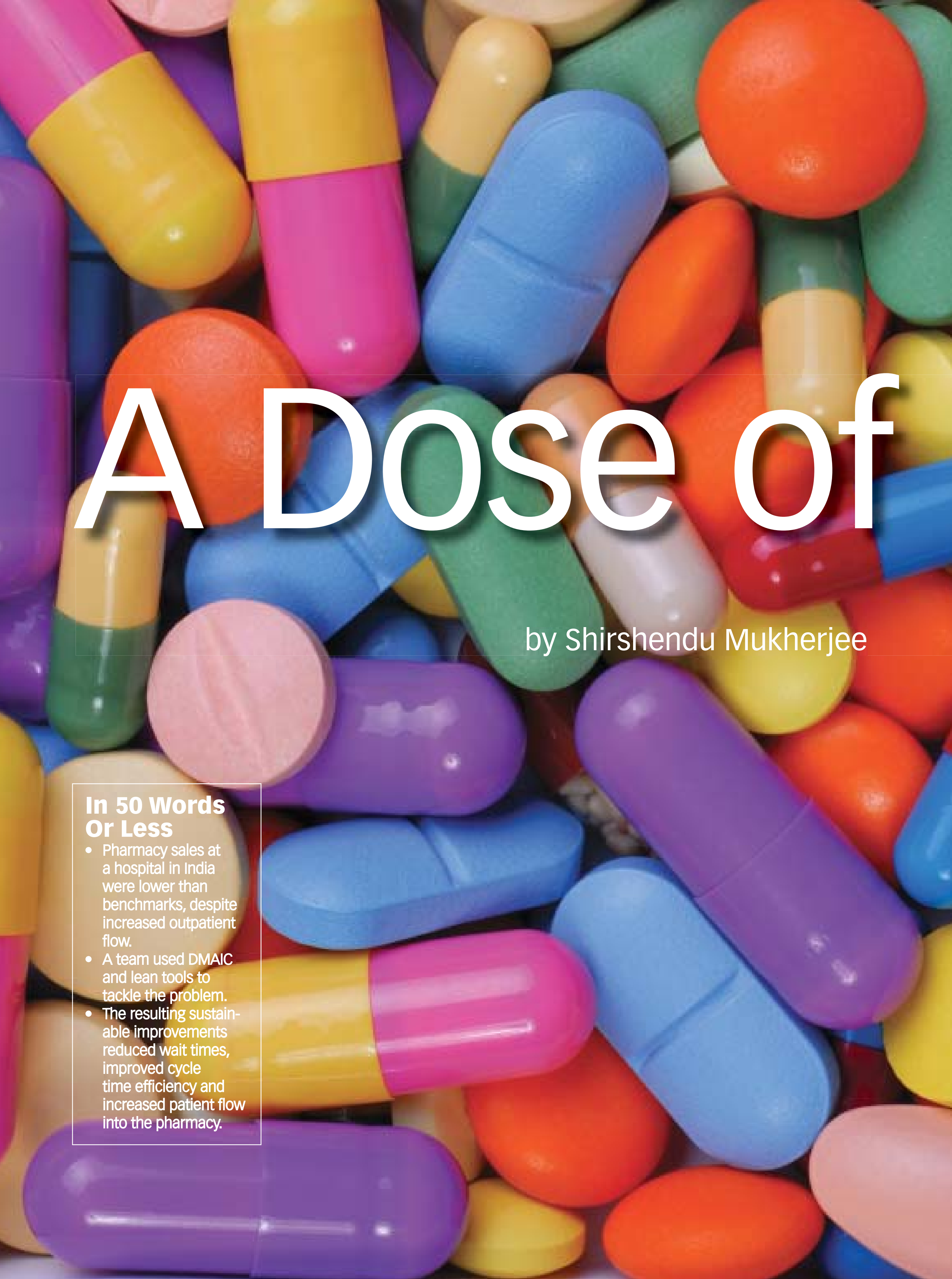


A Dose of

by Shirshendu Mukherjee

In 50 Words Or Less

- Pharmacy sales at a hospital in India were lower than benchmarks, despite increased outpatient flow.
- A team used DMAIC and lean tools to tackle the problem.
- The resulting sustainable improvements reduced wait times, improved cycle time efficiency and increased patient flow into the pharmacy.

