services, the customer must recognize and appreciate the improvements. Many ideas for improvement can come directly from a supplier or from the producer's customers. Many problems in organizations occur because the producer does not understand the important aspects of the customers' needs or customers are not clear about their expectations from suppliers. The interface between producer/provider and their customers presents opportunities to learn and develop changes that will lead to improvement.

Manage Time

This age-old concept provides an opportunity to make time a focal point for improving any organization. An organization can gain a competitive advantage by reducing the time to develop new products, waiting times for services, lead times for orders and deliveries, and cycle times for all functions in the organization. Many organizations have estimated that less than five percent of the time needed to manufacture and deliver a product to a customer is actually dedicated to producing the product. The rest of the time is spent starting up or waiting.

Focus on Variation

Everything varies! But how does knowing this help us to develop changes that will lead to improvement? Many quality and cost problems in a process or product are due to variation. The same process that produces 95 percent on-time delivery or good product is the same process that produces the other 5 percent of late deliveries or bad product. Reduction of variation in such cases will improve the predictability of outcomes (may actually exceed customer expectations) and help to reduce the frequency of poor results.

There are three basic approaches to dealing with variation:

- Reduce the variation
- Compensate (deal with the variation)
- Exploit the variation

The benefits of reducing variation have been well documented during the last ten years:

> A manufacturer of heat exchangers was having problems sealing tubes in their exchanger. Variation in the air pressure system contributed to most leaking tubes. The air pressure system was updated and the stability of 80 psi maintained. This resulted in a dramatic decrease of leaking tubes. This problem had previously been viewed as the fault of workers assembling the heat exchangers.

An automotive company has learned to manufacture engine and transmission parts with minimum variation. The superb fit of the parts has allowed them to reduce the

normal lubrication and servicing required of most cars. The also expect to have better engine reliability and less repair and replacement warranty costs.

Error Proofing

Errors occur when our actions do not agree with our intentions even though we are capable of carrying out the task. Often, we have to act quickly in a given situation or are required to accomplish a number of tasks sequentially or even simultaneously. Making these slips is part of being human. We might do such things as:

- Forget to enter information or enter it incorrectly
- Leave out a step in a process or do them in the wrong sequence
- Include the wrong merchandise in a shipment
- Try to use something in the wrong way
- Put something together wrong

Although these errors or slips are the result of human actions, they occur because of the interaction of people with a system. Some systems are more prone to error than others. We can reduce errors by redesigning the system to make it less likely for people in the system to make errors. This type of system design or redesign is called error proofing.

The frequency of errors is a function of the number of opportunities to make errors and the probability of making an error given we have the opportunity. For example, if the same information is entered in the computer on three separate occasions, we would expect three times more errors than if the information were only entered once.

We should always be looking for ways to reduce the number of steps in a process or the number of parts in a product. This will allow for the opportunities for errors to be reduced. Error proofing is then used to reduce the probability of making an error for a given opportunity. We can error proof by using technology (e.g., adding equipment to automate repetitive tasks), by using methods to make it more difficult to do something wrong, or by the integration of these methods with technology. Methods for error proofing are not directed at changing people's behavior, but rather at changing the system to prevent slips. The methods are directed at reducing errors from actions that are done almost subconsciously when performing a process or using a product.

Focus on the Product or Service

Although most change concepts address the way that a process is performed, many also apply to improvements to a product or service. This section contains eight change concepts that are particularly useful for developing changes to products or services that do not naturally fit into any of the other groupings.

Testing Changes

Once a team has set an aim, established its membership, and developed measures to determine whether a change leads to an improvement, the next step is to test a change in the real work setting. The Plan-Do-Study-Act (PDSA) cycle is shorthand for testing a change — by planning it, trying it, observing the results, and acting on what is learned. This is the scientific method, used for action-oriented learning.

Reasons to Test Changes

- To increase your belief that the change will result in improvement.
- To decide which of several proposed changes will lead to the desired improvement.
- To evaluate how much improvement can be expected from the change.
- To decide whether the proposed change will work in the actual environment of interest.
- To decide which combinations of changes will have the desired effects on the important measures of quality.
- To evaluate costs, social impact, and side effects from a proposed change.
- To minimize resistance upon implementation.

Steps in the PDSA Cycle

Step 1: Plan

Plan the test or observation, including a plan for collecting data.

- State the objective of the test.
- Make predictions about what will happen and why.
- Develop a plan to test the change. (Who? What? When? Where? What data need to be collected?)

Step 2: Do

Try out the test on a small scale.

- Carry out the test.
- Document problems and unexpected observations.
- Begin analysis of the data.

Step 3: Study

Set aside time to analyze the data and study the results.

