5 Building an Engaging Toyota Production System Culture to Drive Winning Performance for Our Patients, Caregivers, Hospitals, and Communities

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Abbreviations

CMS	Centers for Medicare and Medicaid Services
DART	Days Away, Restricted, or Transferred
ED	Emergency Department
EHR	Electronic Health Record
FTA	Fast-Track Area
HRO	High-Reliability Organization
IHI	Institute for Healthcare Improvement
IOM	Institute of Medicine
LVN	Licensed Vocational Nurse
MIT	Massachusetts Institute of Technology
MVV	Mission, Vision, and Values
NASEM	National Academies of Sciences, Engineering, and Medicine
NICU	Neonatal Intensive Care Unit
PDCA	Plan-Do-Check-Adjust
PDSA	Plan-Do-Study-Act
PIs	Pressure Injuries
PO	Per Oral or By Mouth
RN	Registered Nurse
TPN	Total Parenteral Nutrition
TPS	Toyota Production System
TSSC	Toyota Production System Support Center
WOT	Wound Ostomy Team

All vignettes in this chapter are fictional. A glossary can be found at the end of this chapter.

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Chapter Objectives

- To share perspectives and learnings from the early years of applying Toyota Production System (TPS) principles to healthcare
- To show how TPS principles align with high-reliability organization (HRO) principles
- To make TPS principles relatable and understandable to people with varying backgrounds, especially in healthcare
- To show the value of creating frontline problem-solvers to improve performance
- To share perspectives and learnings on building a successful, high-performing TPS culture in healthcare

Opening Vignette

It is early morning at a Toyota plant. The morning huddle with the various line teams has disbanded, and the production output has been increased to meet greater demand, so a new Toyota vehicle will come off the line every 55 seconds. At the morning huddle, everyone was notified that new loading fixtures will be installed to better assist with positioning large dashboards during installation into the new production vehicles. As production occurs, the team tasked with attaching the dashboards notices that several loading fixtures seem to cause slight blemishes on the dashboards, which are visible only under certain lighting conditions.

A team member immediately pulls a cord (called an andon cord) which activates a flashing light and musical tone to signal that a problem has occurred. A problem-solver, who is also the team leader, hears the musical tone and arrives within 20 seconds to assist with the situation and immediately begins investigating the problem.

Not too far behind are other plant leaders who coach a problem-solving exercise with the local team. The team follows the process upstream from the point at which the problem occurred and finds that the new loading fixture lightly rubs some dashboards during the loading process. The clearance between the fixture and the dashboard was insufficient. The countermeasures are immediately deployed, including increasing the clearance from 1/8 inch to 3/4 inch and placing tape around the fixture – which prevented scuffing if the fixture accidentally contacted the dashboard during placement. After the countermeasures were operationalized, no further defects were noted.

This fictitious example demonstrates timely problem-solving that those in healthcare are trying to emulate, where a defect or problem is quickly identified and analyzed, while the evidence is fresh. The frontline team temporarily stops the production line so that the cause of the defect can be uncovered and immediate group problem-solving can occur. The countermeasures were rapidly implemented which prevented any future recurrences. The alignment of the assembly plant with its suppliers can, at times, facilitate this rapid and joint problem-solving. The organizational culture that supports this took years to develop through shared experimentation and learning. It is not unique to this particular Toyota plant. Rather, this culture can be found at any of their plants around the globe. The frontline workers and Toyota leadership know that no defect is to be passed forward. Pushing defects through the system results in increased costs from *muda* (waste) such as rework, recurrence of defects, customer and employee dissatisfaction, and possible safety concerns.

Systems, both human and computerized, need to be in place to rapidly identify defects, deviations from the standard, or abnormal conditions. Healthcare providers, patients, and leaders of other industries often wonder if similar systemic

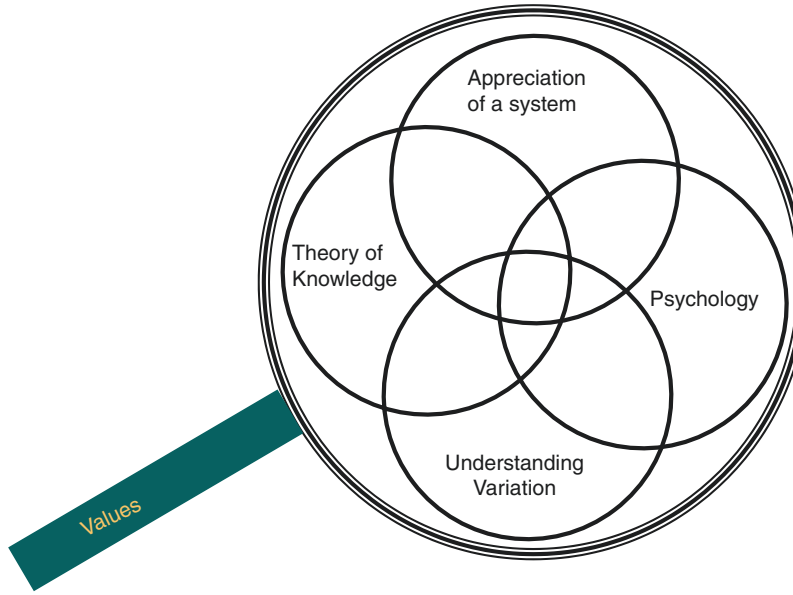


Fig. 5.1 Deming's system of profound knowledge. (Reprinted from by Langley et al. [1] with permission from John Wiley & Sons)

cultural changes can be instilled in their organizations. Such an ideal state employs all four parts of Deming's System of Profound Knowledge [1] – Appreciation of System, Theory of Knowledge, Understanding Variation, and Psychology of Change. All of these parts are interrelated (Fig. 5.1). An examination of the figure shows that the ability of the parts to interrelate and work well together is dependent upon the values of the organization (represented by the handle of the magnifying glass).

Paul O'Neill has discussed the value of habit in changing culture. As the CEO of Alcoa, his focus on employee safety aligned his frontline workforce around a universally acceptable and popular agenda along with delivering improved organizational profitability. The encouragement of habit formation was key in his empowerment of the frontline [2]. Such principles have been applied by Toyota in the Toyota Production System (TPS) since the 1950s. Similarly, through their focus on organizational safety and development of frontline team members, Toyota's financial outlook has improved. More importantly, they have developed a sustainable organizational culture focused on frontline development. It will become apparent that TPS is much more than habit creation, but rather an organizational culture and quality management framework that can help an organization become a learning system, a high-reliability organization, and a desired place to work that achieves and sustains rigorous safety, quality, value, and financial goals.

Weick and Sutcliffe [3] described the need for increased organizational "mindfulness" in the quest for high reliability. A high-reliability organization (HRO) operates under trying conditions but nonetheless manages to have fewer than their share of adverse events. We will return to this discussion of high reliability at the end of this chapter as TPS is a problem-solving, culture-centered improvement system that embodies and facilitates the successful implementation of the five HRO principles:

1. Preoccupation with failure
2. Sensitivity to operations
3. Reluctance to simplify
4. Commitment to resilience
5. Deference to expertise

As mentioned in other chapters, preoccupation with failure refers to the constant vigilance about seemingly small or inconsequential issues being signs of bigger problems. Sensitivity to operations refers to the focus on what is happening on the "shop floor" or where production of goods or delivery of services is occurring. A

reluctance to simplify interpretations encourages diversity in opinions, experiences, inputs, and perspectives. Finally, the latter two principles are most applicable when an error or defect occurs, as no system is perfect. There will need to be anticipatory processes in place that facilitate learning when failures do occur. Commitment to resilience refers to an organization's ability to contain problems and create rapid solutions after errors are investigated. Deference to expertise involves people with the most relevant expertise, regardless of their position in the organizational hierarchy, in any post-event assessments or problem-solving. The introductory vignette demonstrated these principles. Problems are to be expected, so we need to design systems to rapidly detect and react to these problems and prevent recurrence.

From our travels to various hospitals that are supposedly implementing "Lean" as their improvement methodology, the core values that the Toyota Production System represents are often misrepresented and/or misinterpreted.

Here are a few common misconceptions:

- Misconception 1: "LEAN is an acronym that stands for *L*ess *E*mployees *A*re *N*eeded." Leaders and consultants can be quick to assume that a reduction in workers is the answer to cost reduction – which is entirely contradictory to Toyota's philosophy of respect (*will be discussed further in the sections, "TPS Triangle: Philosophy Arm" and "TPS Approach to Delivering Value"*).
- Misconception 2: "You need to spend large amounts of money for consultants to successfully implement TPS in your organization." Toyota considers its people as its most valuable asset. Building an organizational culture of highly engaged and empowered individuals starts from within (*will be discussed in the proceeding sections*).
- Misconception 3: "Implementing TPS in healthcare means we're all going to work like robots." When created and implemented correctly (i.e., developed by the people who do the work and validated continuously at the *genba* or workplace), standardized work is one of the most powerful tools in TPS that keeps processes and practices safe, reliable, and evidence-based. In healthcare, the goal is to standardize around the patient, so that team members can do what they are trained to do – which is to care for people and patients (*will be discussed further in "TPS House" section*).

TPS Approach to Delivering Value

> I will say again: the only way to generate a profit is to improve business performance and profit through efforts to reduce cost. This is not done by making workers slave away, to use a bad expression from the olden days, or to generate profit by pursuing low labor costs, but by using truly rational and scientific methods to eliminate waste and reduce costs. – Taiichi Ohno [4]

Over the past two decades, the healthcare industry (especially in the United States where costs are among the highest globally and outcomes are not necessarily the best overall) has been challenged to improve value in its care delivery systems. Some US healthcare professionals and administrators have suggested that the increased costs are related to the increasing complexity of the procedures or the use of more advanced and, at times, more expensive technology. However, compared to other countries performing comparable procedures, the US health systems remain costlier with poorer outcomes [5].

Value is defined simply as quality divided by cost [6]. Healthcare leaders are often asked by their senior leaders and board members for the return on investment (ROI) for quality and safety. This discussion is difficult, at best, as some benefits cannot be readily measured [7]. Many industries, including healthcare, determine the price of their services using the following equation:

$$\left[\text{Selling Price, as set by the company}\right] = \left[\text{Cost of Goods or Services}\right] + \text{"Profit"}$$

In this equation, as the costs of goods and services will increase over time due to increases in raw materials or staff costs, the selling price is usually increased to achieve the needed profit. We know that the healthcare market will only bear small increases in costs, if any, given the amount of gross domestic product already allocated to overall population medical needs, including direct care, preventative care, technology, research and development, and pharmaceuticals [8]. Similarly, Toyota has long believed that its customers and market conditions limit the price that can be charged. The automotive market is very competitive and will not bear high prices. To survive and reinvest in the future, a company must be profitable by reducing its costs. Toyota rewrites this equation as

$$\left[\text{Selling Price, as set by the market}\right] - \left[\text{Cost of Goods or Services}\right] = \text{"Profit"}$$

Therefore, organizations need to control costs to assure a reasonable profit to reinvest and survive. In healthcare, fruitful partnerships must occur with our patients, their families, insurers, communities, school systems, other health systems, and pharmacies to ultimately reduce costs and deliver value. Toyota proposes reducing costs using TPS as described by the TPS Triangle (Fig. 5.2) and the TPS House (Fig. 5.3). Reduction of costs through the reduction of workforce is not congruent with TPS principles and is detrimental to workforce morale and advancement of corporate production and quality goals:

Fig. 5.2 Toyota Production System (TPS) Triangle. (Used with the permission of Toyota)

> Cost reduction must be the goal of consumer product manufacturers trying to survive in today's marketplace…there is no magic method. Rather a total management system is needed that develops human ability to its fullest capability to best enhance creativity and fruitfulness to utilize facilities and machines well, and to eliminate all waste – Taiichi Ohno [4]

In healthcare, the focus is on preventive and proactive care (e.g., routine physical exams, immunizations, proper diet and exercise) to prevent the more expensive care like emergency department visits. Improving operational efficiencies is the desired result. This includes waste reduction, outcomes, and costs all while increasing workforce and customer satisfaction.

Scientific Method and Becoming a Learning Organization

Taiichi Ohno, the former Vice-President of Toyota Motor Company and TPS leader who helped develop TPS in the 1950s–1970s, often spoke of the intelligent frontline team members who surface problems, work to quickly create countermeasures, and solve these identified problems through testing and application of scientific methodology. In this intentional process of creating and testing hypotheses, a robust learning sys-

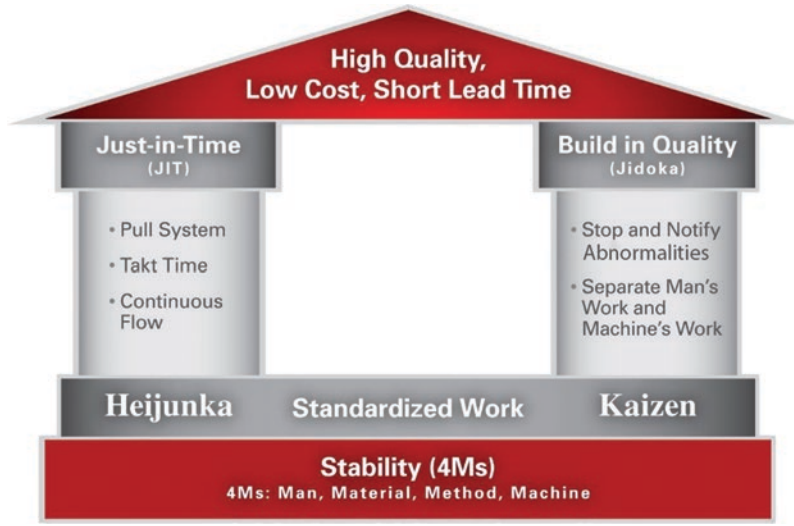


Fig. 5.3. Toyota Production System House. (Used with the permission of Toyota)

tem results. The National Academies of Sciences, Engineering, and Medicine (NASEM), formerly the Institute of Medicine (IOM), has recommended in its numerous publications [9–11] that health systems emulate this very environment, as it greatly enhances organizational agility while creating a system that is most desired by patients, their families, and society as a whole. The role of senior leaders or administrators is to lead, coach, and facilitate the work of frontline members and their development of problem-solving expertise. Simultaneously, these leaders should increase their visibility to the frontline team members and regularly visit the shop floor or areas (e.g., clinical and nonclinical) where the improvement is desired, during which time they can observe, receive input, and provide guidance. The value of local or unit-based huddles, especially with senior leaders present, cannot be overemphasized to drive frontline engagement with TPS and improvement efforts. Decades after the creation of TPS, the Institute for Healthcare Improvement (IHI) High-Impact Leadership framework espouses these very concepts [12].

TPS places tremendous value on the development of the frontline worker and the creation of a corporate culture where people are trained to become problem-solvers or scientists. The application of the scientific method in real time on the automotive shop floor allows learning to occur rapidly, which in turn leads to innovation. This corporate approach supports the development of teams of problem-solvers who are empowered to drive change and innovate. The frontline Toyota workers are vital corporate assets and, by investing in their growth (a concept known as people development), they help create a learning factory where knowledge is gleaned from planned experimentation. This new knowledge is applied and shared throughout the organization – corporate agility results, employees feel valued, everyone wins, and a competitive corporate edge arises. Taiichi Ohno once said that "knowledge is something you buy with money. Wisdom is something you acquire by doing it [13]." You learn by doing!

History's Effect on the TPS

Historically, Toyota started out by making automatic looms. Some principles of TPS were introduced during this time of Toyota's development. The founders of Toyota wanted to provide a greater service to society through automotive manufacturing [4]. The automotive arm of Toyota started in the 1930s, well after other global automakers. Not surprisingly, they had to overcome specific challenges when competing with these larger volume, more technologically advanced, global competitors like General Motors and Ford Motor Company.

Additionally, post-World War II Japan had some challenges not seen in the United States:

1. Geography, especially given its island location off the coast of Asia, with space challenges and limited natural resources.
2. Impaired industrial infrastructure.
3. Limited market for automobiles.
4. Only 2% of automobiles sold were Japanese in origin, and, therefore, the market was dominated by foreign manufacturers.
5. Vehicles were much more technologically complex when compared with Toyota's former business line, automatic looms [4].

Due to these challenges, Toyota further refined TPS through practical trial and experimentation in the 1950s and 1960s. Its founders realized early on that their people, especially their front-line workers, were most capable of learning, creating, and problem-solving. For this reason, they were the most valuable resource and needed to be treated with respect. The value of Toyota's front-line workers is emphasized by the fact that they are always referred to as team members. In a 1988 *New England Journal of Medicine* article [14], Donald Berwick, President Emeritus and Senior Fellow at the IHI and former Administrator of the Centers for Medicare and Medicaid Services (CMS), advocated that healthcare adopt the continuous improvement (*kaizen*) approach to healthcare, which engages people's minds by applying the scientific method to problems. Suddenly, defects are positively looked at as opportunities to learn and improve rather than punitively as a way to identify potential "bad apples."

Steven Spears in *The High-Velocity Edge* [15] fondly described that "Toyota's success is attributable to its 'velocity of discovery' – the speed with which the company improves, innovates and invents." Toyota's founding fathers achieved this by "ensuring that pieces of a larger whole are harmoniously synchronized rather than discordant." The downstream needs and processes paced work further upstream, creating the feeling of a synchronized orchestral piece with all units linked together to deliver the product or service to the end customer. The concept reduced wasted inventory and improved efficiency and quality. Toyota discovered how to do more work, rapidly and more reliably, without using more labor.