DMAIC

Hospital's **Six Sigma and lean** efforts benefit patients **and profitability**

RUBY HOSPITAL, a multispecialty for-profit facility in Calcutta, India, was the first in Eastern India to embrace the ISO 9001 quality management standard and is the only one in the country to have successfully deployed a Six Sigma improvement program.

The advantage of Six Sigma in a small setting, such as a hospital, is that the project's links to organizational strategy can be short, direct and strong.

This was the case with the Ruby project, which was initiated directly from the strategic dashboard top management uses to run the hospital.

Project initiation

The dashboard had consistently indicated revenue from drug sales was lower than industry benchmarks and staying steady despite consistent increases in patient flow at outpatient (ambulatory care) clinics.

Various initiatives, such as round-the-clock service and free home delivery in the neighborhood, had been undertaken but had not been successful in driving sales upward. Once Six Sigma had been deployed elsewhere in the organization, top management decided it was time to take up the pharmacy problem as a Six Sigma define, measure, analyze, improve and control (DMAIC) project that would not only improve the bottom line, but also improve patient satisfaction.

Define

A project team was created, and one of the first tasks the team undertook was a *gemba* investigation.[1] A *gemba* investigation basically involves going to a work area and directly observing the real action taking place. This was essentially a quick, direct, observation-based data collection of information, such as:

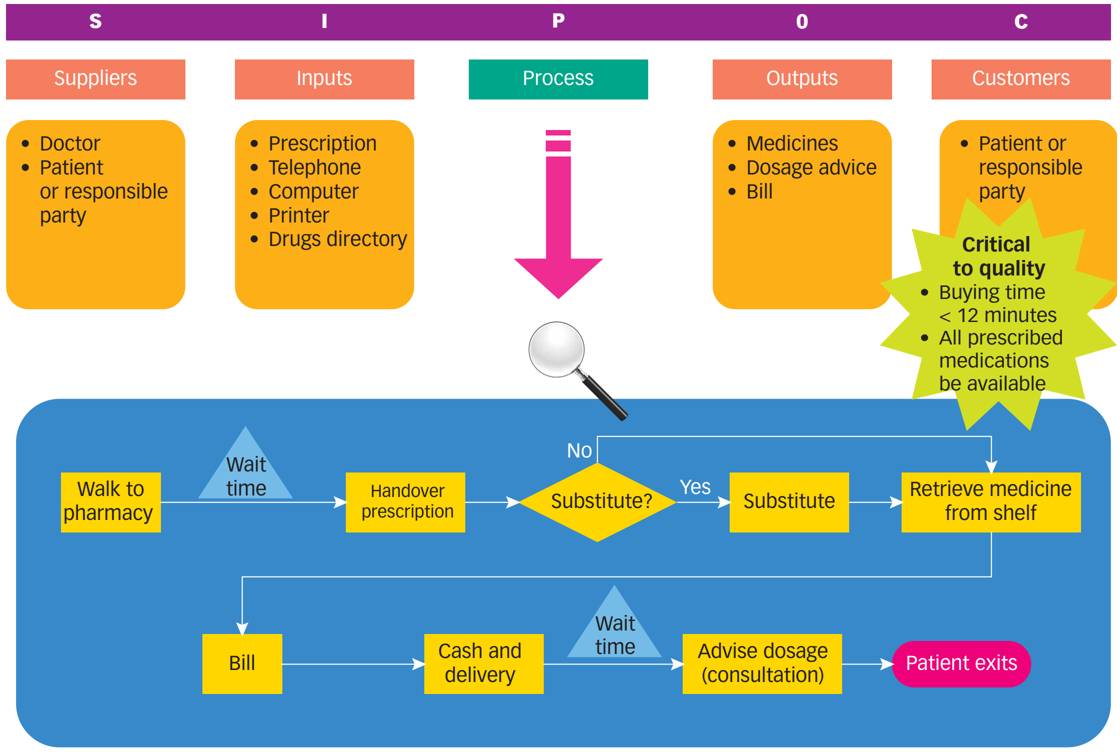
- The percentage of outpatients that was prescribed drugs.
- How many patients purchased from Ruby's pharmacy, and how many did not.
- Whether those who purchased actually bought the complete prescription.

