HEALTHCARE

Lean Six Sigma Reduces Medication Errors

by **Grace Esimai**

Among healthcare errors, medication errors, including those made in prescriptions, pharmacy dispensing, handling by staff and handling by the patient in self-medicating situations, pose the most serious threat.

Interested in quality management in several areas, management at a mid-sized hospital (which chooses to be anonymous) approved a project using lean Six Sigma to determine what changes in policy and practices might be necessary to significantly reduce these errors.

In 50 Words Or Less

- **Medication errors pose a serious threat in healthcare.**
- **A mid-sized hospital used lean Six Sigma to change policy and practices to reduce these errors.**
- **After solutions were implemented, errors dropped sharply, labor costs fell, patients were more satisfied, and employee morale improved.**

Project Team

The group tasked with making this determination was set up in two tiers: a project team overseen by a steering committee.

The steering committee consisted of members of upper management and heads of functional departments. This committee appointed employees with relevant daily floor level experience in various associated processes as members of the project team. Specifically, these individuals were involved in the processes of prescription transcription, order filling and all other steps influencing the error rate in the medication administration records (MARs).

In addition, the project team included individuals who could recommend and implement interventions to error reduction. The project team periodically reported to the steering committee.

Defining the Problem

The process of medication administration at a hospital involves six steps:

1. Selecting and procuring.
2. Storing.

3. Ordering and transcribing.
4. Preparing and dispensing.
5. Administering the medication.
6. Monitoring medication effects.

Due to time constraints, the steering committee defined the most urgent problem as the unknown error rate in the hospital MAR. The scope of the project was to concentrate on the medication order entry (OE) process. The project team charter aimed to investigate a process to dramatically reduce MAR errors by a factor of about 1,000 by the end of the project's five-month duration.

Measuring the Baseline And Tracking Errors

Prior to the formation of this project team, the hospital's quality improvement department had mapped the pharmacy OE and the nursing MAR transcription processes. The project team reviewed and verified the process maps against the current practices and sequence of operations.

The team reviewed the errors observed in February in the pharmacy OE process. An effort was then made to more rigorously define these errors and establish the criteria for cataloging them to aid in root cause analysis and achieve better consistency in error tabulation. This attempt minimized subjectivity and thus achieved a more consistent result overall. The project team subsequently identified the following errors:

- **Additional instructions:** Any physician comments/instructions/indications on the original faxed medication order that are not input by pharmacy.
- **Dose:** Wrong dose or dose differs from original faxed medication order.
- **Drug:** Wrong drug (medication description differs from original faxed medication order).
- **Duplicate order entry:** Same medication description profiled twice with two different prescription numbers.
- **Frequency:** Frequency on MAR differs from original faxed medication order.
- **Omissions:** Certain medication is omitted from the OE process without a reason.
- **Discontinuation order not carried out when received:** Medication that is either indicated or implied to be discontinued may still be entered in the OE by pharmacy.
- **Order not received:** Faxed medication order is not received or cannot be located at the pharmacy.
- **Patient:** Medication order has been profiled correctly/incorrectly on the wrong patient.
- **Route:** Medication order has been profiled with incorrect route (intravenous or intramuscular).

The Pareto diagram of the data gathered at the start of the project is shown in Figure 1. The diagram prioritizes the relative frequency of occurrence in a bar chart for better visualization. At project initiation, the total error rate in the overall MAR process was estimated to be 0.33% or about 3,300 per million.

While reviewing weekly records, the team observed certain errors could be traced back to the

FIGURE 1 Pharmacy Error Pareto Diagram

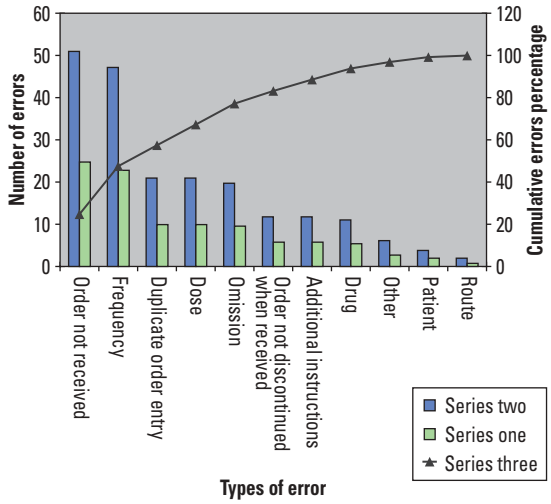


FIGURE 2 February and March Errors By Pharmacy Employees

pharmacy employee who committed them. The team quickly tabulated the errors and discovered a high variability in performance among these employees.