The 1973 global gas crisis brought attention to Toyota Motor Company. They were producing high-quality, safe, small cars efficiently in the quantities needed by their customers with very little waste (*muda*), and remained financially stable during this economic downturn. James Womack and his colleagues at the Massachusetts Institute of Technology (MIT) had been studying Toyota and published *The Machine That Changed the World* in 1990, which highlighted the successful principles of TPS and used the words "Lean production" to refer to TPS [16].

Lean has taken on a wide range of meanings to different organizations due to the misunderstanding of TPS principles. Additionally, Lean can be unfortunately mistaken by the workforce to be a job elimination tool – a way to match staffing to hourly demand, sending people home early when deemed necessary, or to staff light daily [17]. This is contrary to the value that Toyota places on the development of its team members.

Steven Spears and H. Kent Bowen [17, 18] describe four rules that need to be followed in the application of Lean principles which are congruent with TPS principles:

- *Rule 1*: "All work is highly specified regarding content, sequence, timing, and outcome."
- *Rule 2*: "Every customer-supplier connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses."
- *Rule 3*: "The pathway for every product and service must be simple and direct."
- *Rule 4*: "Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level of the organization" [18].

The aforementioned rules have built-in signals to highlight problems automatically and rapidly and to make organizations adaptable to changing situations. These principles require organizational commitment, but, when adhered to closely,

will best align with TPS philosophy. This will become evident in the proceeding sections.

The TPS Triangle

The TPS Triangle (Fig. 5.2) has been used to describe TPS outside of Toyota for greater than 25 years, which coincides with the founding of the Toyota Production System Support Center (TSSC). TSSC is a nonprofit subsidiary that shares TPS with people, companies, and nonprofits outside of Toyota to contribute to society. At first glance, the simplicity of the TPS Triangle is evident. The people of any organization drive its excellence, so at its center is the emphasis on people development. TPS is an organizational culture of highly engaged people solving problems or innovating to drive performance. This culture is created and sustained by a three-part system of (1) philosophy, (2) technical tools, and (3) managerial roles.

The *philosophy side* has four key points:

1. *Customer first* – Understand the customers deeply and provide exactly what they want, only when they want it, and in the amount wanted.
2. *People are the most valuable resource* – Our employees, staff, and volunteers are our most valuable resource and should be engaged and treated as such.
3. *Continuous improvement* – The sum of many, many small improvements by many people accumulates to significant overall performance improvement and innovation.
4. *Shop floor (gemba or genba) focus* – Focus attention on where the customer value-added work is done. In healthcare, this is typically in clinical areas, such as the emergency department, operating room/theater, inpatient unit, or outpatient unit, but it does not need to be, as a project can extend into finance or other nonclinical areas.

These philosophies also fit well for healthcare. First, customers are the priority. In healthcare, the most obvious customers are our patients and their families. We have other customers as well. A hospital unit or team member who receives a patient from another unit or team member is the customer of the upstream unit or colleague. No defect shall be passed on to the next customer. Customers can be internal or external to an organization, including insurers. We should strive to meet or exceed our customers' expectations. Customer and workforce safety are most important. For instance, an emergency department team needs to stabilize an ill patient to the best of their ability before admitting them to the inpatient medical-surgical or intensive care unit. They need to answer the questions of the patient and their family. Similarly, the accepting unit and medical team should expect a patient to be stabilized as much as possible, to receive a proper sign-out from the upstream team, and to have all of the needed chart documentation completed in a timely fashion. This allows for the excellent, team-based clinical care to continue and decreases the possibility of the patient becoming susceptible to a medical error. For this reason, we need to be cognizant of who our many customers are. To reiterate, we do not pass on defects to our customers as this creates customer and workforce dissatisfaction, increased costs from rework of defects, and potential safety problems.

Second, people are the most valuable resource. Only people, after all, are capable of continual learning, especially problem-solving and innovating. For this reason, they must be treated as an organization's most valuable resource and be provided a safe working environment, job security, intellectual challenges, and jobs that add value. The effectiveness and commitment of an organization depend on the motivation and capability of its people. The role of management, or senior leaders, is to motivate and develop these frontline people. In healthcare, we generally think of our caregivers – physicians, nurses, and other allied health professionals who care for patients – as the core frontline people.

Third, these motivated team members move forward to drive continuous improvement and associated problem-solving, also known as *kaizen*, which occurs in small manageable steps. All team members come to work to both do and improve their work. Finally, key improvement

activities occur on the shop floor with the following assumptions: (a) the shop floor (*gemba* or *genba*) is constantly changing; (b) one must be on the shop floor to understand the current state; and (c) the input from the members on the shop floor is invaluable to understanding the current conditions, feasibility of change, and goal of any change, and to set SMART (*S*pecific, *M*easurable, *A*ggressive yet attainable, *R*elevant, and *T*ime-sensitive) targets.

By accepting that all humans learn the most by doing, organizational leaders need to provide frontline team members and managers opportunities to learn, practice, and also fail. The role of a manager, as defined by the *managerial side* of the Triangle, is to engage and develop all team members into problem-solvers. On the *technical side* of the Triangle, team members use many TPS tools and methods (reviewed shortly in the TPS House discussion), to expose problems correctly. In the TPS culture, problems are also brought to the surface quickly as discussed in the initial vignette. We cannot solve problems we cannot see. In healthcare, organizations are investing in better training of their team members in improvement science methodologies to promote problem-solving as soon as a problem is identified. By teaching team members a common institutional standard way to approach problems, they have a common language through which they can immediately describe their initial problems, their ongoing progress, and resolution. This reason for the common language is no different than the reasons that have supported the need for common resuscitation methods, such as basic life support or advanced cardiac life support (BLS/ACLS), in the clinical setting or the use of the scientific method in the laboratory setting.

Toyota places considerable value on customer input and satisfaction. They strive to provide customers with exactly what they want, when they want it. By encouraging patients or their families to provide feedback or speak up, health systems can design desirable services for their patients. By incorporating these family members into the discussion or improvement project involving the care of their loved one, more informed decisions can be made, increasing the likelihood that the project will be successful, lead to meaningful change, and ultimately increase patient and family engagement and satisfaction. Similarly, by encouraging families to initiate rapid response teams, problems can be brought to the surface sooner [19]. Rapid response teams are comprised of hospital team members that respond to the bedside of a patient with early signs of deterioration in response to staff or, in some situations, family member concerns. This is also a perfect example of the application of the aforementioned HRO principles – preoccupation with failure, sensitivity to operations, and deference to expertise. Our frontline workers and families are very aware of the minute-to-minute changes in the clinical status of their loved ones.

By now, Toyota's obvious focus on connecting production to customer preferences and demand, and the focus on the development of frontline team members, is apparent. This reduces waste, promotes the rapid identification and resolution of problems, and ultimately creates a learning system.

Key Learning Points

1. TPS is an organizational culture of highly engaged people solving problems or innovating to drive performance. This culture is created and sustained by a three-part system, as described by the TPS Triangle, of (1) philosophy, (2) technical tools, and (3) managerial roles.
2. In healthcare, this culture must be a win for patients and their families, a win for caregivers, a win for hospitals, and a win for the community.
3. An organization's people are the best learners and advocates that can help drive excellence.
4. Problems need to be brought to the surface quickly as we cannot fix things that we cannot see. Problems detected early are often smaller and more manageable. Missed problems, or delayed detection of problems, can permit problems to

evolve to those that are larger, less manageable, and detrimental.
5. Defects are not to be passed on to our customers, as this creates customer and workforce dissatisfaction, increased costs from the rework of defects, and potential safety problems.
6. Problem-solving is a crucial skill set.
7. The voice of the customer is important and needs to be incorporated into any improvement project.

Toyota Production System House

The Toyota Production System House (Fig. 5.3) depicts the key technical elements of TPS. These concepts will be discussed in detail followed by vignettes from various healthcare organizations that have applied TPS-based improvement science to local problems with direct guidance from TSSC.

The TPS House is covered by a roof which represents the performance that TPS is designed to deliver – very high quality, low cost, and short lead (or wait) time. Safety comes above all else. To achieve high performance, there are two main pillars: just-in-time (JIT) and *jidoka* (building in quality at the source). JIT and *jidoka* require some foundational elements starting with the 4Ms. This stable foundation enables stable operations. Specifically, the foundation requires *M*anpower (People),[1] *M*achine, *M*aterial, and *M*ethod – which need to be of high quality and reliability, and properly chosen. Manpower (People) need to perform reliably with good work habits, proper skill level, good attendance, and low turnover. For instance, a common challenge in nursing and other healthcare roles is managing the rotating shifts over the 24 hours of a day, 7 days per week, and the associated turnover. Finding the correct people for these roles is crucial, as is assuring everyone is working to the top of their licensure and expected competency. Machines need to be available in the right number and location, and be reliable (not break down or create defects). This is especially true in critical areas such as the operating room/theater or intensive care units where key machines such as ventilators must be dependable. Materials (such as references, standardized work documents, and manufacturer guidelines) need to be easily accessible to the people who do the work. Materials in healthcare also refer to the patient, their EHR, and their specimens. We want material to flow. The methods are the best, optimal practices for delivering care and services and are often the result of local continuous improvement efforts. At times, they can be best practices developed at other organizations but adapted and perfected locally through small tests of change. Often included in the foundation is the environment, which can also be referred to as *M*other Nature (or the fifth *M*). The environment needs to be clean, clutter-free, and organized so that it can facilitate high quality, lower costs, and shorter lead times without the introduction of defects.

The 4Ms foundation is required to support and enable the layer immediately above it, which is comprised of *kaizen*, *heijunka*, and standardized work.

Kaizen refers to continuous improvement and problem-solving. TPS encourages continuous improvement since it is small steps of change that, when added together, can result in great innovation. *Kaizen* is the bridge that brings customers and improvement team members together. This has been especially impactful in healthcare when caregivers can experience their processes through the eyes of patients and their family members. Engaging customers/patients as we address imperfect processes helps to create an environment where respect for people, a key TPS concept, is realized. This concept is referred to as "humanize." It helps reinforce why we need to improve and can help provide the motivation to support change remembering that 100% of what we do ultimately impacts our customers/patients 100% of the time.

Heijunka refers to the leveling of work or production. By leveling work, you prevent process bottlenecks or the buildup of inventory in the

[1] Manpower is mentioned here but this refers to humans of all genders.

industrial setting. In the healthcare setting, you can distribute the work evenly so as not to overburden any single person, preventing safety and quality issues. For instance, hospitals have applied this to their operating room scheduling process by distributing the types of cases evenly to the various operating rooms, optimizing work, and balancing the overall flow throughout the week.

Standardized work (a step-by-step document written by the people who do the work outlining the current best thinking on how to perform the process, including step sequence and timing) needs to be defined to maintain changes. Standardized work at Toyota is a framework for maintaining *kaizen* improvements. Once the current practice is known, efforts are made to document and train to this standard until a better way is developed. When a better way is discovered, new work method standards are created. One key point is that standards are a starting point with the expectation that they will be improved. At times, healthcare providers are resistant to standardization without fully understanding that it is a starting point for the improvement process. ThedaCare in Wisconsin has therefore coined the term "flexible regimentation" where regimentation refers to the creation of a common standard process for "performing a specific service based on the best available evidence," and flexible refers to the ongoing work to improve this standard [20]. Standardized work also reduces variation in supplies and instruments used in the operating theater since uniform predetermined supplies and instruments are used for each type of surgery among the various medical providers. As a result, it also plays a critical role in surfacing problems. When abnormal conditions occur, the behavior of following standardized work allows members performing tasks to identify problems rapidly.

The two pillars of the TPS House are just-in-time (JIT) and *jidoka*. The JIT pillar advocates continuous flow, *takt* time, and the use of pull systems. Production is tightly run, where the key components reach an assembly line at the time needed and only in the quantity desired. Everyone in the production process works in sync and is aware of *takt* time. *Takt* time is calculated by dividing the operable time per day by the required number of units of a particular product per day (output). With a high level of JIT, any disruption to flow is immediately visible, so immediate problem-solving can be initiated.

Pull production is important to the concept of continuous flow. Toyota, from its earliest years, realized that extra inventory was disadvantageous. Toyota had very limited financial resources and space in its early years to afford the storage of inventory, so they had to be innovative and find alternative manufacturing solutions. Taiichi Ohno once said, *"manufacturers and workplaces can no longer base production (from) desktop planning alone and then distribute, or push, their products onto the market. It has become a matter of course for customers, or users, each with a different value system, to stand in the front line of the marketplace, and, so to speak, pull the goods they need, in the amount and at the time they need them."* This reduced inventory has given Toyota the ability to tightly regulate their processes to uncover defects when problems arise. The problems become easier to find, and this, in turn, reduces problem-solving time. Ohno further eloquently stated that the goal of *"Toyota Production System is to produce what you need, only as much as you need when you need"* [4, 13]. He realized that mass production without a linkage to the true customer needs would not work long term.

Jidoka (automation with a human touch) refers to processes with built-in quality that immediately signal when a problem occurs, so that a person does not have to monitor a process just looking for defects. An everyday example of *jidoka* is the seat belt alarm that beeps whenever a seat belt is not properly fastened. Back when Toyota was originally an automated loom manufacturer, *jidoka* referred to a loom's stoppage if a string broke, alerting the worker, which, in turn, prevented the manufacture of cloth with defects. At a Toyota plant, *jidoka* may refer to a sensor that stops the line and brings attention to a defect or process abnormality that is then immediately rectified so that the defect or abnormality is not passed on further, leading to a larger problem. Any of the Toyota visual defect detection systems

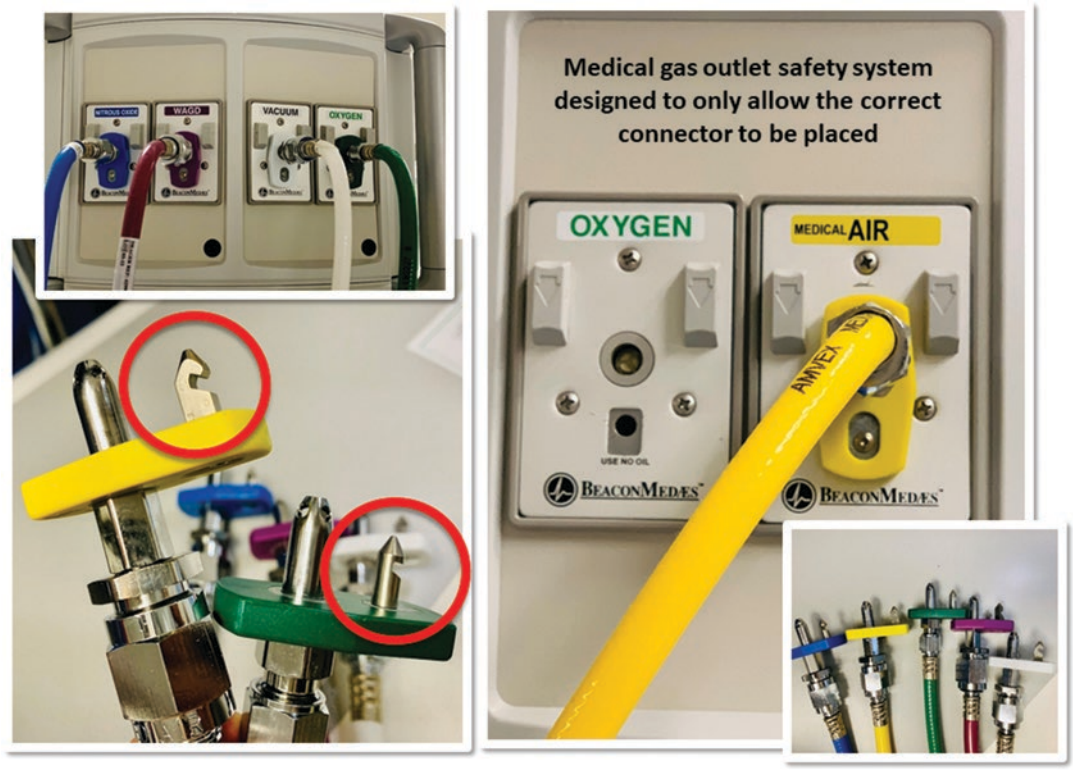


Fig. 5.4 Use of *poka-yoke* to prevent the accidental mixing of anesthesia gases. Note each gas hosing and connector is different to prevent incorrect connections, which, in turn, can lead to an error and potential patient harm

(andons), which can stop an assembly line at their plants, can facilitate the problem-solving process, since problems are immediately pinpointed to their respective microsystem. These can also be manually pulled by a team member. The only reason to stop the line is to ensure that it will never have to be stopped again for the same circumstances. Quick fixes or stopgaps are never a solution. However, they may be temporarily utilized when recurrence prevention takes time to complete.

Andons and *poka-yoke* are important parts of *jidoka*. As mentioned in the introductory vignette, andons are tools for visual control. *Poka-yoke* refers to a built-in quality that prevents defects from occurring. In car manufacturing, parts may be created that only fit one way to prevent incorrect assembly. At home, our riding lawn mowers automatically turn off if the rider gets off the seat while the mower is still running. Similarly in healthcare, the various anesthesia gas connectors only fit specific gas lines, thus preventing the accidental mixing of medical gases (Fig. 5.4). This type of human factors integration has eliminated the accidental fatal administration of gases other than oxygen during operative cases.