The results were surprising: Only 31% of patients with drug prescriptions purchased them from Ruby's pharmacy, and only 50% of the prescribed items were purchased. Also, the billing database indicated 68% of the sales took place between 9 a.m. and noon—the rush hours at the outpatient department.

This data gathering was quickly followed by collecting voice of customer (VOC) feedback. Feedback identified what factors influenced their preference for a particular pharmacy over others, what level of these factors would satisfy them and how Ruby's pharmacy fared on each of these factors vis-à-vis their preferred pharmacy.

VOC indicated two major purchase inhibitors:

SIPOC diagram / FIGURE 1



The improved **capability level** was maintained despite a 61% **increase in patient flow.**

lengthy time to make the purchase and nonavailability of the complete prescription at the pharmacy. The patients also complained about the long time it took to walk to the pharmacy and the subsequent waiting and billing time at the counter, which sometimes was as long as 30 minutes.

As a result, most patients preferred dropping in at their neighborhood pharmacy and picking up the prescribed items on their way home or at another more convenient time.

The data collected through the VOC instrument helped translate the wait time requirements into a one-sided specification of 12 minutes. Nearly 80% of patients surveyed said that once they were through with medical consultation, they would tolerate no more than 12 minutes at the hospital (walking, waiting and buying time combined) for purchasing the prescribed items.

This time limit was identified despite the unique advantages of buying medicines from the hospital pharmacy as opposed to outside retail establishments, advantages such as tightly controlled storage conditions, genuine supplies procured from legitimate suppliers and a "returns accepted" policy in case treatment is changed after a follow-up consultation.

Nonavailability of prescriptions is a different problem that is complicated by the fact that in India, doctors mostly prescribe by brand names. As many as 8,000 different brands of commonly prescribed medicines are available.

The team thought it would be best to take up the nonavailability reduction opportunity as a separate project and sought the sponsor's approval. A project charter did the following:

- Identified the project Y (medicine buying time).
- Defined the defect (buying time exceeding 12 minutes).
- Spelled out how not meeting customer expectations on this critical-to-quality characteristic impacts high-level organizational goals by reducing revenue generation from pharmacy sales.
- Scoped out the project (reducing buying time during the rush hours of 9 a.m. to noon).
- Indicated a likely timeframe to achieve project success through DMAIC.

The VOC summary; supplier, inputs, process, outputs and customers (SIPOC) diagram (see Figure 1); and project charter were presented to the project steering committee at the define phase tollgate review meeting.

The project then moved to the next phase with a new caveat: No additional pharmacy personnel could be hired.

Measure

In the measure phase, the team came up with a data collection plan to baseline the current situation and ensure that accurate and valid data required for analysis in the next phase was available.

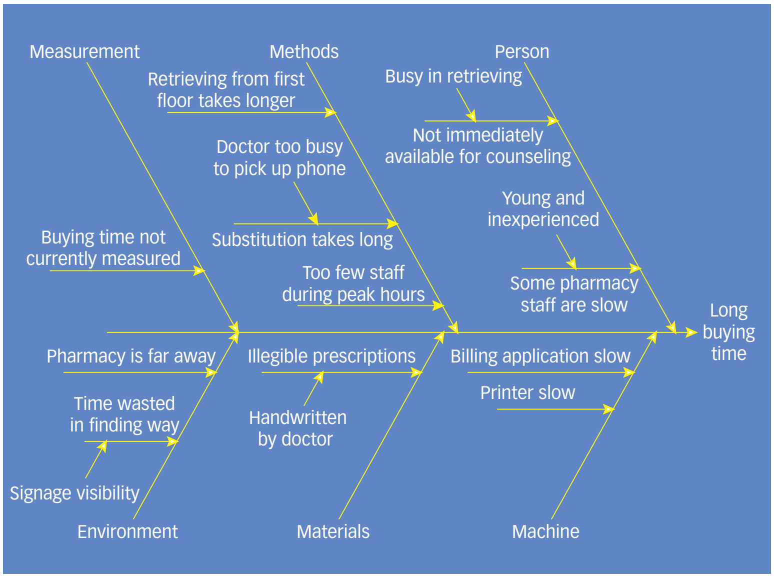
To identify and prioritize the variables on which the data was to be collected, the team first brainstormed a cause and effect diagram, shown in Figure 2 (p. 48). Many potential causes were identified that were later to be verified in the analyze phase.