Some employees committed as many as 112 errors in the two-month period of February and March, while others made as few as zero errors in that same period. There were 21 employees involved with the OE process. Figure 2 shows the results.

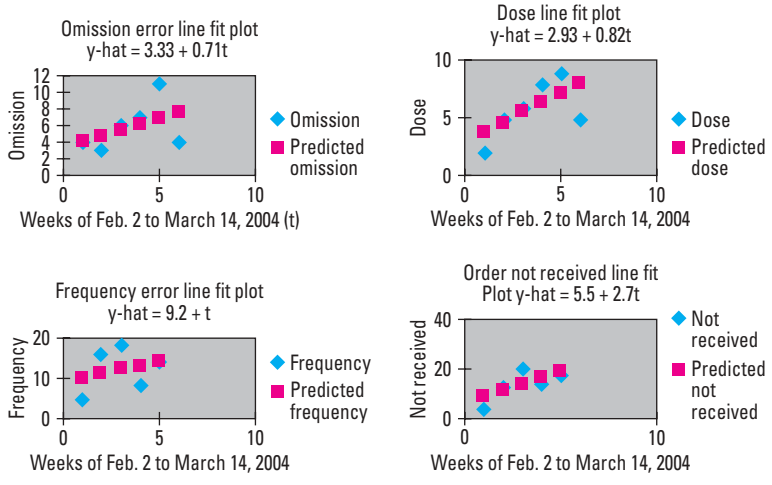
To protect their identities, the project team coded the employees using a simple number scheme. For immediate intervention, the team reviewed the errors during one-on-one meetings with the pharmacy employees and found the high error frequencies resulted from a misunderstanding of certain guidelines and instructions. To correct this, the pharmacy department instituted remedial education and closer supervision of employees.

The next step was to estimate the trend of the errors vs. time. Statistical methods for estimating the trend included moving averages, exponential smoothing and least squares or regression analysis. On running a regression analysis, our choice as the most objective method, evidence of increased errors became obvious (see Figure 3).

Vital Missing Data and Metrics

The basic metric of Six Sigma identifies defects per million opportunities, which can also be represented as a percentage error rate. Error rates are computed from the ratios of the total number of errors associated with a population of transactions and the total

FIGURE 3 February and March Errors Showing Positive Trend



Note: y-hat is the value of y estimated from the data as opposed to the actual or observed value.

number of transactions in the population.

To establish a context for identifying the medication OE errors (or MAR errors) at the hospital, here is an outline of the process sequence: Daily orders are faxed to the pharmacy, where they are profiled on the MAR. Nurses review the MAR and report any error findings to the pharmacy. A pharmacy technician then records the errors by type and who committed them. In this arrangement, it is very difficult to capture errors, such as forgetting to fax an order, that are committed by the nurses themselves. The pharmacy is thus blamed for every error, and there is no accountability at the nurses' end for MAR errors.

Each group believed the other group expected them to do the impossible, understanding neither the nature of its work or its workload.

Another pertinent and vital metric, albeit elusive, is the average order cycle time. This is defined as the average time it takes the pharmacy to fill an order measured from when a physician writes a prescription to when it registers on the MAR as correct.

This metric was not available because the physicians did not write the time of the prescription. They simply wrote the date. It would be important to have such information so root causes of delays could be studied and interventions implemented.

This implementation was especially necessary because it could contribute to labor cost savings as well as the satisfaction of the internal customers (nurses), the internal vendors or customers (pharmacists) and external customers (patients).