In short, *jidoka* prevents the continued propagation of defects and reduces the chance that they will reach the customer, as well as signals problems so that people can immediately investigate their causes to then devise improvements to prevent recurrence. For *jidoka* to succeed, much effort must be placed on work standards, as only once "normal" is defined and made visual can "abnormal" exist. This high level of standardized work has proven to be a challenge for many healthcare organizations. Additionally, the structure of an organization must include people who respond quickly to an andon and have the time and mindset to solve problems, so they never recur. Without such a structure, andons will not be effective.

Looking back at the TPS House (Fig. 5.3), when both the JIT and *jidoka* pillars are balanced above the two lower levels of the TPS House, the roof of the house is level so that the House's goal of producing high-quality and low-cost products with a short lead time can be met. JIT and *jidoka* both deliberately signal and highlight problems during operations. As these problems are solved to prevent recurrence, performance for safety, quality, cost, and lead time improves.

Problem-Solving

As previously mentioned, problem-solving through the use of the scientific method as part of *kaizen* is the essence of TPS. Clarifying and narrowing a problem is crucial, as represented by the funnel (Fig. 5.5). Problems are barriers to progress for an organization but need to be anticipated. There are some problems that require a deeper and more focused approach, such as the eight steps of problem-solving (Fig. 5.5) as described in *Lean Hospitals: Improving Quality, Patient Safety, and Employee Engagement* [17]. Yet others can be quickly resolved using a "just do it" approach.

Generally speaking, the determination of what is a problem requires the definition of a standard of practice or care. Often when problems are uncovered, they are due to the following issues: there is no standard; the standard is not known; the standard is ignored; or normalized deviance results from standards not being completely followed. By creating standards and tracking the variations from the standard, the deviations are readily visible and can be targeted by Toyota's "disciplined, yet flexible and creative community of scientists" [18] who help Toyota move toward a zero defect rate, similar to a health system's analogous journey to zero harm. By having standards in place, experiments, or rapid cycle tests of change, can occur to see if the standard can be improved further. However, without standardization, experimentation cannot occur in a way where its effects can be measured or appreciated.

The eight-step problem-solving method (Fig. 5.5) breaks down problems through the use of a didactic approach in a manner analogous to the scientific method, which is only mastered through practice [17]. The eight steps are often captured on A3-sized (11-inch × 17-inch) paper, which forces teams to stay focused, concise, and

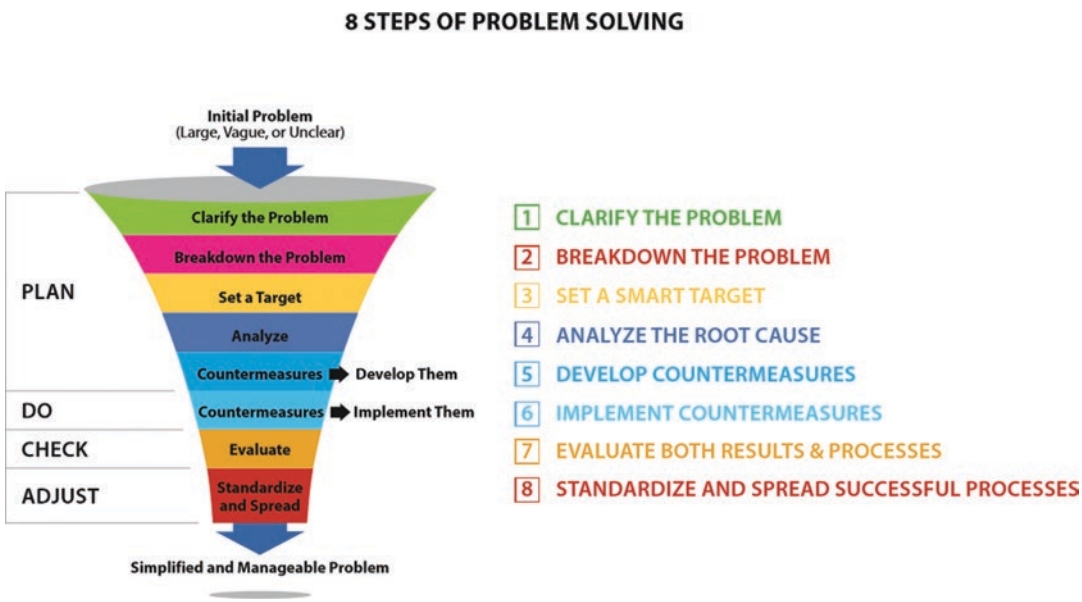


Fig. 5.5 Eight steps of problem-solving. (Figure Courtesy of Eric Cardenas and adapted from Graban [17])

simplify the problem. This A3 problem-solving document is portable, can be used to articulate the goals of the project and how they were developed, and can become the expectation for all improvement projects. The most important part of the A3 is the problem-solving and continuous improvement thinking behind the template. While the A3 is a useful summary document, using the template enables and supports teams' thought processes as they work through a systematic approach to problem-solving rather than simply filling in the boxes on a form.

In his 2011 book, *Thinking, Fast and Slow*, Daniel Kahneman [21] describes how we as humans are wired for automatic, rapid interpretation of input with little or no effort or voluntary control. Dr. Kahneman refers to this as System 1 thinking. In other words, we are quickly able to move from a problem to a solution. In healthcare, this thinking serves us particularly well in life-saving situations. However, not every problem we face in healthcare is a dire emergency. Many of the long-standing problems that we have been unable to solve in healthcare today require us to deliberately seek objective alternative interpretations of data/events or what Dr. Kahneman refers to as System 2 thinking. Anyone who has been on the sharp end of "standard" solutions based on assumptions to problems (including endless e-mail reminders to "just be more careful," countless "read and sign" policy attestations, and redundant in-service education), as a means to "solve" the same issues over and over, can attest that there must be a better way. The eight-step problem-solving provides a structure supporting the System 2 thinking necessary to make sustainable improvements that can transform healthcare. The eight steps using Plan-Do-Check-Adjust as a familiar framework are reviewed in Fig. 5.5; of note, Plan is inclusive of the first five steps of the eight steps.

In step 1, the problem is clarified through fact-based quantifiable data. The current situation is compared to the ideal situation, and the gap is identified. In step 2, the problem is broken down into smaller concrete problems by asking the following questions of the data: what, where, when, and who? When breaking down a problem, it is important to avoid "why" questions that prematurely lead to root causes, as this can misleadingly stop the strategic breakdown of data. Usually, based on the frequency or relevancy of an occurrence, the prioritized problem is chosen. This point of occurrence is identified on the process map. This is confirmed by walking, or observing, the shop floor (also called *gemba* or *genba*) in a process called *genchi genbutsu* (to go look, to see, to understand, to take action). In step 3, we set a target for the prioritized problem which is measurable and concrete, yet challenging. The SMART acronym is often used to lead teams through target setting. SMART stands for *S*pecific, *M*easurable, *A*ggressive yet Attainable, *R*elevant (to the problem), and *T*ime-sensitive. In step 4, the root cause is sought after by looking at all of the possible causes. Facts are gathered through *genchi genbutsu* and the "5-Why" approach is used to uncover the root cause. The 4Ms (Manpower, Machine, Material, and Method) can provide a structure when seeking root causes, and it can also ensure that the problem is looked at systematically without prejudice. By purposefully asking "why" several times, and validating information through *genchi genbutsu*, facts are separated from opinions and assumptions, thus resulting in true root cause(s). Most experts consider step 2 (breaking down the problem) and step 4 (analyzing the root cause) crucial for problem-solving to occur.

In step 5, many potential countermeasures need to be considered. A countermeasure is a set of actions that seeks to prevent the problem from arising again. Countermeasures are different from "solutions" that may just seek to deal with the symptom of the problem vs. the root cause(s). For every root cause, at least one countermeasure should be identified, understanding that one countermeasure may address more than one root cause.

Countermeasures will need to be prioritized based upon costs, ease, feasibility, and other factors. Countermeasures need to be in line with the ultimate goal and organizational priorities. These, in turn, are used to create a clear and concrete plan of action. Consensus needs to be reached around these countermeasures through discussions among

stakeholders, especially those with upstream and downstream process owners, to ensure the implementation of selected countermeasures will not negatively impact other processes.

In step 6, efforts are aligned to implement countermeasures with speed and persistence. When creating the action plan, consider the following:

- Who will be involved and affected (e.g., stakeholders)?
- What is to be achieved and how will it be achieved?
- When are potential completion times?
- Where will the work occur?
- Why is it important work?
- How is it going to be messaged throughout the organization?

Also consider all costs involved (e.g., potential downtime, manpower hours). The improvement team's efforts are messaged to the entire organization to inform and garner support. Monitor progress through the tracking of predetermined metrics. Be persistent and in line with the aforementioned HRO principles. Multiple tests of change may need to occur before success is achieved. The value of the Plan-Do-Study-Act (PDSA), also known as Plan-Do-Check-Act (PDCA), cycle, which has been extensively discussed in other chapters, cannot be understated to test countermeasures. Through the data-driven eight-step process, proper predictions for ideal solutions or countermeasures to problems are made, which consequently increases the likelihood that the ensuing planned tests of change (PDSA/PDCA cycles) will be successful.

Step 7 emphasizes the importance of evaluating results based on the SMART target set in step 3. Evaluate all results from the perspective of the customer, the team members, the organization, and society, seeking to understand the reasons behind the successes and failures. In addition, identify and celebrate potential return of investment(s), or ROIs. This can include cost savings and immeasurable benefits such as people development, team engagement, and a renewed commitment to *kaizen*.

Step 8 stresses the importance of standardizing successful interventions and creating new standards. Share and spread the improved standards with other parts of the organization or other organizations. Plan the next round of continuous improvement.

By developing a standard method for problem-solving, through the eight-step process and A3 document, Toyota has created a procedure for communicating within a team and across its organization. This method allows innovative solutions to spread across teams in a more understandable way. It incorporates PDCA/PDSA cycles for running small tests of change. This data-driven approach requires discipline and fact-based root cause analyses. The direction of an organization is not left to conjecture or the whims of a few strong personalities. In short, at its core, the Toyota Production System is:

- An integrated approach to problem-solving that creates an organizational culture of highly engaged people, solving problems to drive performance. High levels of JIT and *jidoka* expose and signal problems to solve.
- A way to achieve sustainable improvements that help foster a culture of continuous improvement and support the transformative change needed in healthcare.
- An organizational culture created and sustained by a three-part system, as described in the TPS Triangle of (1) philosophy, (2) technical tools, and (3) managerial roles.

Key Learning Points

1. The implementation of TPS requires the creation of a stable foundation which incorporates the four (or five) Ms – Manpower (People), Machine, Material, Method (and Mother Nature).
2. The two pillars (just-in-time and *jidoka*) and all of the foundation levels of the TPS House need to be equal so that its roof can remain level and deliver high-quality goods at a low cost with short lead time. This emphasizes the impor-

tance of all the components of the TPS House to achieve sustainable improvement.
3. The creation of standardized work is an important basis for measuring and driving improvement.
4. Just-in-time (JIT) focuses on customer demand and refers to the production and conveyance/transportation of only what is needed, when needed, and in the quantity needed. It meets the exact demand of the customer in terms of product, timing, and volume.
5. Building quality into a process (*jidoka*), so that defects become readily visible, is crucial to uncovering defects (andon). This has proven to be difficult for healthcare delivery systems to install for a multitude of reasons. Facilitating problem detection is the best way to ensure its rapid resolution.
6. The most important part of the eight-step process is the problem-solving and continuous improvement thinking behind the template. While the A3 is a useful summary document, using the template enables and supports teams' thought processes as they work through a systematic approach to problem-solving rather than simply filling in the boxes on a form.
7. Team member problem-solving skill development is critical and should be facilitated by all leaders and managers. These same leaders and managers need to be problem-solving experts themselves.
8. The shop floor (*gemba* or *genba*) is where all improvement occurs and, for this reason, local team members need to be incorporated into, and at times lead, improvement teams. Leaders need to visit the shop floor often to be visible to team members and better understand any problems they may face (*genchi genbutsu*).
9. The aforementioned summary points complement the definition of TPS. As a reminder, the Toyota Production System is an organizational culture of highly engaged people solving problems or innovating to drive performance. This culture is sustained by a three-part system, as described in the TPS Triangle, of (1) philosophy, (2) technical tools, and (3) managerial roles.

Vignettes with Relevant Discussion

The next sections describe vignettes from actual TPS-driven improvement projects from several health systems, followed by a discussion of the TPS concepts relevant to each vignette. The fictional patient cases are based on actual cases that have occurred at many hospitals but have been modified to protect the anonymity of each case.

Vignette 5.1 Improving the Delivery of Critical Nutrition to Our Most Vulnerable Patients

A 500-gram baby boy is born prematurely at 25 weeks and is cared for by the neonatal intensive care unit (NICU) team. He cannot breathe on his own since his lungs are not fully developed, so he is intubated and placed on a ventilator. At this point, his odds for survival may not be good as a majority of his organ systems are not mature, especially his respiratory, immune, renal, and neurologic systems. His caloric expenditures are high and they will need to be continually replenished, as his energy reserves have not been built up. The baby is immediately started on intravenous fluids, and the decision is made to start him on total parenteral nutrition (TPN). The TPN is ordered at 11 AM and will be delivered in the evening. It will likely be hung at the patient's bedside and the infusion started

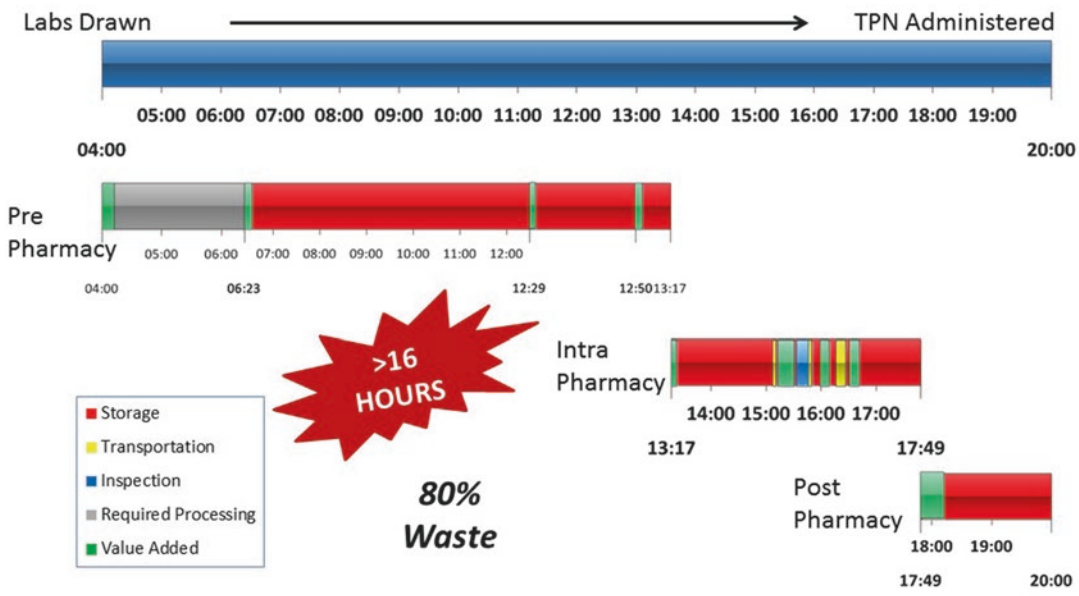


Fig. 5.6 Process map for TPN flow – initial state for a single patient

by 9 PM, 10 hours after the order was placed and 17 hours after his blood was first drawn to assess the various serum electrolyte levels. The parents inquire whether this TPN delivery time is the norm, and they are told that this is, in fact, the case at most organizations.

A process that has taken hours, rather than minutes, can hinder a clinical team's ability to render excellent care and meet the changing needs of a critically ill premature infant. TPN is produced with the hopes of mimicking the nutritional supplementation pathway available in utero from an infant's mother. The members of the TPN process improvement team sought to improve the TPN ordering, production, and delivery processes and reduce the time from TPN order to TPN infusion for an infant [22]. Figure 5.6 shows the process map from the ordering to delivery of TPN for a single patient on a single day.

There was considerable non-value-added time (or 80% waste) built into the original process, as shown by the areas in blue, red, and yellow. Figure 5.7 illustrates the different types of waste (*muda*). Figure 5.8 shows the same process after the various changes were implemented.

Multiple changes were implemented. The TPN production areas were reorganized to maximize efficiency using 5-S concepts (5-S = *S*ort, *S*et in order, *S*hine, *S*tandardize, and *S*ustain; Fig. 5.9). Within the pharmacy, the technicians' workflows were streamlined by placing supplies at the point of use, decreasing par levels (and therefore, on-hand inventory), and decreasing the automated TPN compounder's changeover time by standardizing its setup and breakdown (Figs. 5.9 and 5.10). The latter was created by using a video to demonstrate the standard setup and breakdown procedures, and technicians were then trained to this standard. This training was routinely repeated to ensure that there was no normalized deviation from this standard.