The data collection plan took into consideration each brainstormed potential cause—except those that were completely absurd, immeasurable or unanimously voted to be untrue. The team measured total buying time as the sum of the cycle times of each individual step in the process, along with waiting times.

Each day, the team tracked and measured three patients' movements and flow with a stop watch. We used systematic process sampling: We treated the first patient coming out of the doctor's consultation room during each of the three hours between 9 a.m. and noon as a sample. The team thought the one-hour gap would prevent autocorrelation in the cycle time data.

Before two members of the team collected the cycle time data, a gage repeatability and reproducibility study was conducted to ensure measurement error was within acceptable limits. The measurement error (percentage of study variation) was found to be 9.8%. Because it was less than 10%, it was deemed to be acceptable.

Cause and effect diagram / FIGURE 2



The team collected the buying time data for three weeks and assessed it for distribution fit (it was found to fit the normal distribution shown in Online Figure 1 at www.qualityprogress.com). An individual X control chart (I-chart) was created after removing the Sunday observations. The Sunday observations were removed because patient inflow on Sundays is only 20 to 30% of the inflow on weekdays. Analyzing those data together with the rush-hour weekday data would mix up different populations (volume effect) in the data set and violate the project scope definition.

As seen in Online Figure 2, the buying time data was found to be in control. This meant the team could now confidently baseline the medicine buying process in terms of its capability to meet customer specifications. It came as no surprise that the medicine buying process was highly incapable of meeting customer requirements (see Online Figure 3).

Analyze

In this phase, the goal was to identify and verify the root cause that led to unacceptably high buying time for customers. By now, the data were in place, and the team started by analyzing the contribution of the various process steps to total cycle time (buying time).

The Pareto chart in Online Figure 4 identified "walk to pharmacy" as the biggest contributor, followed by "retrieval." Together, they made up 64% of the buying time. The process steps, however, contributed only 11.03 minutes. The remaining 10 minutes was waiting time in front of the various service desks.

The team suspected this high wait time during the peak hours was due to demand overwhelming capacity and felt challenged by the hiring constraint placed by the steering committee. The team also believed it had to focus on the retrieval process because the walk to the pharmacy was a hospital design outcome and could not be directly impacted through the project.

Nevertheless, the team decided to verify the hypothesis developed earlier with fishbone diagramming that many patients were taking a long time to reach the pharmacy because of inadequate signage. The team randomly selected a sample of patients and asked whether finding the pharmacy was a problem. Respondents who answered "yes" were asked whether they thought this could be corrected by more signage. The answers proved finding the way to the pharmacy was not a real issue at all—only an assumption of the team.

As part of analysis activities, the team also needed to verify most of the other brainstormed potential causes from the fishbone diagram. At this point, I reminded the team to do a thorough analysis instead of making unnecessary assumptions or being overwhelmed with imaginary challenges.

It was suggested that some lean tools could be used to gain additional insights or help focus the improvement project. The team decided to use value stream mapping (VSM) from the lean toolkit to analyze the process from cycle time, *takt* time and value-added perspectives.[2]

VSM is a type of process mapping that is more complex than traditional flowcharting. It captures not only workflow, but also information flow, material flow and several process data attributes in a single map. *Takt* time is the rate at which the customer buys your product. A *takt* time of two minutes means that over the course of a day, week, month or year, the customers are buying at a rate of one every two minutes.

Most of the causal hypotheses from the fishbone diagram did not hold up against data and evidence, with two exceptions:

1. Whenever substitution was resorted to, it took extra

MORE FIGURES ONLINE

Seven additional figures illustrating work done by the Ruby Hospital improvement team can be found at www.qualityprogress.com.

time because doctors—already busy with their patients—would often be late in answering calls from the pharmacist.

2. Retrieval took a long time because almost one-third of the prescriptions needed to be obtained from storage on a different floor—the first floor.

