Tapping the Knowledge That Hides in Data

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The foundation for continuous quality improvement (CQI) is built on three fundamental activities:

- Listening to the Voice of the Customer (VOC)
- Listening to the Voice of the Process (VOP)
- Using data to make decisions.

Organizations that clearly demonstrate CQI (e.g., the Baldrige winners or organizations that have won state quality awards) are able to skillfully blend all three activities together. A singular focus on one of these activities or even two is not going to achieve CQI. It is when all three activities are combined simultaneously and on a daily basis that quality, as envisioned by Deming and Juran, will be realized.

This article is not meant to be a comprehensive review of all three activities. Instead it addresses only the third activity - using data to make decisions.

The Challenge of Understanding Variation

It's Friday afternoon and you have already started thinking about the relaxing weekend that lies ahead. Then the phone rings. Within seconds of picking it up, you realize that this is the call you had anticipated but wished would not come on a Friday afternoon. It's your boss reminding you about the management meeting on Monday. Typically this would not be a major event. But this time, for you, it will be. It seems that the numbers for your facility are "below expectations" for the past month, and you have to explain why your facility is not meeting its targets. You thank your boss for the reminder and, as you hang up, you remember what happened to your friend Scott when he had to go through this ordeal the previous month. At that time, your numbers looked fine. In retrospect, all you can really remember about that day was how pale Scott looked as he tried to explain why his numbers were below average. You also remember thinking how this whole affair reminded you of an inquisition.

Now as you sit in a numb stupor looking out your window, you realize that your time has come. Suddenly your secretary sticks her head in your office and brings you back to reality by saying, "I'm out of here, have a nice weekend." "Oh sure," you think, "I'll have a nice weekend. I'll spend all my time trying to develop a list of reasons why my numbers are not acceptable. I'll spend all weekend worrying about the inquisition on Monday!"

This is obviously a situation you do not want to be in. Yet, stories like this are legendary in organizations that do not understand variation. So, what would you do? You basically have two choices. First, you could develop a list of reasons why your numbers do not live up to expectations. This usually consists of one or more of the following tactics: (1) developing a series of complex sentences that try to divert attention from the numbers, (2) pointing fingers at other factors (some real and some imaginary), (3) blaming individuals (who are usually not attending the meeting) for poor work habits and low motivation, and (4) throwing yourself on the mercy of the inquisition court.

The second, and more preferable choice, is to not waste your time trying to explain why your numbers are down this month but were up last month. The reason they are down this month is that they WERE up last month. Variation occurs in all that we do. You will drive yourself and all those around you absolutely crazy if you try to explain (rationalize) why two data points are different. If the performance of the process over time is unacceptable, then change the process. Focusing on aggregated numbers without understanding how they vary over time, is a futile exercise. This type of thinking typically fosters competition between units and departments, builds barriers between individuals, and, most importantly, undermines the delivery of quality care. It is reflective of what one statistical expert refers to as "numerical illiteracy." According to Wheeler (1993:vi):

> *Numerical illiteracy is not a failure with arithmetic, but it is instead a failure to know how to use the basic tools of arithmetic to understand data. Numerical illiteracy is not addressed by traditional courses in primary or secondary schools, nor is it addressed by advanced courses in mathematics. This is why even highly educated individuals can be numerically illiterate.*

In short, aggregated data presented in tabular formats or with descriptive statistics will not help you measure the impact of process improvement/redesign efforts. Aggregated data can only lead you to making judgments (e.g., this data point is lower than the previous data point). If you are serious about CQI and truly want to make improvements, then you need to look at data from a quality improvement perspective.

The Solution

It is fortunate for all of us that the solution to numerical illiteracy is easy to understand. The solution lies within knowledge. Knowledge of the principles and techniques of statistical process control (SPC).

SPC had its origins in the early 1920s, during a time when this country was struggling with a fairly basic question - How can you increase production and maintain quality? The man who helped answer this question was Dr. Walter Shewhart (for more information on Shewhart and his work see Schultz, 1994).