Within the NICU, medical team rounding, which involved the physicians, nurses, and phar-

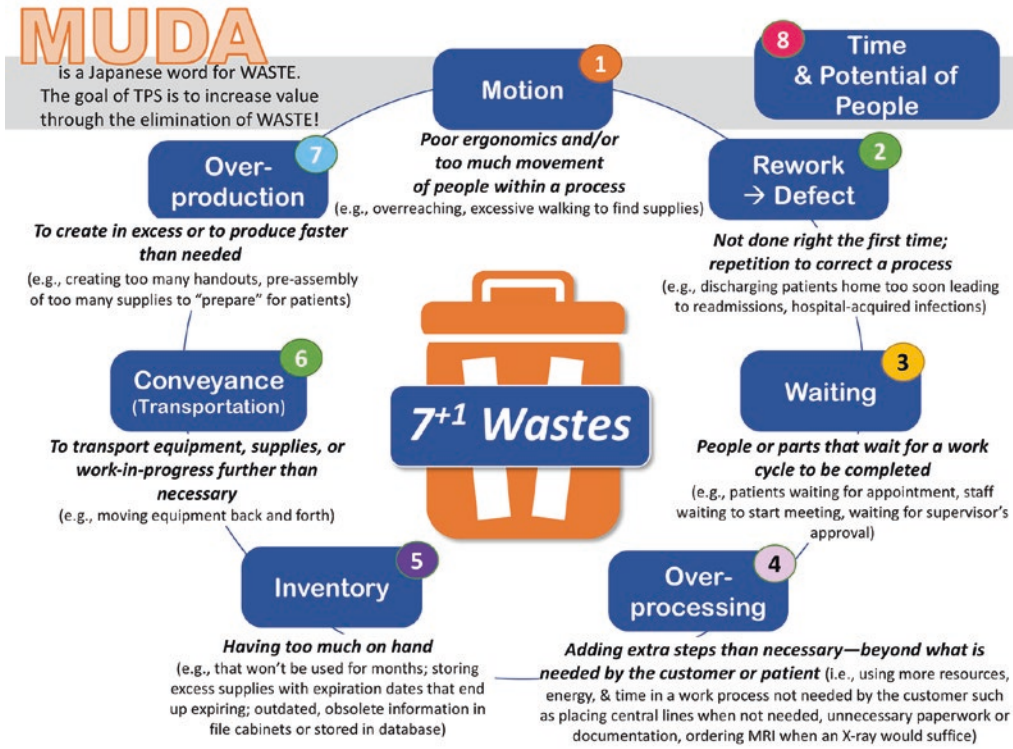


Fig. 5.7 The 7 + 1 types of waste. The seven (7) types of muda (waste) are motion, rework (that lead to defect), waiting, overprocessing, inventory, conveyance (transportation), and overproduction. In healthcare, wasted time and potential of people is commonly referred to as the eighth waste, which includes the inability to support people to function to the highest of their licensure

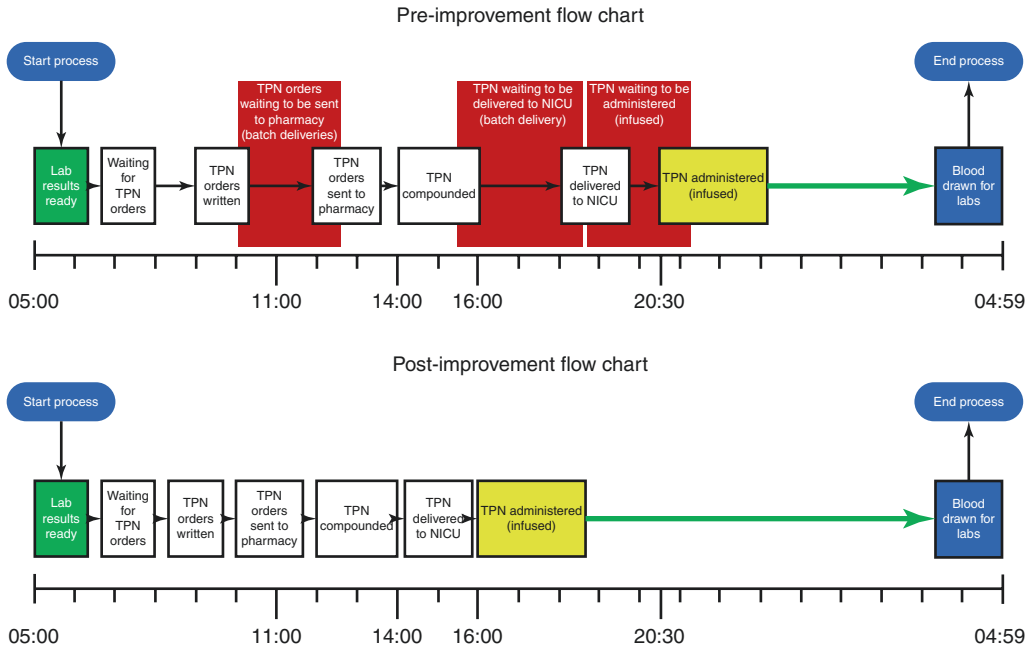


Fig. 5.8 Process map for TPN flow – pre-improvement (top) vs. post-improvement (bottom). The top figure shows the waste in the system pre-improvement. The red boxes in the first map indicate waiting time (representing waste or muda). The bottom figure represents TPN flow post-improvement

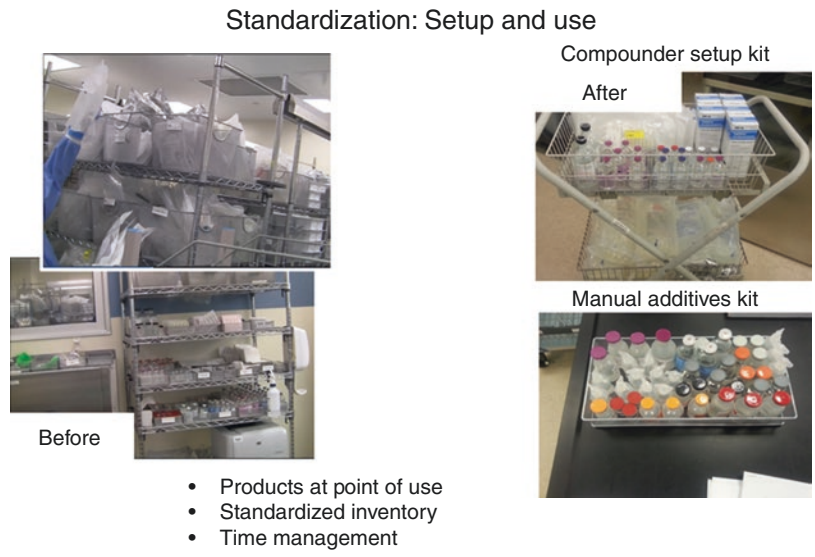


Fig. 5.9 Standardization of the TPN materials and additives

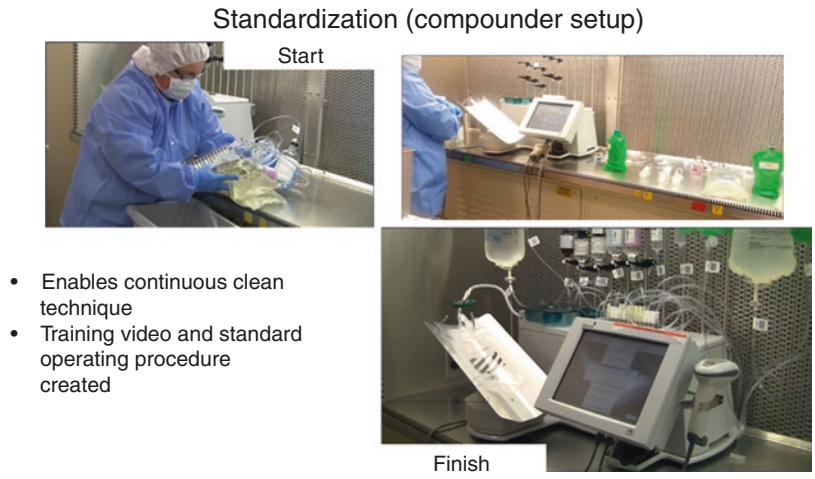
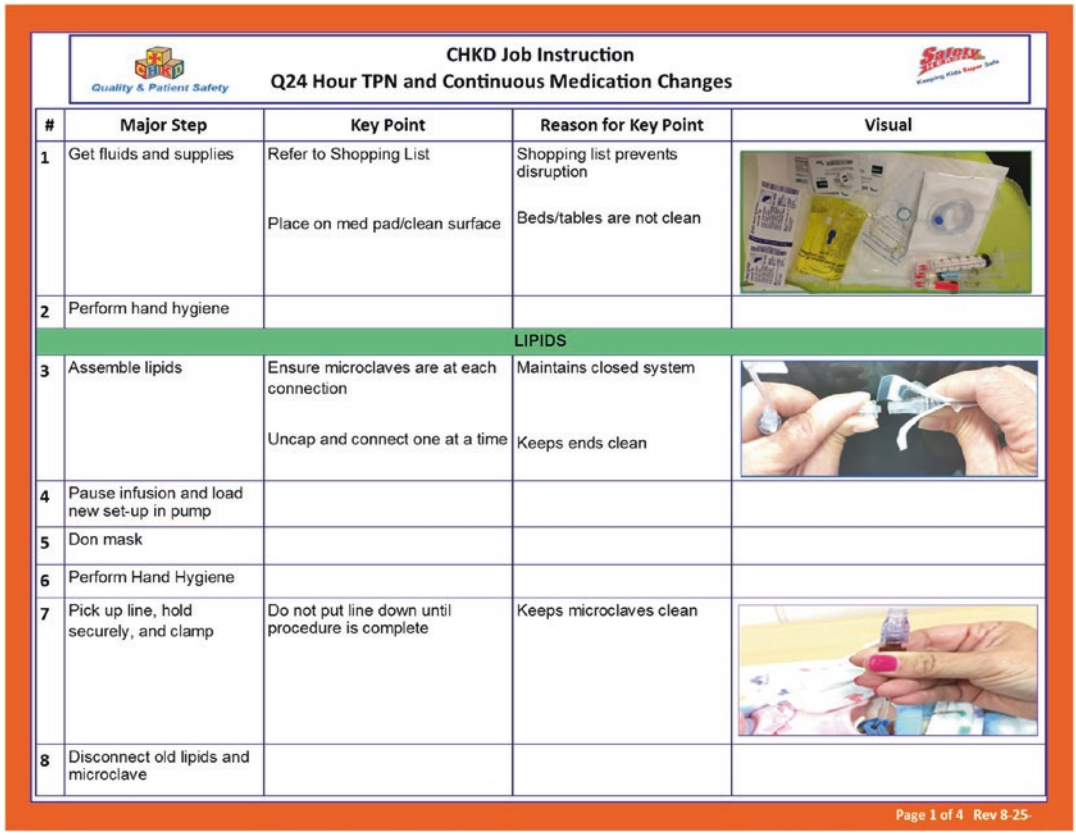


Fig. 5.10 Standardization of the TPN compounder setup

macists, was standardized over all 7 days of the week. The goal was to have most TPN orders sent to the pharmacy for compounding before the end of the morning.

Additionally, the daily TPN initiation times were changed, so this task fell to the day shift (7 AM–7 PM) team which, in turn, releveled the work (*heijunka*), since many more tasks traditionally fell onto the evening shift (7 PM–7 AM) team. Job instruction sheets (JIS) were created to teach the day shift nursing team how to start the TPN infusion and related standardized work. Since all patients who were receiving TPN also had central venous catheters, the efforts to standardize TPN delivery also required the creation of standards as to how TPN was infused using these central lines (Fig. 5.8). The JIS showed the "what" of each step in the "Key Point" column and the "why" behind each step in the "Reason for Key Point" column (Fig. 5.11). Additionally, to improve TPN delivery times, a TPN ordering software program was created within the electronic health record (EHR) with built-in algorithms that prevented ordering errors. Since this program communicated directly with the TPN compounder, errors from the re-transcription of



CHKD Job Instruction
Q24 Hour TPN and Continuous Medication Changes

Quality & Patient Safety

#	Major Step	Key Point	Reason for Key Point	Visual
1	Get fluids and supplies	Refer to Shopping List Place on med pad/clean surface	Shopping list prevents disruption Beds/tables are not clean	
2	Perform hand hygiene			
		LIPIDS		
3	Assemble lipids	Ensure microclaves are at each connection Uncap and connect one at a time	Maintains closed system Keeps ends clean	
4	Pause infusion and load new set-up in pump			
5	Don mask			
6	Perform Hand Hygiene			
7	Pick up line, hold securely, and clamp	Do not put line down until procedure is complete	Keeps microclaves clean	
8	Disconnect old lipids and microclave			

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Fig. 5.11 Job instruction sheet (page 1 of 4) for TPN administration

paper orders into electronic orders were eliminated. This is a great example of *jidoka*!

The TPN delivery improvement project resulted in a 45% reduction in the average time of TPN delivery to the patient after the initial order. All previous transcription errors which resulted from the rework that had been part of the initial process were eliminated as well. By addressing the TPS House's roof, its JIT (especially with the creation of a pull system) and *jidoka* pillars, lead time reduction and the maintenance of high quality were achieved (Fig. 5.12).

Key Learning Points

1. Understand the current state of a process before implementing change, identifying value-added and non-value-added times. Value-added time refers to time that improves a process and is important to your customers (patients, in this situation).
2. Organize the work areas to maximize efficiency while minimizing inventory. These concepts of organization are referred to as the five *S*s – *S*ort, *S*et in order, *S*hine, *S*tandardize, and *S*ustain.
3. Processes need to be designed to focus on the customer first, not what is easiest based on layout, machines, or old habits.
4. Standardization is a critical first step for quality improvement. Without a standard, *kaizen* cannot take place.
5. *Heijunka*, or leveling of work, is critical to prevent team member burnout, improve patient safety, and improve efficiency.
6. Building in quality, or *jidoka*, as with the TPN compounding software pro-

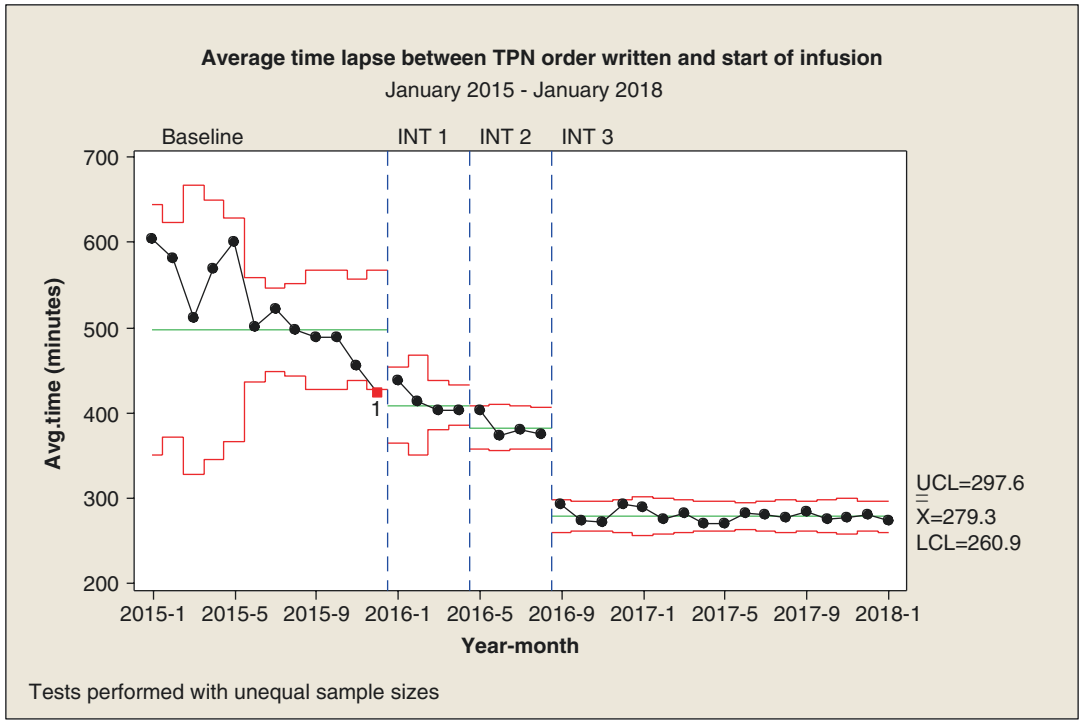


Fig. 5.12 Average time between the TPN order written and start of the TPN infusion. The X-bar chart shown below displays the reduction in average TPN delivery times from approximately 500 to 280 minutes through the changes described in this vignette. Mean values for each phase are denoted by the green lines

gram, can improve the ability to detect defects.

7. Use job instruction sheets (JIS) to share and teach standard work to frontline team members. The JIS show the "what" of each step in the "Key Point" column and the "why" behind each step in the "Reason for Key Point" column. The pictures provided in the "visual" column provide further clarification and guidance for each major step.

Vignette 5.2 Improving the Pain Medication Reassessment Process in the Emergency Department

It is the first Wednesday of the month, and Margo, the nurse manager for the emergency department (ED), is in her office preparing to meet with her supervisors. As she looks over the ED Quality Data Metric Report she just received, she shakes her head in disbelief. Once again, the ED is below the target for pain reassessment – a key measure of pain management for her department. Not just a little under the target, data showed that only 55% of ED patients were being reassessed by their nurse timely (per hospital and regulatory requirements) after receiving pain medications. "Barely half!" she exclaimed to herself as she glanced back at the file cabinet that held all the pain management in-service education provided to each shift for the past six (6) months. She remembered that she even had kept a copy of the colorful poster created by the unit secretary to remind staff of the importance of reassessing patients for pain – a staff member's

idea to help improve their compliance. "After everything we have done, how can our compliance be so low?" she thought to herself as her management team begins to fill the room for their weekly meeting.