Although a third pharmacist was permanently stationed on the first floor to take care of this requirement, the handover and search added time to this activity. This was a clear conclusion from the multivari chart shown in Online Figure 5, which was created to analyze retrieval times and identify the major sources of variation. The team used a stratified random method of sampling to select the data for this analysis.

Another reason for this long retrieval time was multitasking by the two pharmacists, who counseled the billed-and-waiting patients on dosage instructions as they retrieved medicines from storage.

The team created a current state VSM for the medicine buying process (see Figure 3), which depicts the process, with separate branches showing customer and provider workflow. The timeline toward the bottom of the map shows the time traps for each nonvalue-added activity while also showing the time spent on each value-added activity and bottoming out to a lower level to indicate the valued-added times.

The team understood value-added activity to be only what added value from the patients' perspective and for which they would therefore be ready to pay. The lead time in the map refers to the sum of all value added time (VA/T), as well as nonvalue-added activity times. The ratio of the VA/T to the lead time is the process cycle efficiency (PCE).

The value stream exercise pointed out that the buying process was running with a cycle time efficiency, or PCE, of only 10.2%. That means as much as 89.8% of the process time was adding no value for the customers and was a waste from their perspectives. A large component of this was the wait time before retrieval, billing and counseling.

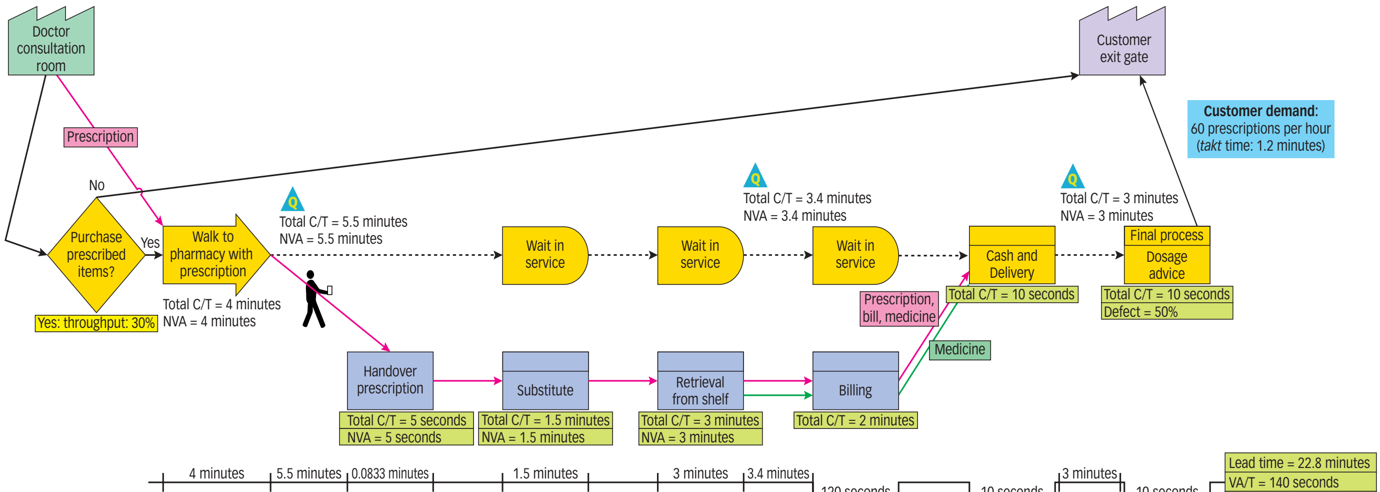
Considering the peak hours of demand, retrieval, billing and counseling were all bottlenecks in the process (each of the individual cycle times was larger than the *takt* time requirement), it became clear this constraint needed to be addressed to improve flow and reduce wait time.

Even more interesting was the insight that patient flow and information flow (prescription) were bundled. Unbundling these two flows, in theory, would lead to increased efficiency. This brought the walk to pharmacy step back into focus and proved to be an eye-opener and an exciting challenge to be addressed in the improve phase.