Shewhart argued that all work can be viewed as a series of interrelated processes. Since customers are the recipients of process output, it stands to reason that organizations that focus on maintaining efficient and effective processes will meet and exceed customer expectations. Shewhart's recommendation for creating efficient and effective processes was very simple. He maintained that if you understand the variation that occurs within a process, you would be able to make appropriate management decisions that will produce quality products and services. Shewhart distinguished two types of process variation, common and special.

Common cause variation is an inherent part of every process. It is random, and is due to regular, natural or ordinary causes. Common cause variation affects all outcomes of the process and results from the regular rhythm of the process. It produces processes that are stable or "in control." One can make predictions, within statistical limits, about a process that has only common cause variation.

Special cause variation, on the other hand, is due to irregular or unnatural causes that are not inherent in a process. Special cause variation affects some, but not necessarily all outcomes of a process. When special causes are present, a process will be "out of control" and unstable. The future performance of a process also will be unpredictable if special causes are present.

A health care example might help clarify these two types of variation. When a patient is hooked up to telemetry, variation in his/her vital signs will be observed. In fact, there is great concern if variation is not observed and the patient is considered to be a "flat line." If the patient's heartbeat is observed at 59, then 61, then 60 and so on, there is no need for immediate concern. This is what would be called common cause variation. It represents normal fluctuation in the heartbeat process. If, on the other hand, the patient's heart rate starts to climb and goes from 65, to 70, to 75, continues past 100 beats per minute and settles at around 140 beats per minute, this would usually be seen as a signal that the patient is exceeding normal variation. At some point, the patient would move from common cause state to one that reflects special cause variation. At some point action would be taken to correct the heart's rhythm and bring it back into a common cause level of performance. Action would not be taken, however, while the patient was demonstrating acceptable common cause variation.

The basic points that Shewhart taught were: (1) variation exists in all that we do, (2) processes that exhibit common or chance causes of variation are predictable within statistical limits, (3) special causes of variation can be identified and eliminated, (4) only processes that exhibit common cause variation can be improved, and (5) attempting to improve processes which contain special causes will increase variation and waste resources.

Understanding variation from a conceptual point of view provides only a start. If you are truly interested in quality improvement, you have to take action to improve something. Decisions about taking action can be greatly enhanced by using the simple tool that Shewhart created, the control chart.

What is a Control Chart?

Control charts are convenient, easy to understand and can detect special causes in a process. Basically, a control chart is a running record of a process over time (Figure 1). Data are plotted in time sequence with time always presented along the horizontal or X-axis. The Key Quality Characteristic (KQC) or indicator, (e.g., patient falls, restraint utilization or the number of meals processed in a day), is placed on the vertical or Y-axis. Once the data points are plotted they are connected. The mean (or average) of the data is determined and plotted on the chart. This is typically referred to as "X bar" or the centerline (CL) of the process. The upper control limit (UCL) and lower control limit (LCL) are the other two distinguishing characteristics of a control chart. These lines are drawn parallel to the centerline. The control limits provide the basis for (1) determining the capability of the process, and (2) identifying whether the process exhibits common or special causes of variation.

In this article, it is not be possible to explain the statistical theory behind control charts, or how to construct and interpret them. Readers interested in these topics should consult Carey and Lloyd (2001), Pyzdek (1990), and Wheeler (1995).

The beauty of the Shewhart control chart lies in its simplicity. It requires little data (about 20 data points to construct a reliable chart), is easy to read and interpret, and provides guidance for making sound management decisions. An example is the best way to demonstrate the utility of the control chart.

Tracking Patient Falls

In January 2002, your facility introduced a new program to reduce the number of patient falls. As Risk Manager, the question you've been asked repeatedly is, "Did this new program have the desired impact?" To answer this question, you decide to take advantage of the knowledge and experience of the team that created the new program. They have been working on this process since February 2000 and have: (1) developed a standardized operational definition of a patient fall (which was probably a major accomplishment in and of itself), (2) developed and implemented an ongoing data collection plan, (3) established a baseline, and (4) prepared the control charts shown in Figures 2 and 3.