- Complete the analysis of the data.
- Compare the data to your predictions.
- Summarize and reflect on what was learned.

Step 4: Act

Refine the change, based on what was learned from the test.

- Determine what modifications should be made.
- Prepare a plan for the next test.

Example of a Test of Change (Plan-Do-Study-Act Cycle)

Depending on their aim, teams choose promising changes and use Plan-Do-Study-Act (PDSA) cycles to test a change quickly on a small scale, see how it works, and refine the change as necessary before implementing it on a broader scale. The following example shows how a team started with a small-scale test.

Diabetes: Planned visits for blood sugar management.

- **Plan:** Ask one patient if he or she would like more information on how to manage his or her blood sugar.
- **Do:** Dr. J. asked his first patient with diabetes on Tuesday.
- **Study:** Patient was interested; Dr. J. was pleased at the positive response.
- **Act:** Dr. J. will continue with the next five patients and set up a planned visit for those who say yes.

Tips for Testing Changes

1. **Stay a cycle ahead.**
   When designing a test, imagine at the start what the subsequent test or two might be, given various possible findings in the "Study" phase of the Plan-Do-Study-Act cycle. For example, teams that are redesigning same-day admission criteria should also be planning how those criteria will be applied.
2. **Scale down the scope of tests.**
   Dimensions of the tests that can be scaled down include the number of patients, doctors, and others involved in the test ("Sample the next 10" instead of "Get a sample of 200"), and the location or duration of the test ("Test it in Operating Room #1 for one week").
3. **Pick willing volunteers. Work with those who want to work with you.**
   ("I know Dr. Jones will help us" instead of "How can we convince Dr. Smith to buy in?")
4. **Avoid the need for consensus, buy-in, or political solutions.**
   Save these for later stages. When possible, choose changes that do not require a long process of approval, especially during the early testing phase.
5. **Don’t reinvent the wheel.**
   Instead, replicate changes made elsewhere. For example, instead of creating your own atrial fibrillation treatment protocol, try modifying another hospital’s protocol.

6. **Pick easy changes to try.**
   Look for the concepts that seem most feasible and will have the greatest impact.
7. **Avoid technical slowdowns.**
   Don’t wait for the new computer to arrive; try recording test measurements and charting trends with paper and pencil instead.
8. **Reflect on the results of every change.**
   After making a change, a team should ask: What did we expect to happen? What did happen? Were there unintended consequences? What was the best thing about this change? The worst? What might we do next? Too often, people avoid reflecting on failure. Remember that teams often learn very important lessons from failed tests of change.
9. **Be prepared to end the test of a change.**
   If the test shows that a change is not leading to improvement, the test should be stopped. Note: "Failed" tests of change are a natural part of the improvement process. If a team experiences very few failed tests of change, it is probably not pushing the boundaries of innovation very far.

Linking Tests of Change

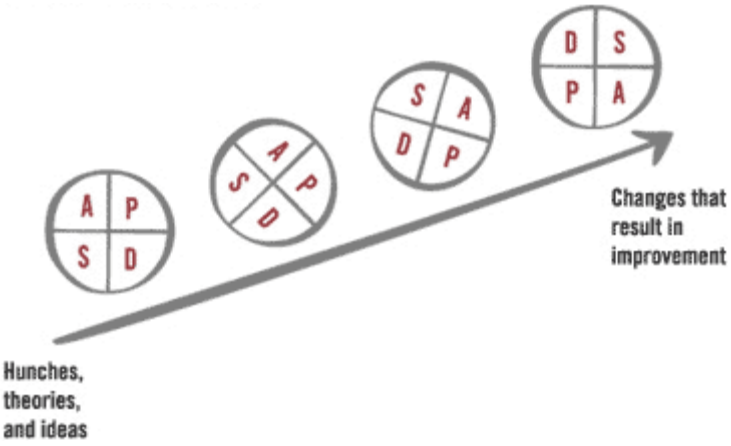
Testing changes is an iterative process: the completion of each Plan-Do-Study-Act (PDSA) cycle leads directly into the start of the next cycle.

A team learns from the test — What worked and what didn't work? What should be kept, changed, or abandoned? — and uses the new knowledge to plan the next test. The team continues linking tests in this way, refining the change until it is ready for broader implementation.

Note: People are far more willing to test a change when they know that changes can and will be modified as needed. Linking small tests of change helps overcome an organization's natural resistance to change and ensure physician buy-in.

Tips for Successful Linked Tests of Change

- Plan multiple cycles for a test of a change.
- Think a couple of cycles ahead.
- Scale down the size of the test (the number of patients or location).
- Test with volunteers.
- Do not try to get consensus, "buy-in," etc.
- Be innovative to make the test feasible.
- Collect useful data during each test.
- Test over a wide range of conditions. Try a test quickly; ask, "What change can we test by next Tuesday?"