Analyzing the Problem

Finally, after all the investigation, the project team found the root causes of all the different types of errors to be one or a combination of the following:

- There were problems with the fax machines that used regular telephone lines, and related technical problems caused unnecessary delays, duplicate order entries and nonreceipt of faxed orders in the pharmacy.
- Problems with the legibility of physicians' handwriting and use of personal nonconventional abbreviations were partly responsible for wrong doses, drugs and frequencies. Some drug errors arose from the use of generic vs. trade names.
- Distractions and interruptions during the order entry process, such as phone calls or questions and conversations with colleagues, caused omission errors, the selection of incorrect drugs or doses from the dictionary, wrong frequency and duplicate order entries.
- Nonreconciliation among nurses and pharmacists regarding the physician's orders regarding the standard way to administer the medication, such as the route, number of times a day and when during the day.
- Other common cause and human errors such as not discontinuing orders when received due to oversight, dispensing wrong doses due to becoming used to a certain dose and selecting medication from nursing station floor stock and forgetting to note a change in dose.

During the investigation, the project team also observed the number of human errors could have arisen from stressful and dissatisfactory work conditions. The team therefore decided each of the two work groups involved should fill out a customer satisfaction survey on their perception of needs and expectations of the other group. Figures 4 and 5 give the nurses' survey results. Figures 6 and 7 display the results of the pharmacists' survey of the nurses.

It is interesting to note from Figure 5 only 3% of the nurses said the pharmacy employees were rude, contrasting with the overwhelming majority of pharmacists from Figure 7 who claimed the nurses were extremely rude (69%) and impatient (3%).

Apparently, the pharmacists at this hospital were

FIGURE 4 Nurses' Satisfaction With Pharmacy

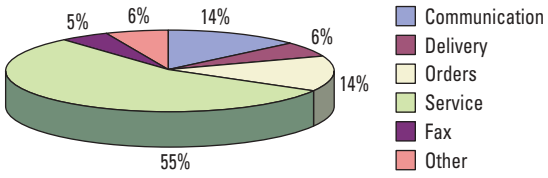


FIGURE 5 Things Nurses Disliked About Pharmacy

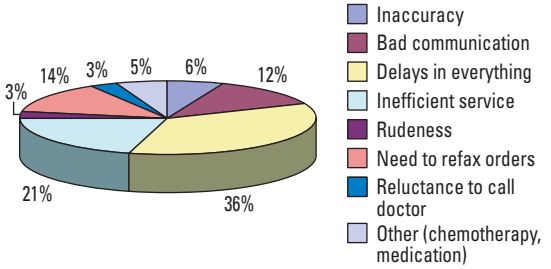


FIGURE 6 Pharmacists' Satisfaction With Nurses

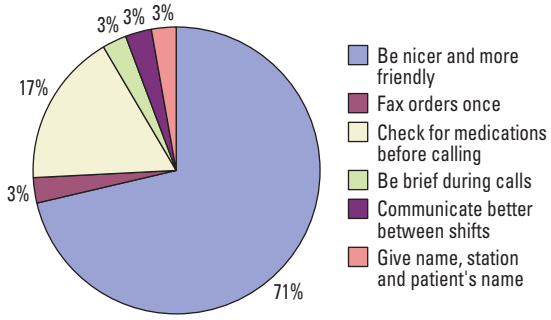
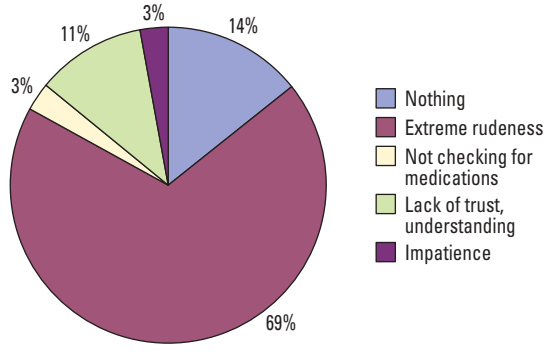


FIGURE 7 Things Pharmacists Disliked About Nursing Department



not friendly and polite to the pharmacists as they carried out their daily duties. They seemed to fail to recognize they and the pharmacists were customers of each other, deserving the same courtesy they offer their external customers, the patients. Each group believed the other group expected them to do the impossible, understanding neither the nature of its work or its workload.