Each data point on the chart represents the total number of falls occurring within the facility each month. Notice that both charts shows the number of falls both **before** (the historical baseline) and **after** the falls prevention program. Finally, note that the mean and control limits on the chart are based on the 24-month period from February 2000 through January 2002. Not all of the 32 data points on the chart were used to compute the control limits. This was done in order to compare the pre-program falls with the number of falls after the program was introduced.

The left side of Figure 2 represents the baseline or history of the falls process prior to implementation of the prevention program (February 2000 through January 2002). During this period the process was stable and predictable (common cause variation) with a mean ($\overline{X}$) of 53, an upper control limit (UCL) of 75 and a lower control limit (LCL) of 31. This means the process can be expected to produce roughly 53 falls each month, though it is capable of producing as few as 31 or as many as 75 falls each month due to normal variation in the process.

The right side of Figure 2 demonstrates the impact of the falls prevention program on the falls process. During each month after the falls prevention program was introduced (February 2002 through September 2002), the process produced fewer falls than the mean number of falls during the baseline period. These eight data points below the centerline constitute a special cause (i.e., a signal that there has been a downward shift in the process). But in this case it was a desirable special cause since the falls prevention program was expected to reduce the number of falls.

Now that the process has shifted to a more acceptable level of performance (i.e., a lower number of falls each month), we can compute control limits just for the new process. Figure 3 shows what are called historical control limits. In this case, we have two sets of control limits, one for the old process and one set for the new process. The new process also shows us that the mean is lower (45 falls per month) and that the control limits are a little closer together (UCL = 65.6 and the LCL = 25.2)

Conclusions

The information presented on this control chart does not tell the team whether or not it should continue its efforts to reduce the number of patient falls. It merely tells the team that the initial efforts have been successful, and that the current process produces fewer falls per month than the baseline process. Should the team decide to introduce another intervention to further reduce the number of falls? The answer to this question lies with the team. As owners of the process, they need to decide if the process is capable of further improvement and if the resources are available to support this work. If the facility is part of a system, for example, maybe they can obtain comparative reference data (norms) and see how their performance compares to that of the other facilities in the system. If such data does exist, then there is an opportunity for internal benchmarking.

The team would also be well advised to continue monitoring the number of patient falls over the coming months, even if they decided not to introduce any further improvement efforts. The reason is that the team should be responsible for the performance of the process and confident that the observed improvement is maintained during future months. The control chart provides the conceptual and statistical foundation for doing this. It also lays the foundation for overcoming numerical illiteracy.

If you take this approach (as opposed to spending your time trying to justify/rationalize why this month's number is lower than last month's number) you will be in a much better position to really explain what is occurring with the numbers on Monday morning. You will also be able to enjoy your weekend!

References

Carey, R. and Lloyd, R. *Measuring Quality Improvement In Healthcare: A Guide To Statistical Process Control Applications.* ASQ Quality Press, Milwaukee, WI 2001

Schultz, L. *Profiles In Quality.* Quality Resources, New York, NY 1994.

Wheeler, D. *Understanding Variation*. SPC Press, Inc., Knoxville, TN 1993.

Wheeler, D. *Advanced Topics In Statistical Process Control.* SPC Press, Inc., Knoxville, TN 1995.