Per usual, each supervisor provided a brief update on their areas of responsibility. Walter, Margo's newest supervisor, was just finishing his update when he shared a flyer from the Lean Department offering an A3 class. "I really am interested in taking this class. I just have to get your approval and bring a real problem for which we have data. I will need your help to identify a small team, including line staff that we can pull offline for 1 hour a week, dedicated to solving the selected problem for the next few months. What do you think?" Margo sighed, "Here's the most recent pain reassessment compliance data. Let's do this – I'm all in!"

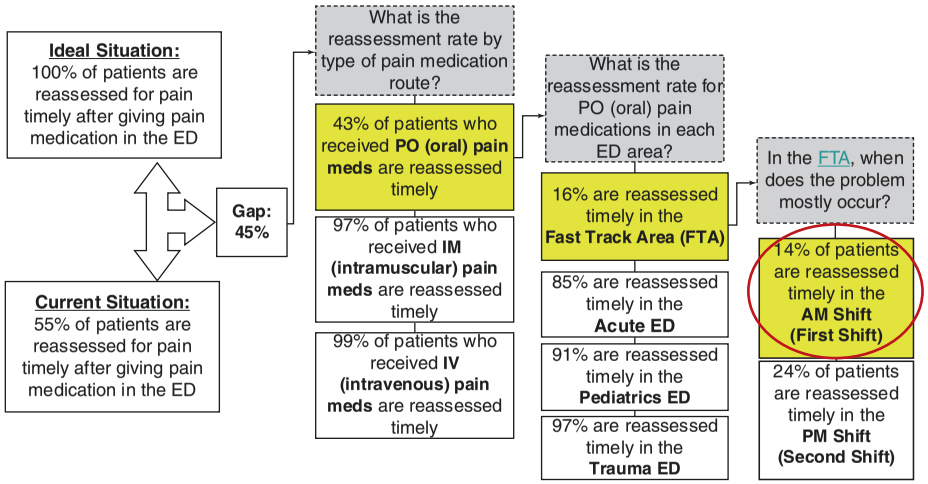
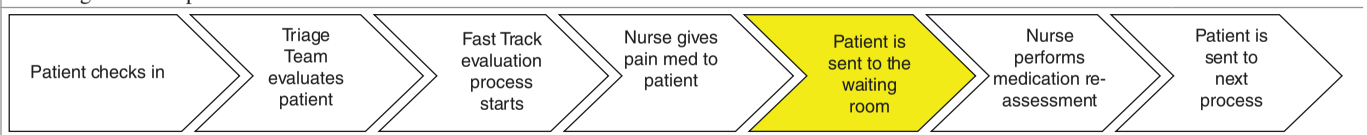
A pain reassessment team was formed and included Margo, the nurse manager; Dr. Beverly Chase, an emergency medicine physician; Randy, an RN (registered nurse); Lisa, an LVN (licensed vocational nurse); and Walter, the newly appointed team leader for this initiative. They called themselves, "The A-Team" and agreed to meet every Wednesday for 1 hour just before the weekly staff meeting. The following is a summary of the team's improvement efforts (Table 5.1) which walks through the eight steps of problem-solving (Fig. 5.5).

This vignette illustrates the robust methodology outlined in the eight steps of problem-solving. Normally all eight steps are captured on a single A3-sized document, but were formatted here to meet the publication needs of this textbook. As mentioned earlier, the use of the A3 document as a standard permits easier communication, idea sharing, and standardization and spread of successful change ideas across an organization.

Key Learning Points

1. The eight-step (A3) problem-solving process can be successfully applied to solve long-standing problems in healthcare.
2. Breaking down the problem using data (step 2) is key to helping the team prioritize and focus their improvement efforts on the most problematic area first.
3. In step 4, the 5-Whys analysis is used to arrive at the root cause. For instance, a team member asks "why" moving down the causal analysis tree to arrive at the root cause. To double-check the rationale, one can state "therefore" to move upwards from the root cause.
4. Generally in step 4, we look for one root cause to a problem. In some cases, there will be a root cause with additional contributing causes. In these vignettes, the main and contributing causes are being classified as root causes for the sake of simplicity.
5. Developing standardized work is a critical first step for quality improvement. Without a standard, kaizen (continuous improvement) cannot take place.
6. Building in one-piece flow into the process where patients are brought back into the FTA, stay until pain is reassessed, and re-medicated for pain if indicated, decreases the waste of motion and waiting for the patient and improves care and experience.
7. Commitment, support, and humility are modeled by the nurse manager as she encouraged the new supervisor to lead the improvement team, allocated dedicated time for team members to do improvement work, and supported the team by joining as a member and not the

Table 5.1 Eight steps of problem-solving for Vignette 5.2

Step 1: Clarify the problem – background data/ information	Pain is the most common reason patients come to the emergency department [23, 24]. Inadequate and untimely pain management in the ED is a global problem – despite the availability of resources, protocols, and effective interventions [25] Internal audits revealed that only 55% of ED patients were being reassessed within the appropriate timeframe (per hospital and regulatory requirements) after pain medication was administered *Ideal situation*: 100% of patients who receive pain medications (meds) are reassessed for pain timely in the ED *Current situation*: Only 55% of patients who receive pain medications (meds) are timely reassessed for pain in the ED There is a need to improve pain reassessment in the ED which is a high patient volume unit with considerable acuity and, as a result, prone to problems
Step 2: Breaking down the problem	 Breaking down the problem:
Identify the point of occurrence	
Prioritized problem	Only 14% of patients who received PO (oral) pain medication in fast-track area (FTA) and who are sent back to the waiting room during the first shift are reassessed for pain timely (the ED staffing is traditionally based on two 12-hour shifts. The first shift refers to the 7 AM to 7 PM shift. The second shift refers to the 7 PM to 7 AM shift)

(continued)

Table 5.1 (continued)

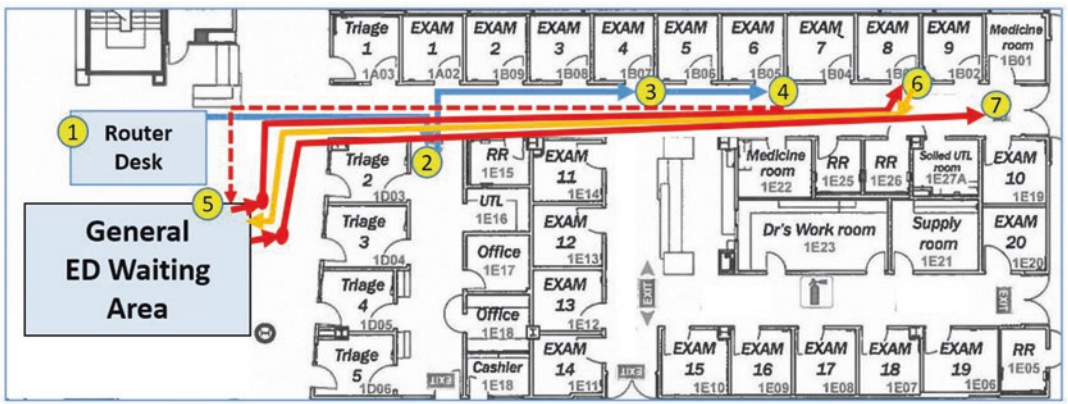
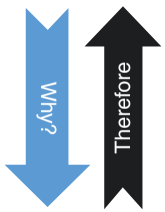
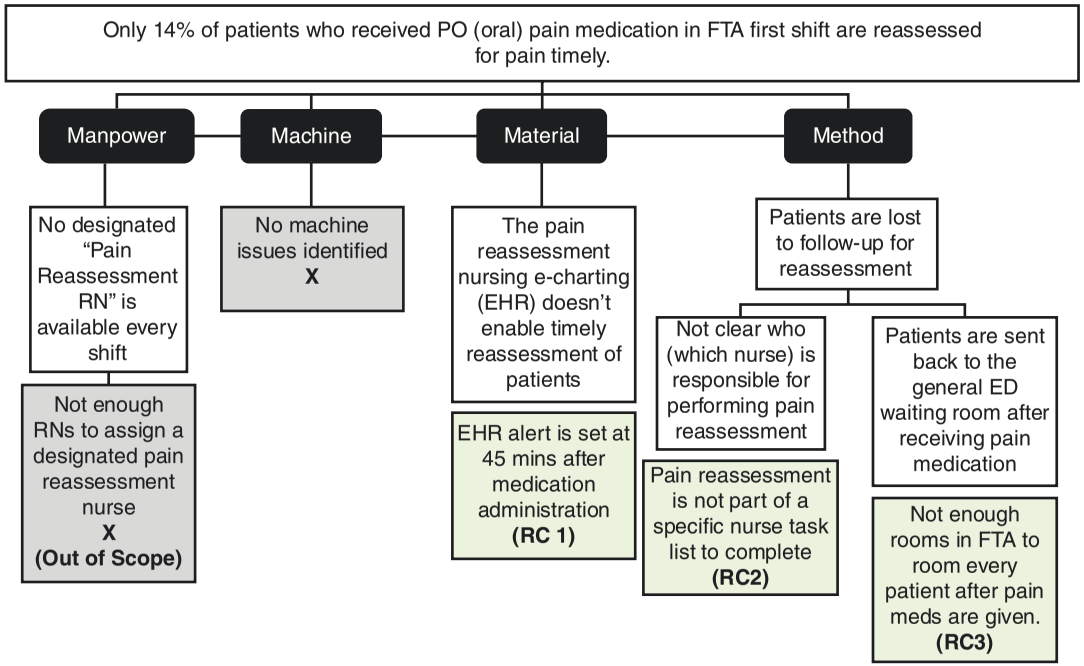
Current conditions/*genba* observations	To validate the internal audit, the team conducted *genchi genbutsu* and observed FTA first shift's processes The FTA team observed: *Manpower*: Nursing staffing – i.e., registered nurses (RNs) and licensed vocational nurses (LVNs) – is frequently at a bare minimum *Machine*: No issues identified *Material*: The EHR alert for pain reassessment is set at 45 minutes, leaving the nurses only 15 minutes to complete the task *Method*: There is a misunderstanding on who should reassess a patient's pain level. When RNs were asked, most responded that it is the responsibility of the nurse (RN or LVN) who gave the medications to reassess the patient, while most LVNs stated that it is the responsibility of RNs to reassess a patient's pain level after pain medications are given Workflow – Below is the current process and diagram of the flow of the patient visiting FTA needing pain management: Task 1: Patient checks in at the router desk Task 2: Patient is called into FTA to be evaluated by the triage team Task 3: Patients are sent to either room 4 or room 5 to have their medical evaluation process initiated Task 4: During the evaluation of the patient, if pain medications are needed, they are sent to room 6 or room 7 to receive pain medications Task 5: After a patient receives pain medications, they are sent to the waiting room Task 6: If applicable, a patient is called from the waiting and directed to room 8 for further workup Task 7: Patients are called back to room 7 to obtain discharge information Diagram of workflow: 
Step 3: Target setting	Improve timely reassessments of patients who receive oral medications in the FTA during the first shift from 14% to 100% by December (3 months)

Table 5.1 (continued)

Step 4: Analyze the root or main cause(s)/ identify root or main causes (RC)





The team identified three root causes (green boxes below, RC 1–3) by asking "why" the prioritized problem happens, followed by checking the logic of the root causes by stating "therefore" for each root cause up to the prioritized problem (Generally in step 4, we look for one root cause to a problem. In some cases, there will be root cause with additional contributing causes. In these vignettes, the mean and contributing causes are being classified as root causes for the sakes of simplicity)

For this step, ask "why" as you move down the casual analysis tree and arrive at the root cause. One can double-check the reasoning by moving up, or backwards, on the tree and state "therefore".

(continued)

Table 5.1 (continued)

Step 5: Develop countermeasures

For each root cause, the team develops at least one countermeasure, understanding that one countermeasure may address more than one root cause

Root Causes (RC)	Countermeasures (CM)
RC 1: EHR alert is set at 45 mins after medication administration	Change electronic health record to support reassessment policy requirements (CM1)
RC 2: Pain reassessment is not part of a specific nurse task list to complete	Modify FTA reassessment workflow by developing standardized work (CM2)
RC 3: Not enough rooms in FTA to room every patient	Reconfigure ED set up to allow patients to remain in the FTA after pain medication administration (CM3)

Step 6: See countermeasures through

The team needs to develop a plan for how the countermeasures will be implemented. The plan includes who will be accountable and when actions are to be completed:

Countermeasures (CM)	Plan	Who?	When?
Change EHR to support reassessment policy requirements (CM1)	1. Change the EHR alert from 45 minutes to 30 minutes to allow more time for the nurse to complete pain reassessment. 2. Meet with the EHR workgroup to gain consensus 3. Implement changes to EHR 4. Train staff and establish go-live date	WW WW WW MK/WW	10/1 10/15 10/25 10/30
Modify FTA reassessment workflow by developing standardized work (CM2) and reconfigure ED set up to allow patients to remain in the FTA after pain medication administration (CM3)	1. Dedicate a room for patients to remain in FTA post pain med administration for reassessment 2. Validate process, update standardized work. 3. Obtain equipment (e.g., 6 chairs) 4. Infrom team–in all shifts–of new process 5. Update standardized work and audit standardized work; provide updates at weekly visual management board meeting	BC BC/WW DR MK/WW WW	10/15 10/20 10/30 10/25–10/30 10/15

Table 5.1 (continued)

Step 7: Evaluate both results and processes	Compliance to pain reassessment during the FTA first shift improved from 14% to 94%, and overall ED compliance improved from 55% to 90%. While significant improvement was achieved, the 100% target was not met. Barriers: Despite the new processes in place, dedicated time for improvement work (e.g., auditing of standardized work) became limited due to high staff turnover and slowed progress for a period of time. Some of the additional benefits and return on investment (ROI) ignited enthusiasm for a team-based approach to develop standardized work for other processes in the ED. The team was propelled to create workflows for other areas within the ED, including the transition of care to the urgent care center. Improved psychological safety (achieved 100% positive response in a staff engagement survey) and human development (staff acknowledging how their work, ideas, and involvement support the organizational goals) created a structure platform for weekly multidisciplinary problem-solving discussion	Date:12/15
Step 8: Standardize and spread successful processes	Pain reassessment data for FTA is displayed on a visual management board – now monitored and analyzed weekly for all shifts to ensure improvement is sustained and ideas to further improve are captured. Part of the huddle in front of the visual management board is the discussion of the instituted continuous observations of standardized work and how the process can be further improved. The new electronic health record alert change (from 45 to 30 minutes) was adopted throughout the healthcare network. Further, causal analysis is now performed on individual cases not in compliance, and results are communicated back to individuals and the team for further ideas to improve and for immediate recurrence prevention discussion. Improvements are shared within the ED and across the organization. Reflections: While the target of 94% timely pain reassessment was not achieved, the team became empowered and encouraged to exceed this target in the coming months – not only on the first shift but also on the second shift. Having current data displayed and readily available to all has ignited shared accountability and healthy competition to improve care and meet compliance across the unit.	Date: Ongoing

leader (HRO principle of deference to expertise).
8. The 4Ms provide an excellent framework for systematic root cause analysis.
9. Visual management boards help to provide a forum for communication of key performance metrics, building staff engagement and knowledge of departmental goals, and their individual role in helping to meet them.
10. The implementation, standardization, and resulting spread of the new electronic health record alert for pain reassessment were successful since it had first been tested on a small scale.

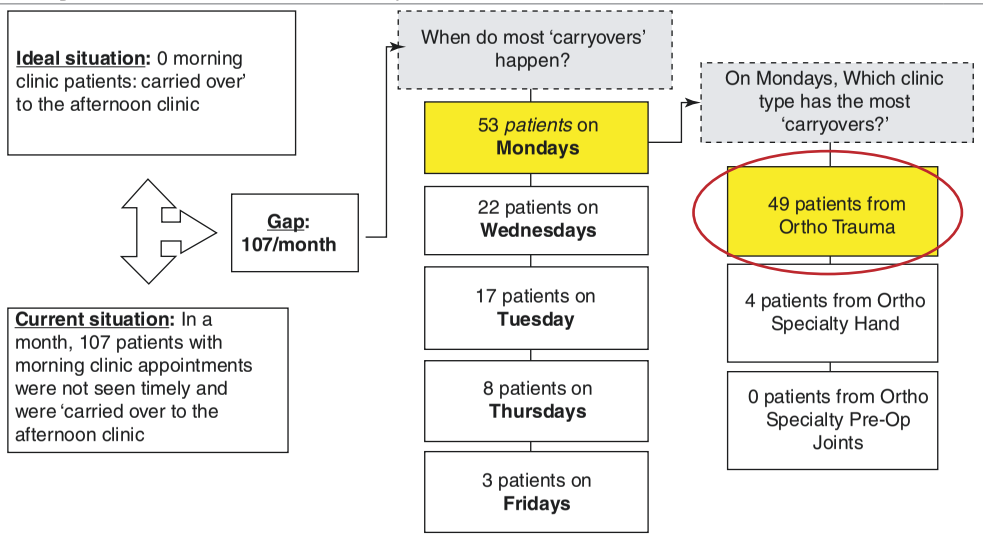
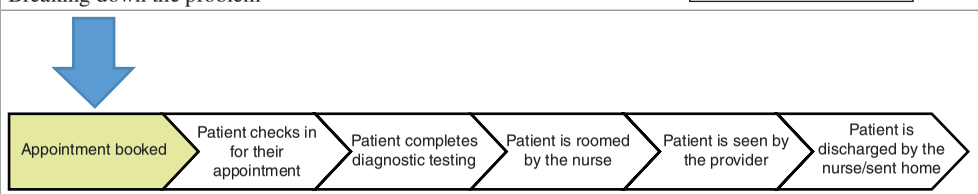
Vignette 5.3 Improving the Clinic Cycle Time for Orthopedic Patients

A 38-year-old male motorcyclist (Mr. M) was brought to the ED after he was accidentally hit by a car. His chief complaint was that his right wrist was painful. The patient stated that, when he fell off his bike, he landed on his right wrist. Diagnostic tests were performed, and the orthopedics trauma team (abbreviated ortho trauma) was consulted. Based on the X-ray, the patient was diagnosed with a new acute distal radial bone (wrist) fracture. Ortho trauma stabilized, reduced, and splinted the injured wrist. The patient was sent home and was instructed to go to the ortho trauma clinic the next day (Monday) when it opened at 7:30 AM to be seen by a hand specialist.