Improve

With a small number of causes, or Xs, to work with, the improvement phase now focused on these root causes to come up with effective solutions. To address the retrieval time, the team developed the idea that the medicines being stored on the first floor

Original current-state medicine buying VSM / FIGURE 3



NVA = nonvalue added, C/T = cycle time, Q = Waiting in line for service, - -➤ = Information flows, VA/T = value added activate time

Healthcare needs solutions that **address both patients and providers** and not just one **at the expense of the other.**

could instead be shelved on the ground floor—the same floor as the pharmacy.

Simple 5S principles could be used to free up more space on the ground floor. A shelf reorganization plan was developed so ground floor shelves could carry more variety and lighter inventory. The third retriever now could be stationed on the ground floor and be better utilized.

The rest of the causes were not so easy to address. Asking the retrievers not to multitask would decrease retrieval time even more but add to the queue and waiting time prior to the dosage counseling step. Reducing queues and waiting times without increasing manpower at the pharmacy looked like a tall order, too.

VSM clearly indicated the existence of bottlenecks. Configuring calls from the pharmacy so they would sound with a different ringtone was technically possible, but would it lead to doctors actually giving priority to these calls and answering them more quickly?

Reducing the walk time still seemed to be an impossible idea, although VSM analysis suggested the clues mentioned earlier. Using creativity techniques helped at this point. Separation principles and TRIZ 40 problem solving principles developed by Russian scientist Genrich Altshuller helped unearth a novel approach.[3]

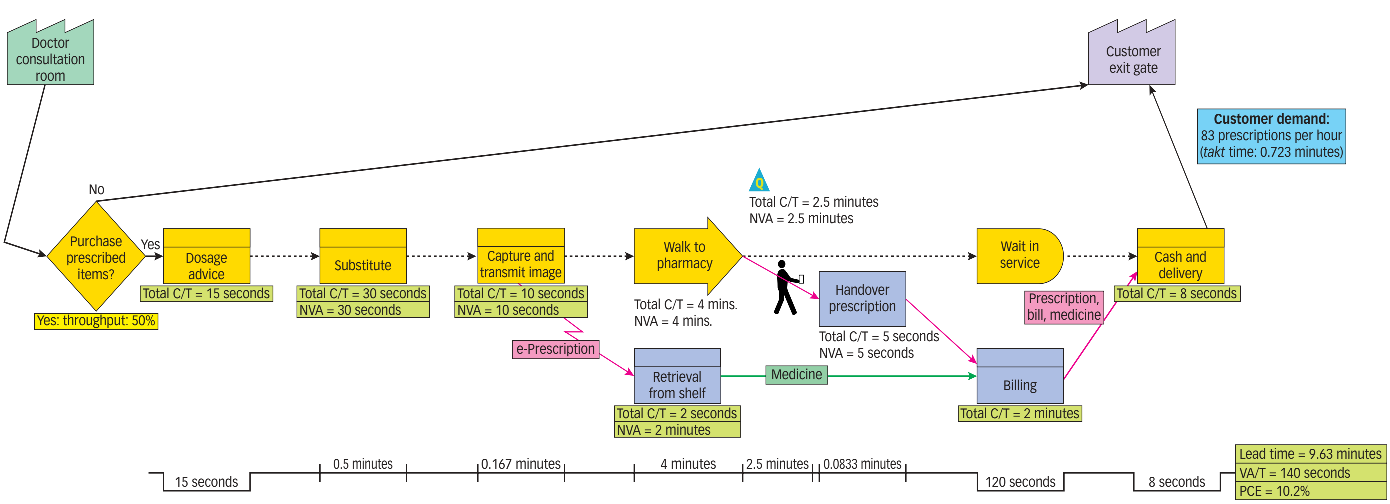
TRIZ Principle 22 basically says, "Turn lemons into lemonade." The team concluded that if it couldn't get the patients to the pharmacy any faster, why not use that walk time to do activities in the process that are nonvalue added from the patients' perspective but are business value added from the hospital's perspective?

A breakthrough idea took shape—capturing and transmitting a digital image of the paper prescription to the pharmacy before the patient started his long walk. This would allow retrieval to start long before patients reached the pharmacy in person.

The team created a solution package along with a to-be process map. Instead of helping on the ground floor, the former first-floor retriever could instead be moved upstream and stationed at the outpatient department common area. There, he or she would meet patients coming out of consultation rooms and counsel them on dosage instructions while also capturing and transmitting a digital image of the prescription.