Developing Error Reducing Solutions

The project team combined lean methods and Six Sigma techniques in the error reduction process. Lean methods generally aim at the identification and gradual evolutionary elimination of waste (error).

The Six Sigma techniques use statistical procedures and five well-defined phases of the define, measure, analyze, improve and control (DMAIC) roadmap to achieve profitability and quantum gains in quality, sometimes as a result of redesign of the process maps and installation of new equipment.

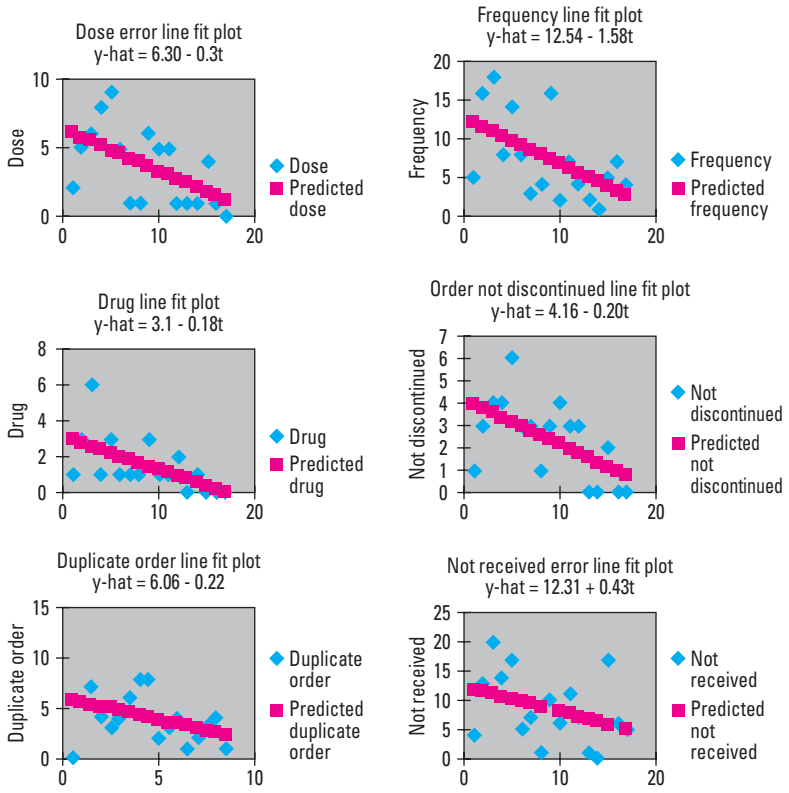
In healthcare, the best approach appears to be error prevention using software that flags mistakes so employees will take immediate corrective action. The project team therefore approved or recommended the following solutions:

- **Institution of a high performance standard through instruction and supervision.** The project team discovered factors contributing to substandard performance and increasing the error trend, including the misunderstanding of instructions and guidelines by some pharmacists. A higher performance standard was immediately instituted through instruction and supervision. This effort, using lean methods, yielded significant positive results.
- **Facilitywide (full) implementation of computerized physician order management**

(CPOM). The project team considered the CPOM program paramount to reducing or permanently eliminating errors caused by illegibility of physicians' handwriting and faxing of handwritten orders. Timelines would be monitored because the exact time a prescription was written would be recorded, thus eliminating undue delays.