Scrambling for transportation, Mr. M had to take two separate buses to make it to the clinic by 7:30 AM. On the way, Mr. M called his boss to let him know what happened to him and that he would be into work immediately after his appointment was finished. The clinic was packed with patients – all with some sort of cast or bandage on one limb or the other. At 7:45 AM, Mr. M was relieved when his name was called, and he was escorted back into an exam room by a nurse. After asking him a few questions, and performing a brief assessment, the nurse informed Mr. M that the hand specialist team would soon be reviewing his case and would be in as soon as possible. After about 30 minutes of waiting, Mr. M fell asleep in the chair, exhausted for having spent the entire evening in the emergency department the night before. He was awakened a few times as the nurse reentered the exam room to check on him and, each time, she reassured him he would be seen as soon as possible. Around noon, Mr. M peaked his head out the door asking the nurse for directions to the nearest restroom. When he returned, the nurse informed Mr. M that he may want to get something to eat in the cafeteria as he most likely would not be seen until after 1:00 PM. Hungry, tired, and frustrated, Mr. M left the clinic, quickly ate, and called his boss to let him know he still hadn't seen the doctor yet and would most likely not make it into work at all. Mr. M returned to his exam room at 1:00 p.m. as instructed by the nurse. Mr. M was seen by the hand specialist at 1:30 PM – 6 hours from the time he arrived at the clinic that morning! While relieved when he was informed by the specialist that he did not need to have surgery on his wrist, Mr. M couldn't believe he had lost a whole day of work – a day he wasn't going to get paid for. Mr. M was given clinic discharge instructions by the nurse that included a follow-up appointment the following Monday. As he left the clinic at 2:15 p.m. he wondered, "How am I ever going to pay for all this and get my bike fixed? I have to work – I just can't take another day off from work to sit here all day."

Table 5.2 walks through the 8 Steps of Problem-Solving for this vignette.

Table 5.2 Eight steps of problem-solving for Vignette 5.3

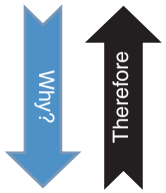
Step 1: Clarify the problem-background data/information	The organization's guiding principles include putting patients first, improving their experience, and respecting people. In the ortho trauma clinic, patients report staying for their visit longer than anticipated. Along with overall patient experience, "perceptions of information, instructions, and the overall treatment provided by physicians and other caregivers" are also negatively influenced by prolonged clinic times [26]. An internal review of data revealed that some patients who were scheduled for morning appointments were staying until later in the afternoon. The clinic termed these patients "carryovers" – patients scheduled in the morning clinic with cycle times so long they were "carried over" to the afternoon clinic, negatively impacting the clinic cycle time throughout the entire day. As part of an overall improvement initiative to reduce the ortho trauma clinic cycle time (time from when patients are checked into the clinic until the time they are discharged), the team prioritized understanding and reducing the number of "carryovers" (high volume, high risk, and problem-prone). *Ideal situation*: 0 patient "carryovers" from morning appointments to the afternoon clinic *Current situation*: In a month, 107 patients were unable to be seen timely and were "carried over" to the afternoon clinic.
Step 2: Breaking down the problem and method of measurements	 Breaking down the problem
Identify the point of occurrence	

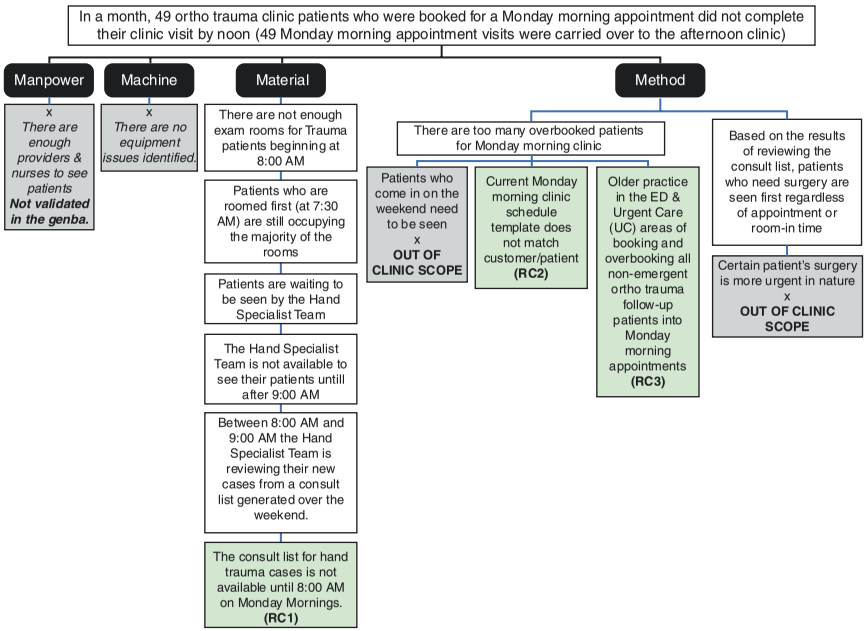
(continued)

Table 5.2 (continued)

Prioritized problem at the point of occurrence	In a month, 49 ortho trauma clinic patients who were booked for a Monday morning appointment did not complete their clinic visit by noon (49 Monday morning appointment visits were carried over to the afternoon clinic).
Current conditions/*genba* observations	Based on the prioritized problem, *genba* observations were conducted by ortho trauma clinic staff for the next two Monday mornings and found the following to be consistent: *Manpower*: There are enough providers and nursing staff to see patients *Machine*: No issues identified *Materials*: Trauma patients, who come in through the emergency department (ED) and urgent care clinic (UCC) over the weekend, are told to report to ortho trauma clinic at 7:30 AM Monday for follow-up (patients are booked and overbooked into the morning appointment slots). This was identified when the team visited the ED *genba* Hand patients are prioritized and are traditionally given the earliest morning appointments. This was also learned from the visit to ED *genba* A list of patients with non-emergent hand injuries is created by the trauma consultant. The list prints out at 8:00 AM in the ortho trauma clinic on Mondays Each case is reviewed by the hand specialist team to determine the treatment plan and whether surgery will be required when they meet from 8:00 to 9:00 AM on Mondays If the hand specialist team determines a patient will need to be scheduled for urgent surgery, the patient is prioritized to be seen regardless of their clinic appointment time *Method*: ED and UCC traditionally book and overbook all non-emergent trauma cases from the weekend to early Monday morning appointments. This was garnered from ED *genba* and validated in the ortho trauma clinic
Step 3: Target setting: set *SMART goal	Decrease the monthly number of ortho trauma clinic patients with Monday morning appointments who are carried over to the afternoon clinic by 50% (from 49 to ≤25 patients) in 1 month

Step 4: Analyze the root or main cause(s)/ identify root or main causes (RC)





The team identified three (3) root causes (green boxes below) by asking "why" the prioritized problem statement is happening, followed by checking the logic of the root causes by stating "therefore" for each root cause up to the prioritized problem.

(continued)

Table 5.2 (continued)

Step 5: Develop countermeasures	

Root causes (RC)	Countermeasures (CM)
RC 1: The consult list is only available to the hand trauma specialists on Monday morning at 8:00AM	• Increase the number of times the hand trauma specialist team is given the consult list in a week (CM1) and standardize expected time (i.e., before 7:30AM) (CM2) • Revise hand trauma specialist appointment time slots to 8:20 • AM(CM3) Standardize completion time of trauma specialists' review of the consult list (i.e., by 8:20AM) (CM4)
RC 2: Current Monday morning clinic schedule template does not match customer/patient demand	• Identify types of appointments that are getting overbooked (CM 5) and create a new appointment types (e.g. Trauma Hand) to match patient/customer demand (CM6)
RC 3: Older practice in the ED & Urgent Care (UC) areas of overbooking patients into Monday morning slots	• Provide copies of new schedule to areas who schedule patients (CM7)

<table>
<tr><td>Step 6: See countermeasures through</td><td>The team needs to develop a plan for how the countermeasures will be implemented. The plan includes who will be accountable and when actions are to be completed:
<table>
<tr><th>Countermeasures (CM)</th><th>Plan</th><th>Who?</th><th>When?</th></tr>
<tr><td>Increase the number of times the hand trauma specialist team is given the consult list in a week (RCI/CMI) and standardize expected time (i.e., before 7:30AM) (RC1/CM2)</td><td>1. While EHR restructures electronic consult process, consult list will be sent by the Ortho Trauma team by 07:30AM
2. Notify hand team of new changese</td><td>Dr. H</td><td>8/22</td></tr>
<tr><td>Revise hand trauma specialist appointment time slots to 8:20AM (RC1/CM3)</td><td>1. Communicate go-live date (8/23) of updated template to team
2. Reschedule current patients who still have 7:40AM appointments and inform patient of rationale of changes (i.e., to decrease waiting times)</td><td>NP</td><td>8/20</td></tr>
<tr><td>Standardize completion time of trauma specialists' review of the consult list (i.e., by 8:20AM) (RC1/CM4)</td><td>1. Communicate updated template to Hand team
2. Revise schedule of Hand team to be at the clinic in time to review consult list starting at 7:30AM.</td><td>Dr. H</td><td>8/20</td></tr>
<tr><td>Identify types of appointments that are gettiing overbooked (RC2/CM 5) and create a new appointment types to match demand (RC2/CM6)</td><td>1. Follow up with scheduling department on request for updated EHR appointment type (to add "Ortho Trauma Resource: Hand Trauma) based on data
2. Reallocate Trauma Clinic resources (i.e., 12 appointment 20-min slots, 2 rooms, manpower) to Hand Trauma based on data
3. Schedule and commnunicate go-live date (8/23) of updated template to team</td><td>Dr. M</td><td>8/23</td></tr>
<tr><td>Provide copies of new schedule to areas who schedule patients (RC3/CM7)</td><td>1. Reach out to services and areas who schedule non-emergent hand trauma appointments (i.e., the emergency department, urgent care, other clinics)
2. Provide copies of new schedule (both printed and electronic copy)
3. Develop electronic calendar system to improve sharing of future updates</td><td>Dr. M</td><td>8/20</td></tr>
</table></td></tr>
<tr><td>Step 7: Evaluate both results and processes</td><td>The monthly number of morning ortho trauma clinic patients carried over to the afternoon decreased from 49 to 21 patients – a 57% improvement
Some of the additional benefits and return on investment (ROI):
Mondays' clinic cycle time decreased from an average of 3 hours and 36 minutes to 2 hours and 15 minutes, which is a 37.5% improvement
Several staff ideas for improvement continue to be discussed and small tests of change are initiated during weekly team meetings</td><td>Date: 9/30</td></tr>
<tr><td>Step 8: Standardized successful processes</td><td>Carryovers are tracked and analyzed daily (through ortho's visual management board). The team developed routine data-based discussion (at least weekly) with the ortho clinic team members to analyze and address clinic issues to make small incremental improvements each day to optimize capacity
Reflections: While the 57% improvement is a positive change, the team is looking forward to their next PDCA to continue to level out the clinic schedule and daily operations to achieve their ideal state to see all their patients in a timely manner</td><td>Date:
On-going</td></tr>
</table>

Key Learning Points

1. The TPS eight-step process and the problem-solving thinking of the A3 process can be successfully applied to outpatient clinic problems by an interdisciplinary team of clinicians and surgeons, nurses, and ancillary staff with administrative support.
2. The balancing of the clinic schedule by designating specific hand clinic slots to match customer demand, and revising/streamlining the hand specialist workflow, eliminating unnecessary batching of case reviews, is an excellent demonstration of *heijunka* (level loading or balancing of the workload).
3. The importance of *genba* (shop floor) and *genchi genbutsu* (go look, go see, to understand and take action) was demonstrated especially in steps 2 and 4 (breaking down the problem and root cause analysis) of the eight-step process. Data told the team that "trauma" patients were the most problematic. However, through *genchi genbutsu* the team was able to go beyond the available data. Through direct observations in the *genba*, the team identified that patients required to be seen by hand trauma specialists within "trauma" were the early morning bottleneck which led to long waits for all trauma patients and a significant factor in causing carryovers.
4. The importance of involving a team of experts, including members from other areas of the hospital (ED) and reinforcing the HRO concept of deference to expertise, is highlighted in the vignette.
5. The changes implemented by the ortho team led to a significant reduction of *muda* (waste) for patients (waiting) and clinic staff (rework of having to recheck on patients multiple times).

Vignette 5.4 Reduction of Pressure Injuries in Patients and Days Away, Restricted, or Transferred (DART) Days in Their Providers

An 8-year-old complex medical needs patient born with a large omphalocele (open abdomen associated with a chromosomal defect during prenatal development where parts of the intestine and liver grow outside the abdominal cavity) was placed on mechanical ventilation in a pediatric intensive care unit as part of the postoperative clinical pathway associated with her plan of care following the surgical reduction of an intestinal obstruction secondary to adhesions. The clinical team managing the care of this patient was afraid to turn her to the lateral or prone position for fear of disrupting the recent repair. Given the patient weighed 30 kg and had multiple attached devices, including monitoring equipment, this patient could not be turned by a single staff member without risking employee back injury. The nurse completed her Braden Q assessment just after the beginning of her shift (8:00 AM) but scored the patient a 22 (low risk of developing a pressure injury on a scale of 0–26), not recognizing the high risk due to the patient's immobility. The nurse is called to the care of another patient in respiratory distress and does not complete her head-to-toe skin assessment on this patient. The other patient is finally stabilized, and the nurse begins to document her care of both patients in the EHR, noting that it was now 4:39 PM and that she was administering scheduled medications for her patients. The nurse ends her shift at 7:00 PM, and the oncoming nurse completes a head-to-toe skin assessment along with the Braden Q assessment. She finds an advanced (stage 3) pressure injury (PI) on the patient's occiput and proceeds to treat the patient based on recommendations from the wound

ostomy nurse. After applying the prescribed treatment for the PI, she remembers that her coworker injured his back turning a similar patient 2 weeks prior and has yet to return to work. She asked the charge nurse for assistance to turn the patient.

Members of the pressure injury reduction team sought to address the number of PIs that were developing across the organization. They used the eight-step problem-solving methodology (Fig. 5.5) and quickly walked through the various steps of identifying the gap in performance, breaking the problem down to a manageable scope. Figure 5.13 shows, by breaking down the problem (step 2 of the eight steps of problem-solving; Fig. 5.5), that Unit I had the highest occurrence of PI. By carefully examining the PI cases in Unit I, they found that PIs developed in patients that were not turned regularly and in patients with multiple devices used for complex medical treatment. In accordance with step 3 (target setting), they chose to address the patients who were inconsistently turned. While focusing on that cohort of patients, they uncovered several staff injuries related to lumbar strain and were able to use data gathered from direct observation, the EHR, and occupational health to identify that the problem was bigger than initially anticipated. This team set a target (step 3 of the eight steps of problem-solving; Fig. 5.5) of reducing the occurrence of PIs located on the occiput of patients. While working through the 5 whys (step 4 of problem-solving; Figs. 5.5 and 5.14), the team found that patients were not turned when two things were present: (1) the lack of perception of the risk of the patient's ability to develop a pressure injury (identifiable when the Braden Q Scale is used appropriately) and (2) the patient was perceived to be too heavy to turn alone. As the first countermeasure, the team worked with frontline staff to create a simplified standard for assessing patient risk of developing pressure-related injuries by simplifying the verbiage of the Braden Q Scale (a risk assessment tool used to identify patients at risk for developing pressure injuries, where the lower the score, the higher the patient's risk of developing a PI). Using the wound ostomy team (WOT), they tested inter-rater reliability between frontline staff and the WOT using the newly developed modified standard tool for assessing risk, the modified Braden Q [27] (Fig. 5.15).