Figure 1. Elements of a Control Chart

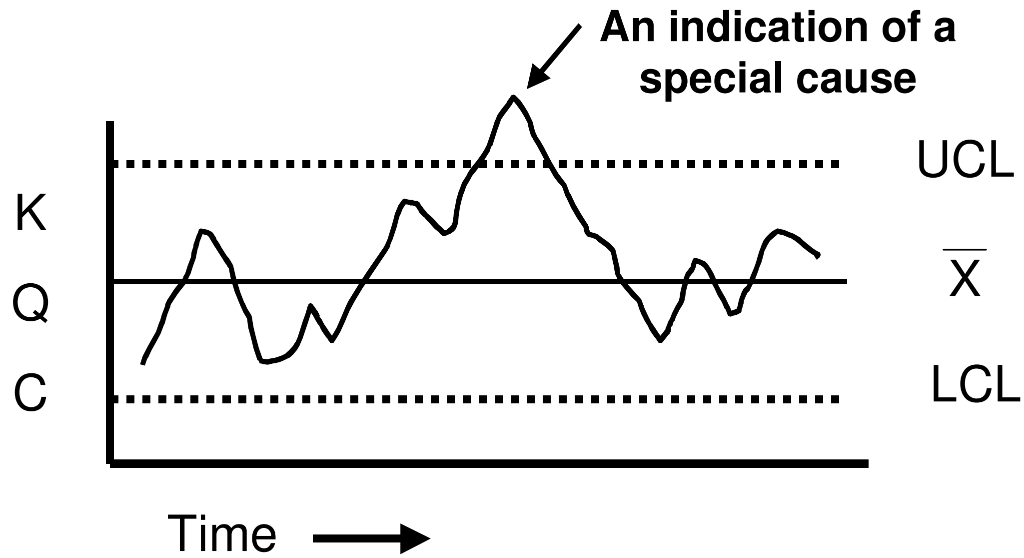

Figure 2. Patient Falls by Month with the Baseline Period as the Control Limits

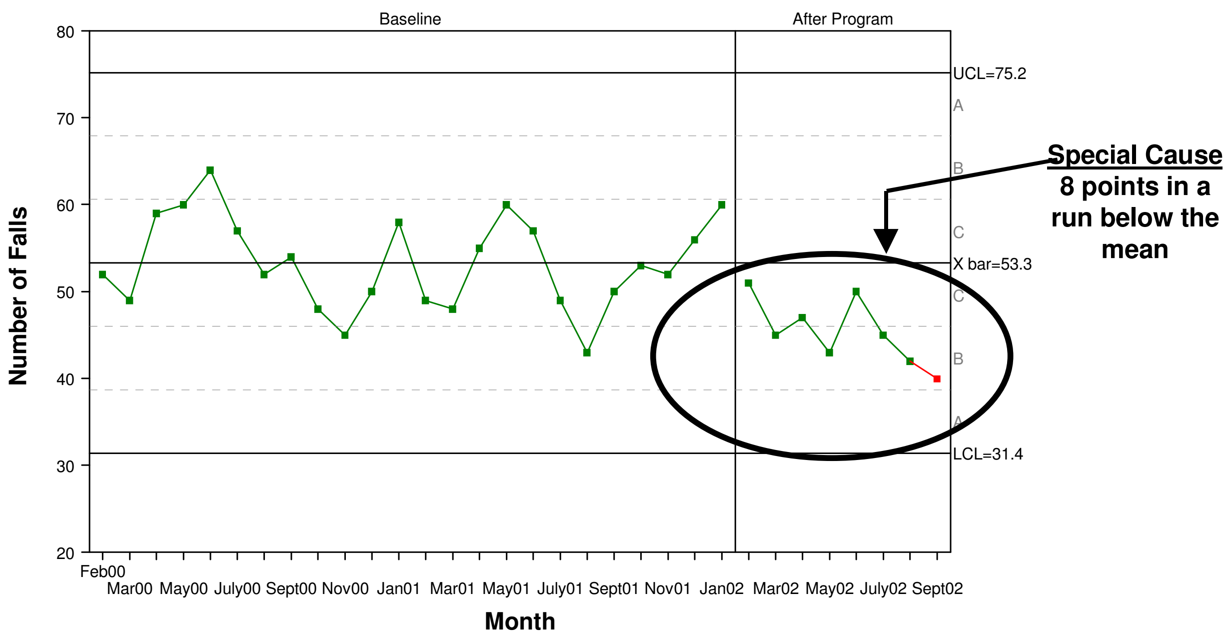

Figure 3. Patient Falls by Month with Historical Control Limits (Baseline Control Limits compared to After the Program Control Limits)