The team ran simulations on this new process model to understand the impact on the total cycle time. The results were quite encouraging. The total cycle time dropped to an average of 9.21 minutes, with 81.43% of

New current-state medicine buying VSM / FIGURE 4



patients experiencing a buying time of less than 12 minutes (see Online Figure 6).

Before piloting the concept, the team conducted a failure mode effects analysis (FMEA) and neutralized foreseeable risks. The pharmacy and outpatient department personnel were fully trained, and a pilot spanning two 3-hour rush periods over two days was successfully conducted.

Following this, the team documented the improvement plan and rolled it out under close supervision. Within a month, the team conducted a tollgate review and presented the results of the implementation, including the new capability.

Cycle time efficiency had increased from 10.2% to 25.3%. Compared with no patients experiencing a total buying time of 12 minutes or less before the project, the improvement efforts resulted in as many as 88.9% of patients experiencing a total buying time of 12 minutes or less (see Online Figure 7). The average buying time had decreased from 21.10 minutes to 9.26 minutes.

By now, more and more patients were aware of the improvement, and as a result, patient flow into the pharmacy increased by 23%. Management was happy with the improvement but expressed concern that the new arrangement could again come under pressure as patient flow increased further. To take care of this eventuality, the team indicated that it had worked out a plan to cross-train the purchase clerk and storage assistant in the pharmacy to help with billing whenever the patient queue in front of billing exceeded three people.

The team also committed to run further simulations to understand at what point additional resources (such as a biller and retriever) would be required to maintain the buying time commitment to patients.

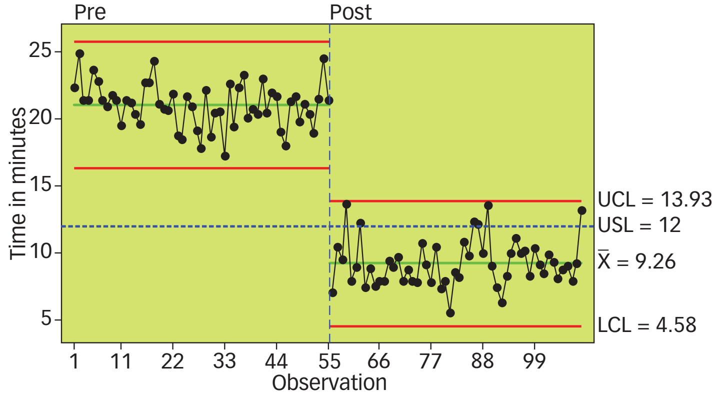
Control

Over two months, the team developed a new as-is VSM (see Figure 4), and the new process was made a part of the ISO 9001 QMS documentation to enable process control through regular QMS audits.

The team once again validated the measurement process to ensure data was still being collected in a repeatable and reproducible manner. A process capability study was again carried out, and the team found the improved capability level was being maintained despite a 61% increase in patient flow.

A comparative control chart shown in Figure 5 demonstrates the improvement achieved. The team developed a control plan for regularly and consistently measuring the buying time and taking timely corrective action in case the data indicated negative trends or points in the control chart that suddenly appeared outside the control limits, signifying sudden process shifts due to assignable causes.

I-chart of total buying time before and after improvement / FIGURE 5



Lessons learned

Healthcare across the world today sorely needs solutions that address both patients and providers and not just one at the expense of the other. This case study proves once again that Six Sigma methods can be successfully applied across countries and cultures irrespective of industry or sector.

Best of all, it shows how a problem that was identified at the business level was actually solved at the customer level, resulting not only in benefits just for customers, but also as a windfall for business. QP

NOTE

The ideas and opinions in this article are the author's and do not reflect those of the Deutsche Bank Group.

REFERENCES

1. Masaaki Imai, *Gemba Kaizen: A Commonsense, Low-Cost Approach to Management*, McGraw Hill, 1997.
2. Michael L. George, *The Lean Sigma Pocket Toolbook: Quick Reference Guide to 100 Tools for Improving Quality and Speed*, McGraw Hill, 2004.
3. Genrich Altshuller and Dana W. Clarke Sr., *40 Principles: TRIZ Keys to Innovation*, extended edition, Technical Innovation Center, 2005.

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