Once the gap between the WOT and the frontline staff's Braden Q Scale results was narrowed, the team turned their focus to creating a standard used to train staff on turning patients alone, using a safe and simplified method (countermeasure 2). All Unit I staff were trained using JIS, and the standard was maintained using random audits by peers, WOT, and local leadership. As a result of staff using the new standard for turning patients alone, employee

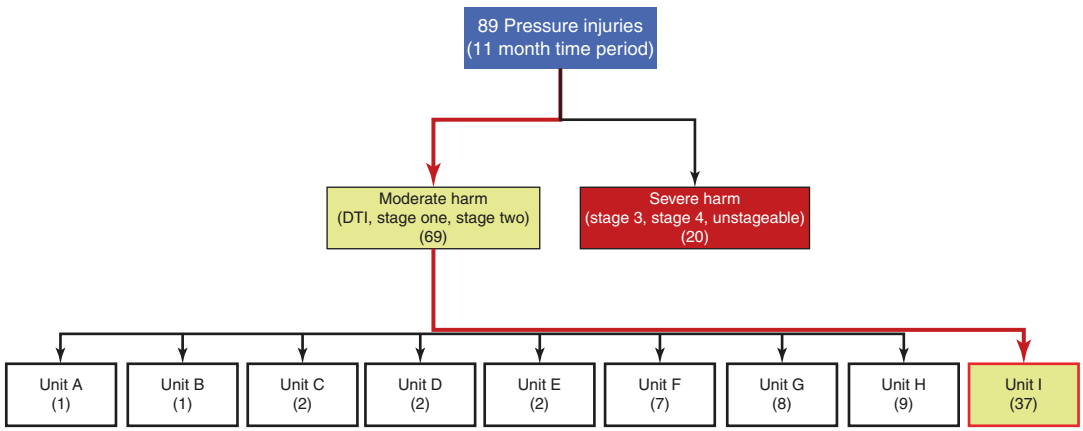


Fig. 5.13 Step 2 of problem-solving – breaking down the problem

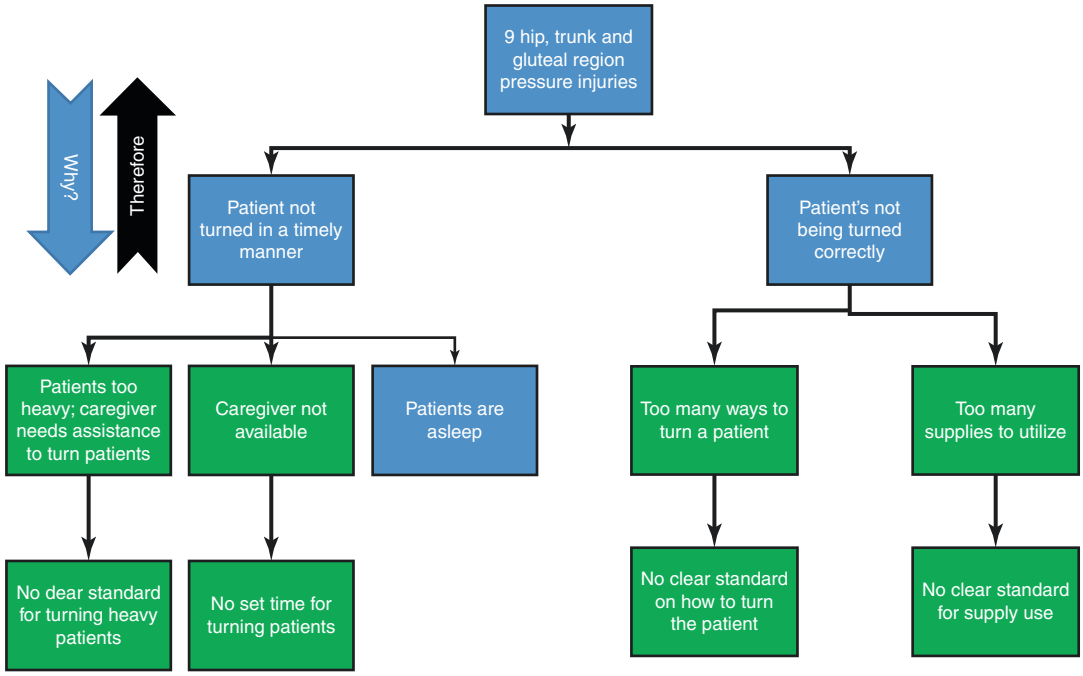
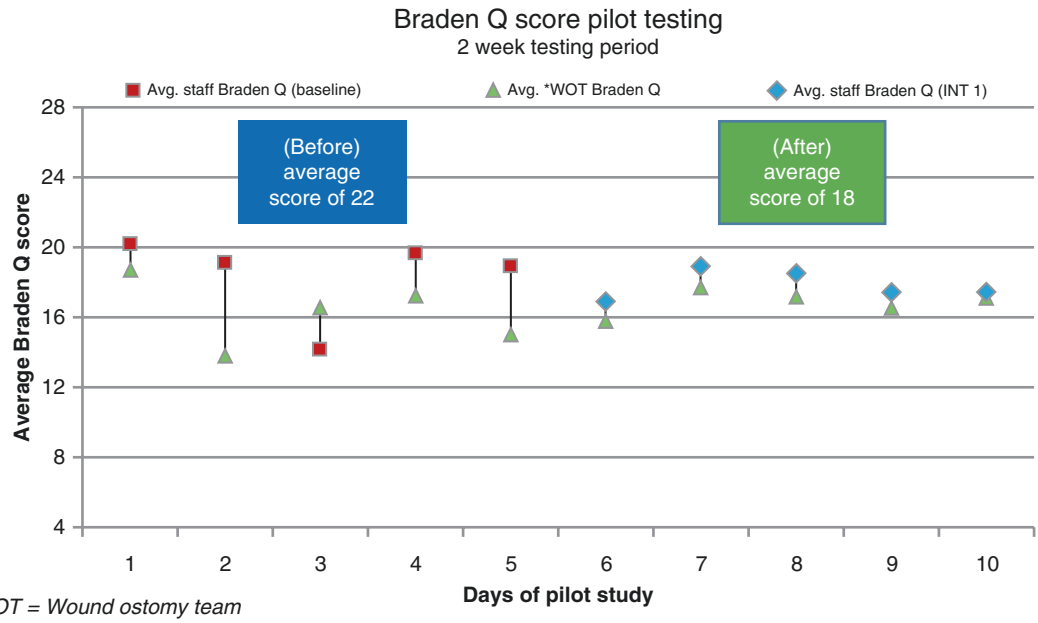


Fig. 5.14 Step 4 of problem-solving – root cause analysis using the 5 whys. The question "why" is asked repeatedly to arrive at the root cause(s). The lowest green boxes represent the root causes. To double-check the analysis, "therefore" can be applied as shown in step 4 of Vignettes 5.2 and 5.3



**WOT = Wound ostomy team*
Baseline Data Source: Electronic Health Record
Intervention 1: Use of a modified Braden Q scale

Fig. 5.15 Narrowing the gap between staff and WOT Braden Q scoring after training

injuries measured by the number of days away, restricted, or transferred (DART) has been reduced.

This vignette demonstrates the challenges of patient care. Ill and immobile patients are prone to PI, which often are subtle before they become larger and more obvious. The TPS encourages the creation of processes that bring these problems readily to the surface. Unlike the automotive assembly line, it is difficult to create processes that automatically uncover a PI and stop hospital processes, as described earlier for the *jidoka* pillar. In healthcare, there is value in setting up auditing processes and assigning accountability to identify PI in a more timely fashion, such as regular clinical skin assessments and creation of wound care teams that routinely audit at-risk patients.

Similarly, prevention strategies are helpful. The team's problem-solving exercise revealed that PIs were related to the absence of standards on how to take care of at-risk patients, especially the use of standard preventive methods (e.g., regular patient turning) and bedding materials (those that would facilitate turning or reduce pressure on at-risk body surfaces). Frontline team members had not been trained to adequately assess a patient's skin to detect and classify these pressure injuries as they occurred, so they were trained by the WOT. As shown in Fig. 5.15, the frontline staff responded well to their training on the use of the Braden Q assessment tool, so much so that their assessment scores nearly mirrored those of the expert WOT (compare days 1–5 vs. days 6–10).

The problem-solving exercise (Fig. 5.14) also revealed that heavy patients posed a challenge to the staff with regard to turning. The use of the Turn and Positioning System (TAPS) (Fig. 5.16) enabled patients to be turned with minimal risks to the frontline staff. This equipment was stocked on all units that cared for heavier patients, and frontline staff members were trained to the newly created standard using a JIS (Fig. 5.17) and simulation (Fig. 5.18), which improved their ability to care for patients at risk for PI through the implementation of prevention and early detection strategies.

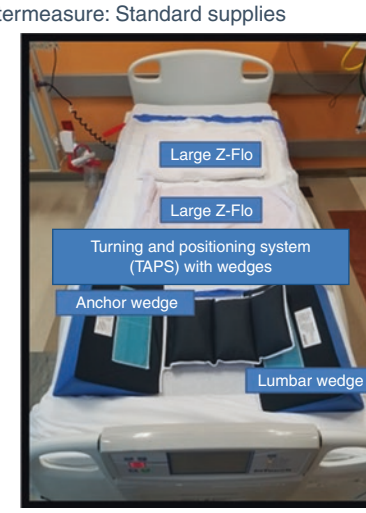


Fig. 5.16 Standardized supplies to enable easy turning (Z-Flo pillow, wedges, and TAPS) of patients

Key Learning Points

1. The phrase "if the student has not learned, then the teacher has not taught" emphasizes the value of teaching a standard process or method. If frontline team members are not taught a standard and the learning is not reinforced, variations in practice as well as normalized deviation will occur. This can have devastating consequences.
2. The creation of standardized work, which emphasizes best practices and the use of JIS to teach to the standard, can help improve outcomes.
3. The eight steps of problem-solving, when done properly, can discover hidden root causes.
4. In healthcare, the use of timely, unbiased, and robust auditing processes can be an alternative to *jidoka*, which is used extensively at the Toyota manufacturing plants.

CHKDHS Job Instruction: Positioning Patient with TAPS
(Placed in Bed Supine)

#	Major Step	Key Point		Reason for Key Point	Visual
1).	Gather supplies based on shopping list criteria	**Shopping List Criteria:** Tissue/Perfusion ≤ 2 ***OR*** Braden Q Score ≤ 18 ***AND*** Weight >35kg	**Supplies:** 1 Turning Assisted Positioning System (TAPS) with TAPS Sheet ***AND*** 1 Gizmo ***AND*** 2 Large Z-Flo	Use of shopping list criteria reduces chance of disruption of workflow	
2).	Setup bed	*With bed at waist level of the clinician and side rail down:* 1). Place 1 Large Z-Flo at the head of the bed aligned with the width of the bed 2). Position TAPS lenghwise with the mattress; black straps down, just below the Z-Flo 3). Place TAPS sheet on the top of TAPS 4). Place 1 Large Z-Flo near foot of the bed, aligned with the width of the bed		Ensures appropropriate product is used to reduce the patient's chances of developing a pressure related pressure injury	
3).	Place patient in bed per protocol, raising side rails closest to patient's left arm.				
4).	Position patient supine (from patient's right side)	Align top of shoulder with top of TAPS.		Assures appropriate position on TAPS Reduces additional sliding of patient	
5).	Position TAPS Anchor Wedge	1). Place anchor wedge black side up, under the TAPS, under the patient's right thigh 2). Push anchor under legs through to the patient's left side 3). Place lumbar wedge, under the TAPS, behind the patient's right lumbar without wedging under the patient		Reduces additional sliding of patient Reduces pressure to sacrum	
6).	Position all lines and wires	1). Use the Gizmo to untangle and gather all lines and wires 2). Drape them across the patient 3). Lead lines and wires to their respective devices 4). Raise side rails		Reduces chance of device related pressure injury	
7).	Reposition Bed	1). Raise foot of bed to desired height 2). Raise head of bed to desired height		Reduces patient sliding	

Fig. 5.17 Job instruction sheet shows the use of TAPS to position the patient

Used medical simulation

Fig. 5.18 Using simulation to teach the new standard described in the job instruction sheet

Building a Successful TPS Culture

Building a TPS culture takes planning, considerable culture building, and training, similar to our medical education processes. For instance, when physicians, nurses, and other allied health professionals are trained, they go to a school where they are taught key concepts and fundamental principles. While in school and during their internships and residencies, they are exposed to practical concepts and procedures and learn through observation while under the guidance of their teachers or coaches. During these training years and early part of their careers, they are paired up with good coaches who provide continued guidance. Learning TPS is no different (Fig. 5.19) in that most learning is by doing, or practice, under the auspices of a good coach. There are three phases – education by concept, exposure/observation, and practice with a good coach. Key to this success are good coaches who can provide guidance to TPS teachings. These phases can occur in one of the two likely ratios (10:10:80 or 20:20:60). In other words, 10–20% of TPS can be learned with formal training/classroom exposure and 10–20% from exposure or seeing TPS in action. However, the greatest learning is from hands-on experience or direct involvement with team problem-solving, a key aforementioned point from the teachings of Taiichi Ohno – learning by doing. Compared to medicine, TPS concepts are relatively simple. In fact, they are so deceptively simple that people sometimes skip the learning by doing.

As with any project dealing with change, the goal is to start with small tests of change. TSSC also embraces the model line concept, where building the TPS culture should first occur within a single service line or program. That single area is developed fully to the point where it can serve as a model of successful TPS implementation for others within a system to look to for advice, support, and leadership. The newly trained unit members and leaders can also be redeployed to coach similar improvement projects elsewhere in the organization.

Chandrasekaran and Toussaint [28] recently described a set of best practices that can help sustain a TPS culture within a health system. First, instill TPS behaviors in managers at all levels of the organization. Senior leaders need to be present and visible at regular intervals in the various organizational huddles. There will

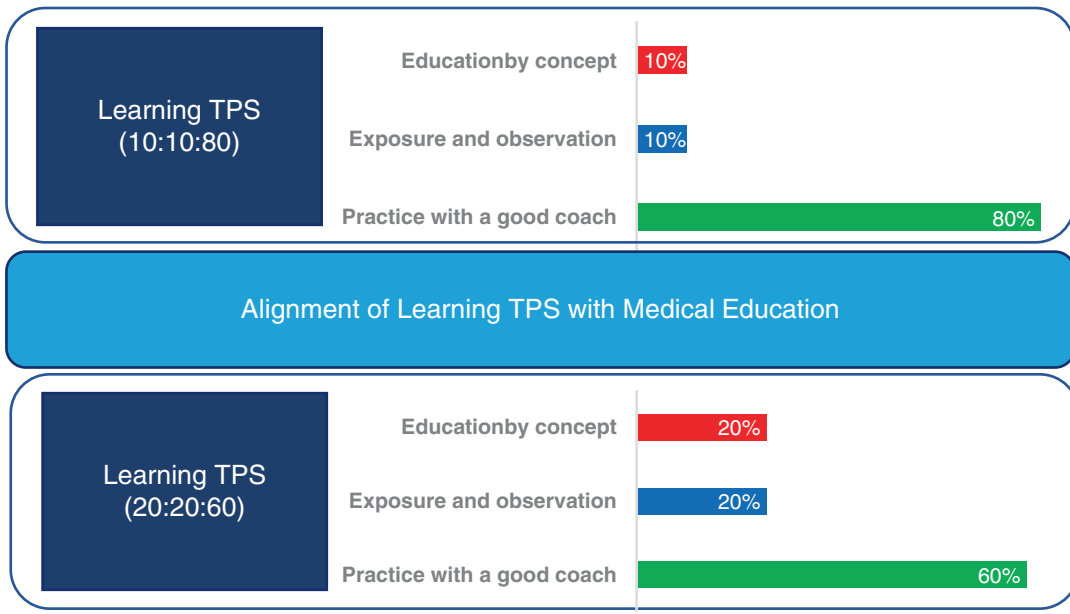


Fig. 5.19 Three phases of TPS training and implementation and their alignment with medical education

need to be succession planning for the senior leaders, especially the CEO and various board members, with specific preference to those who understand and embrace TPS. Stories of success need to be created and shared. Finally, the quality and cultural management system needs to be a TPS-based operating system. All of these aforementioned concepts will permit problems to come readily to the surface to be resolved in a timely fashion, since problem-solving is part of the daily culture and expectation.

The application of TPS principles to a healthcare organization requires a new mindset that might at first appear foreign, especially with regard to the role of leaders. Kim Barnas, while a senior leader at ThedaCare in Appleton, Wisconsin, best described this mindset or business improvement system as comprising of eight key elements which are similar to TPS or their lean principles [29]:

1. *Status reports* – local daily dialogues that occur throughout the organization which enable situational awareness.
2. *Daily team huddles* – enable teams to discuss opportunities for improvement, challenges, and ongoing improvement projects.
3. *Managing or auditing to the established standard.*
4. *Problem-solving.*
5. *Transparency* – defects and problems are brought forward along with accomplishments.
6. *Advisory teams* – advisors comprised of team members or leaders from across the organization are available to individual units to provide knowledge and expertise where needed.
7. *Scorecard* – tracks actual monthly performance metrics against goals.
8. *Leadership standard work* – leaders round regularly and set standard work expectations for all team members, including themselves (see reverse fishbone diagram; Fig. 5.20).