Examples of Linked Tests of Change

Example 1: Improve management of the diabetic population blood sugar levels.

- Cycle 1: Develop a system to track hemoglobin A1c levels for the diabetic population.
- Cycle 2: Establish a protocol for hemoglobin A1c routine measurements.
- Cycle 3: Undertake collaborative planning for control levels.
- Cycle 4: Set targets for hemoglobin A1c levels.
- Cycle 5: Implement the protocol with all staff.

Example 2: Decrease length of stay (LOS) for Emergency Department (ED) patients with x-rays.

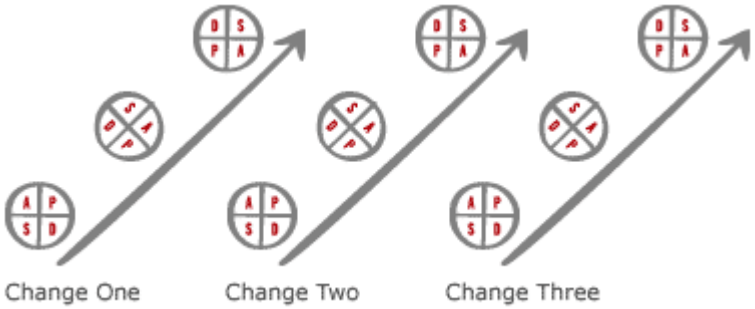
- Cycle 1a: Pilot quick-look for extremity x-rays on one shift. Monitor LOS for patients with x-rays and error rate. Review results with Radiology.
- Cycle 1b: Revise documentation process and try quick-look for two days.
- Cycle 1c: Redesign viewing area and continue quick-look for two weeks.
- Cycle 1d: Make quick-look standard practice and monitor.

Testing Multiple Changes

Typically, teams test more than one change at a time. All of the changes are aimed at achieving the same ultimate goal. Using several linked Plan-Do-Study-Act (PDSA) cycles allows a team to test more than one change simultaneously.

Example of Testing Multiple Changes

A team working on reducing the average extubation time for elective coronary artery bypass graft (CABG) patients worked on several changes at the same time. Each of the changes went through several linked Plan-Do-Study-Act (PDSA) cycles.



Change 1: Standardize pain management.
In order to be extubated early, patients must not be too heavily sedated. The team began by revising the existing standards for postoperative pain management. Instead of using the traditional high dose of morphine, the team tested the use of smaller, more frequent doses. In this way, patients' pain was managed adequately, yet patients were awake enough to be extubated safely.

Change 2: Standardize anesthesia management.
Patients cannot be extubated if they are heavily sedated. The team tested having anesthesiologists use lower doses of sedatives to prevent patients from remaining heavily sedated long after the surgery was completed.

Change 3: Establish a rapid weaning and extubation protocol run by nurses and respiratory therapists.
The team also developed a set of criteria that patients need to meet in order to be extubated safely, given the changes in anesthesia and pain management.

Change 4: Reduce delays in obtaining arterial blood gas (ABG) results.
The team identified delays in obtaining ABG results and weaning parameters as barriers to early extubation. They assigned a dedicated respiratory therapist to obtain these results.

Change 5: Educate physicians, nurses, certified registered nurse assistants (CRNAs), and respiratory therapists on the new goals and procedures for early extubation.

Change 6: Extend the changes from elective CABG patients to all CABG patients.

Implementing Changes

After testing a change on a small scale, learning from each test, and refining the change through several PDSA cycles, the change is ready for implementation on a broader scale-for example, for an entire pilot population or on an entire unit.

Implementation is a permanent change to the way work is done and, as such, involves building the change into the organization. It may affect documentation, written policies, hiring, training, compensation, and aspects of the organization's infrastructure that are not heavily engaged in the testing phase. Implementation also requires the use of the PDSA cycle.

Example

Testing a change:

Three nurses on different shifts use a new medication reconciliation and order form.

Implementing a change:

All 30 nurses on the pilot unit begin using the new medication reconciliation and order form.

Spreading Changes

Spread is the process of taking a successful implementation process from a pilot unit or pilot population and replicating that change or package of changes in other parts of the organization or other organizations.

During implementation, teams learn valuable lessons necessary for successful spread, including key infrastructure issues, optimal sequencing of tasks, and working with people to help them adopt and adapt a change.

Spread efforts will benefit from the use of the PDSA cycle. Units adopting the change need to plan how best to adapt the change to their unit and to determine if the change resulted in the predicted improvement.

Example

If all 30 nurses on a pilot unit successfully implement a new medication reconciliation and order form, then spread would be replicating this change in all nursing units in the organization and assisting the units in adopting or adapting the change.