- **Installation of a system to separate the fax and phone lines as an interim measure to reduce the faxing problems.** We believed this step would reduce the errors related to nonreceipt of faxed orders at the pharmacy and duplicate orders, reducing man-hours and tension between the nursing and pharmacy employees.
- **Unit based pharmacists and agreement on standard times of medication administration among hospital nurses and pharmacists.** If the pharmacists were unit based, some understanding of each other's job and its scope would likely develop between pharmacists and the nurses in each unit. The work therefore would become streamlined, and nurses and pharmacists would know their internal customers by name—an added bonus to customer satisfaction.
- **Monthly meetings to foster better relationships between nurses and pharmacists.** This will help eliminate wrong perceptions nurses and pharmacists currently hold of each others' jobs and help change a stressful workplace to a place where people work cordially as a team to achieve the common strategic goal—patient care and satisfaction.
- **Designation of a pharmacy employee to serve as a telephone operator for all external calls.** During the analyze phase, the team found distractions from outside phone calls caused numerous errors. A solution could be designating a pharmacy employee to take these calls so the pharmacists can concentrate on what they are doing.

FIGURE 8 February to June Weekly Errors Showing Negative Trend



Implementing and Sustaining the Solutions

Considering the available data from February to June, you can observe progress in the error reduction effort. The simple linear regression analysis of each of the errors clearly shows a downward trend (see Figure 8).

Figure 9 shows most of the errors have been dramatically reduced, with the total number dropping from 213 in February to 96 in June, a 55% reduction. Figure 9 also clearly shows the differences in absolute numbers between the February and June frequencies for each type of error.

The team further made a comparison of February and June OE errors

FIGURE 9 February and June Pharmacy Order Entry Errors by Error Type

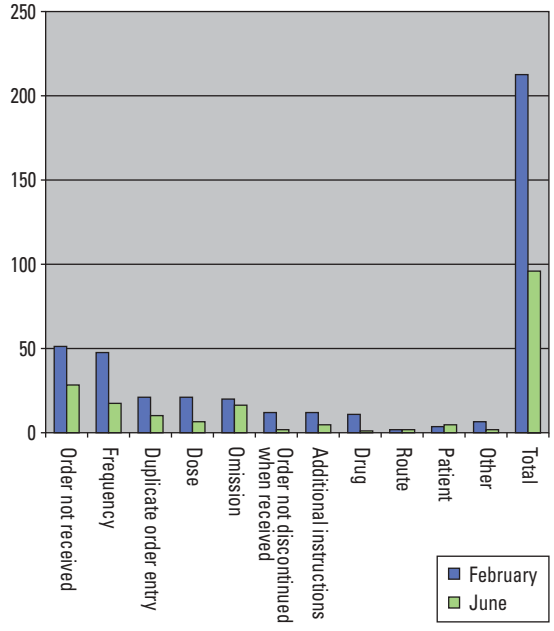
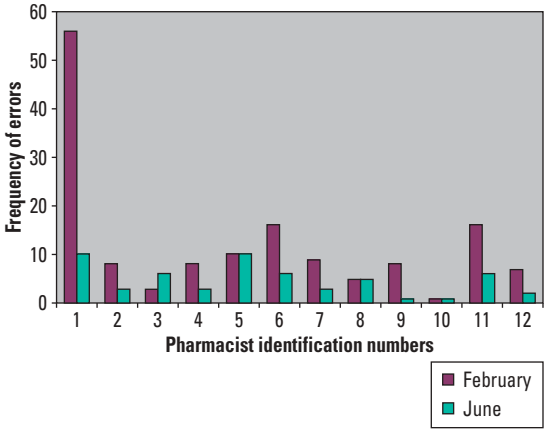


FIGURE 10 February and June Errors By Pharmacist



by pharmacist. Figure 10 shows a significant reduction for most of the pharmacists. The non-pharmacist errors caused by faxing problems and recorded as "orders not received" continued to be high, although an almost 50% reduction (from 51 in February to 28 in June) was attained.

Other benefits of instituting a lean Six Sigma methodology at this mid-sized hospital were:

- Reversal of OE errors from an increasing to a downward trend for most types of errors.
- A decrease in the total error rate from 0.33% to 0.14% in five months.
- Estimated labor cost reductions of $550,000 (annualized at $1.32 million). It is noteworthy the current results are realized by simply creating awareness through pharmacy department meetings and fresh instructions and training to the pharmacy employees.
- Patient satisfaction.
- Improved employee morale and better relationships between nurses and pharmacists.

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