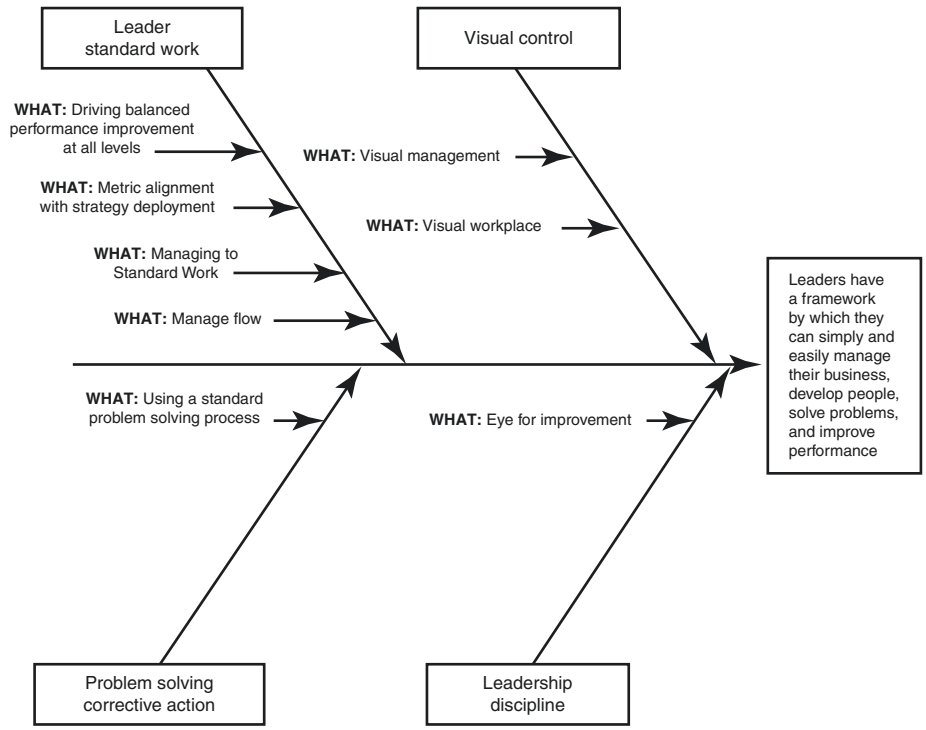


Fig. 5.20 Reverse fishbone diagram that depicts the role of any leader. This is a cause-and-effect diagram [30] in which the desired leadership outcomes were first defined and then the actions needed to create the effect were tested and implemented if successful. (Reprinted with permission from Kim Barnas [29])

The latter point emphasizes the role of any leader in an organization committed to adopting TPS. Every organizational leader has a structured day which begins by assessing and understanding the current state and anticipating problems (Fig. 5.20). The goal is to move from a "firefighting" mentality to an anticipatory focus where problems can be solved before they become critical. Leaders need to become more visible, more respectful, actively supportive of the organization's improvement initiatives and daily work, and process improvement focused. As discussed in the Bundles and Checklists chapter (Chap. 13), some hospital leaders use *kamishibai* cards (K-cards) as rounding tools to improve compliance with best practice bundles. Problem-solving is everyone's responsibility. Teams work together to solve problems using the scientific method and leaders encourage and facilitate this. All improvement projects must be aligned with corporate goals which are rigorously reviewed annually.

Summary and Closing Discussion

The application of the Toyota Production System to healthcare is a recent development. While there are many differences between manufacturing and healthcare, we believe that the principles are applicable. The TPS culture can be invaluable when properly inculcated into the daily mainstream operations of an organization and can especially assist with its cultural and quality transformation. TPS is, after all, an organizational culture of highly engaged people solving problems to drive performance that is created and sustained by the three-part system described by the TPS Triangle (Fig. 5.2).

Many healthcare organizations have started the "mindfulness" journey to becoming a high-reliability organization – and as a result, improve their quality and safety outcomes. Weick and Sutcliffe [3] referred to mindfulness as the quality of attention. The agility needed to address the ever so changing opportunities, and threats facing mindful organizations and their team members, is due to the constant refinement of existing expectations, continual improvement of cognitive foresight, and rapid learning from events as they occur. Toyota is one such mindful organization where their journey to sustained excellence has occurred through careful planning and the focus on the development of its team members – one member at a time. They have realized that the HRO journey takes time, may have occasional setbacks, yet have processes in place that promote resilience. They have created a successful organizational culture that they have to reinvigorate every time a new plant opens or its team members retire or transfer. Toyota has accentuated the value of continuous process improvement and the related problem-solving. It has integrated the principles of the TPS Triangle (Fig. 5.2), as well as the technical tools described in the TPS House (Fig. 5.3), throughout its global operations.

TPS requires senior leadership team and management commitment and visible participation, especially with the modeling of desired behaviors, new habit formation, problem-solving skills for all, and all of the HRO principles mentioned earlier in this chapter and throughout this textbook. The power of TPS is in the method which mandates constant demonstration of competence through the application of learned principles, participation in improvement projects, and accountability for personal growth and that of your respective teams. In short, TPS leaders are visible, known to all, and enable the success of their teams. They are lifelong learners, teachers, and coaches.

Process visibility is also crucial. Only if the current state of pre-existing processes can be defined can problems be brought to the surface and processes improved, ultimately leading to better outcomes. Problem-solving is everyone's responsibility, as is the resulting shared learning. Taiichi Ohno coached his disciples by drawing a chalk circle onto the floor (often referred to as Ohno's Circle [31]) and then asking them to stand in it and thoughtfully observe the actual processes on the shop floor. His disciples then reported on the various problems observed and were asked to use data-driven and observation-confirmed problem-solving to arrive at solutions. Data was collected through simple observations

initially. Later, more complex data collection was made possible from the various automated *jidoka* tools that had been implemented on the shop floor. The resulting problem-solving occurred quicker. The value of each team member's learning by doing cannot be overstated.

As a corollary, healthcare teams are inappropriately focused on the unavailability of automated data rather than embracing the value of collecting data through simple, yet purposeful, observations from which to drive cycles of change. The "just do it" mentality is sometimes lost in the pursuit of perfection, but all improvement methods mentioned throughout this text will not be successful if they succumb to analysis paralysis. Toyota encourages small PDCA/PDSA cycles using simple data collection methods and austere, inexpensive countermeasures. The proper use of problem-solving permits better prediction to increase the likelihood of successful PDCA/PDSA cycles.

Toyota prides itself on its safety record for its team members and customers, but this can only happen if issues are rapidly addressed through multiple test cycles of change. After all, it is the cumulation of small cycles of change that eventually lead to bigger changes and breakthrough innovation. Even if automated data were available, verification of the current state through observation of the shop floor through *genchi genbutsu* is of utmost importance to breaking down any problem and analyzing for the root cause (steps 2 and 4 of the eight steps of problem-solving; Fig. 5.5). Also as described in the HRO principles – sensitivity to operations and deference to expertise – Toyota's frontline teams are the experts and always assist with any unit and even an interfacility-based problem-solving exercise. Toyota's leaders are present, directly interacting with team members and coaches to facilitate the problem-solving process. This is quite the contrast from some healthcare organizations where problem-solving may occur without the direct involvement of and guidance from their senior leaders. Ideally, there should not be any perceived or actual barrier to the bidirectional communication or flow of ideas and feedback between the organization's leaders and its team members. Not surprisingly, Taiichi Ohno valued leaders who excelled at mentoring and teaching.

TPS also provides organizations with a framework for sustaining results through the creation of a culture where organizational goals and expectations are evident to all team members and linked to the yearly organizational strategic priorities. Often the best judge of organizational culture is as an outsider looking in. Multiple clients of TSSC, Toyota's not-for-profit entity charged with sharing TPS outside of Toyota, have commented that Toyota's team members "point in the direction that they will be walking before crossing a street" and "do not walk while talking or texting on their mobile devices" – both key safety behaviors they practice when in one of Toyota's busy manufacturing plants. Clearly the value of modeling behaviors is not lost upon Toyota team members. Similarly, Toyota leaders and managers are required to demonstrate ongoing mastery of problem-solving methods. This continuous cultural reinforcement, facilitated by TPS, is paramount for sustaining and continually building upon past results that leads to new, improved, and innovative products and methods.

Clearly, Toyota and its production system and its history deserve our attention. Toyota's corporate DNA [18, 32] appears to have encoded the principles of the TPS Triangle which, in turn, has been engineered into the DNA of its leaders and team members. Healthcare and other industries are trying to understand how a similar transformation can be facilitated within their respective realms. Toyota's journey has been deliberate. It has been subject to its constraints in its initial development from the global economic climate facing post-World War II Japan, ongoing challenges from the changing global landscape, and a result of the successful application and practice of the scientific method by all of its leaders and team members.

As a final thought, healthcare systems are complex and problems are inevitable, especially with regard to human error. We need to simplify these complex processes, and eliminate faulty processes that make errors more likely to happen, by employing the TPS. TPS is a different way of thinking and can be the methodology to move

any organization along its HRO journey. Its success requires commitment and internal reflection from an organization's leadership and team members. A review of Toyota's history reveals a well-orchestrated journey with the development of processes to address and learn from the unexpected! A few healthcare organizations have succeeded in the application of TPS, but they have been on a multiyear journey with ongoing commitment to becoming even better. It remains to be seen whether the application of TPS will start increasing the velocity of change and innovation in healthcare, as we try to attain the goals of delivering value to our customers, both patient and team member, with zero harm.

Key Closing Points

1. The Toyota Production System is an organizational culture of highly engaged people solving problems or innovating to drive performance. This culture is sustained by a three-part system, as described in the TPS Triangle, of (1) philosophy, (2) technical tools, and (3) managerial roles.
2. The TPS philosophy consists of four key points: (1) customers first, (2) people as the most valuable resource, (3) continuous improvement, and (4) shop floor focus.
3. Bringing problems to the surface is important. Problem-solving skills, as part of *kaizen*, are important to teach team members.
4. Team members learn best by doing.
5. When done properly, culture driven by TPS is a win for patients and their families, a win for caregivers, a win for hospitals, and a win for communities! If it is not win, win, win, win…, then it is not TPS.
6. TPS adoption can assist with the high-reliability journey of any healthcare organization.

Editors' Comments

This chapter represents a comprehensive overview of one of the most productive, efficient, and well-known improvement process frameworks historically: the Toyota Production System. The editors sincerely appreciate the efforts of Toyota in creating this thorough chapter aimed at describing their company's journey to develop the Toyota Production System. We find the granularity of the chapter of significant value for the reader so that one can understand the nuances and broad applications of the Toyota Production System.

The most exciting part of the chapter is the direct application to healthcare. The second half of the chapter focuses on the use of the Toyota Production System methods and processes in healthcare; the authors accomplish this by using actual cases with the methods detailing the specific interventions with the resultant data. Without the specific information, the reader would have been left with a theoretical understanding of their system; however, the second half of the chapter brings the teaching full circle by showing the reader how the Toyota Production System has been applied and continues to be applied in healthcare – driving outcomes that heretofore were not able to be achieved. The value of its eight steps of problem-solving methodology cannot be understated. The TPS, its Triangle and House, and its problem-solving methodology can stand alone or be used in part with other methods including the IHI Model for Improvement (as discussed in Chaps. 4 and 9).

This chapter epitomizes the concept of this textbook: to take theory and demonstrate how to put it in action and the benefits that can be derived from such an application. The quest for zero harm was the impetus for the editors – we keenly

realize that to get to zero harm, we will need to think differently and broaden our toolkits. This chapter achieves the trifecta of teaching a theoretical framework, applying this to healthcare, and inspiring us with the case studies.

Acknowledgments The authors would like to thank Adam Campbell, Maya Godambe, Michael Goss, Nathan Hurle, Elizabeth Martinez, Lisa Parker, Elizabeth Pittman, and Teresa Saulnier for the critical review of this chapter.

Glossary of Relevant Terms

5-S refers to a visually based process for organizing the workplace to reduce waste, especially time spent looking for supplies, and consists of the following components: *S*ort, *S*et in order, *S*hine, *S*tandardize, and *S*ustain. 5-S becomes 6-S if you include Safety.

Andon a signal which is automatic or manual that indicates to everyone in its proximity that a problem has been detected. It often also tells the nature and location of the problem and, therefore, is critical to effective problem-solving.

Fishbone, *Ishikawa*, or Cause-and-Effect Diagram a tool used to identify potential causes for an effect or problem. This is very effective when used in conjunction with problem-solving.

Gemba/Genba refers to the shop floor or place of work being examined.

Genchi Genbutsu refers to the purposeful process of walking and making humble observations on the shop floor or where the work takes place. "To go look, to go see, to *understand*, to take action."

Heijunka refers to leveled work or production.

Humanize to create an environment where respect for people, a key TPS concept, is realized remembering that 100% of what we do ultimately impacts our customers 100% of the time.

Jidoka refers to "automation with a human touch" or the process of building in quality or quality at the source. *Poka-yoke* and andons are part of *jidoka*.

Just-In-Time refers to the production and conveyance/transportation of only what is needed, when needed, and in the quantity needed. It meets the exact demand of the customer in terms of product, timing, and volume.

Kaizen refers to continuous improvement and problem-solving.

***Kamishibai* card (K-card)** a tool used to ascertain team member knowledge of a given best practice (often used to perform audits of standardized work or as rounding tools to improve compliance with best practice bundles).

Kanban refers to a signal, which usually is an information-laden card, attached to equipment or supplies that enhances a pull system by signaling upstream of the need for new production and delivery of a product to the point of need, i.e., usually the location of the card.

Lead Time the time from initiation to completion of a process.

Muda refers to the waste in a process within an organization. There are seven categories of *muda*: *m*otion, *r*ework/defects, *w*aiting, *o*verprocessing, *i*nventory, *c*onveyance/transport, and *o*verproduction. The acronym MR. WOICO is often used to help teams remember the different types of wastes. In healthcare, wasted time and potential of people is commonly referred to as the eighth waste.

One-Piece Flow refers to the continuous flow of goods or parts from step to step without any batching, no work-in-process intermediate product or any intermediate accumulation of inventory. Often, to facilitate, one-piece flow steps in a process are laid out in a cellular or U-shaped layout.

Poka-yoke is a part of *jidoka* and refers to the hardwiring of a process so that errors cannot occur. This is also referred to as mistake proofing.

Pull System refers to the integrated system of production and delivery from downstream to upstream processes where upstream suppliers deliver product to downstream processes

only upon signaled need. This reduces excess inventory.

Push System refers to operations where products are made and inventory created based upon expert corporate forecasts.

Shop Floor see *gemba* or *genba*.

Standardized Work is a key framework for *kaizen* improvements. It is a step-by-step document written by the people who do the work outlining the current best thinking on how to perform the process. Once standardized work is established, planned tests of change can occur to eventually get to a better standard.

***Takt* Time** is the rate at which products or services should be produced to meet customer demand. *Takt* time is the total available production time divided by customer demand. For instance, if any emergency department is open 24 hours per day and sees approximately 240 patients per day on average. Its *takt* time is then 6 minutes.

Value Stream (or Process) Map is a visual flow map that shows how activities or processes are interconnected to design, order, and provide a given product or service.

Chapter Review Questions

1. Which is a key characteristic of the Toyota Production System (TPS)?
   A. All important decisions must be made only by the senior leadership team from the confines of their boardrooms or offices.
   B. TPS dedicates many resources toward developing and encouraging team member problem-solving skills.
   C. TPS was created in the 1980s.
   D. TPS was widely adopted by many US car makers in the 1950s and 1960s.

   Answer: B. If you examine the TPS Triangle, the core value of the TPS is to focus on the development of the frontline team member. TPS philosophy encourages a shop floor focus which is visited regularly by senior leaders.
2. *True or false*: Transparency is an important cultural trait that needs to be adopted by healthcare organizations to bring problems to the surface quickly.

   Answer: True. Healthcare systems cannot fix problems that are not known. Team members need to be given the authority and asked to be accountable to bring problems to the surface while they are small and manageable. Safety events at healthcare systems may be related to recurrent problems that were either hidden from the surface or not addressed completely when they were noted the first time. Transparency builds trust with team members, customers, and other stakeholders.
3. What are the key TPS traits that are most beneficial for healthcare?
   A. Senior leaders are visible in *kaizen* activities and model desired behaviors.
   B. Problems can be best visualized through *genchi genbutsu*.
   C. Andons are part of *jidoka* and can be used to identify abnormalities.
   D. Leveling the work (*heijunka*) can improve patient safety.
   E. All of the above.

   Answer: E. All of the answers listed are correct. Briefly, the TPS Triangle (Fig. 5.2) discusses the importance of senior leader modeling of desired behaviors and the value of the shop floor for visualizing and bringing problems to the surface. The TPS House (Fig. 5.3) discusses the key tools or technical aspects of TPS, including h*eijunka* and andons.
4. Who are your customers when you, as the emergency department physician, are admitting a 7-year-old male patient in the emergency department to the inpatient unit?

   Answer: The most obvious customers are the patient and his family who are with him during his emergency department and inpatient stay. Additional customers include the inpatient unit staff and physicians. As the ED clinician, you must stabilize the patient to the best of your ability. You must then prepare and give the best handoff to the inpatient unit. You must also call the primary care physician to let them know about their patient that you just admitted to the hospital.

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Additional Resources

Catalysis is the first organization of its kind to exclusively focus on educational programs and resources designed to transform healthcare value. Their website is: www.createvalue.org

Toyota Production System Support Center (TSSC) website has multiple examples of the application of TPS: www.tssc.com

Video highlighting the TPN project discussed in Vignette #1: https://www.youtube.com/watch?v=cekpkEYc2cY