Quality Resource Brief

TRIPLE AIM ACHIEVEMENT • AUGUST 2016

Measures Of Variation

"The change from volume- to value-based health care delivery requires new skills for leaders, managers and direct care providers. Today, department managers who are responsible for patient safety and quality outcomes must make informed decisions. The data available to guide those decisions often are incompatible and outdated. A basic understanding of statistics is essential when striving to improve patient safety, quality and care coordination."

This edition, second in a sequential series, will provide a basic understanding of the application of statistics necessary to evaluate and improve care delivery.

COMMON TERMS

The following terms frequently are used in research, evidence-based practice and quality improvement.

Range – The difference between the highest and lowest number in a dataset.[1]

Standard Deviation – A measure of the amount of variation in a set of data values.[1]

Variance – Measures the dispersion of data.[1]

Common Cause Variation – Variation arises from fluctuation caused by unknown factors resulting in a steady but random distribution of output around the average of the data. It is a measure of the process potential, or how well the process can perform when special cause variation is removed.[2]

Special Cause Variation – A type of variation that is caused by known factors that result in a non-random distribution of output. Special cause variation also is referred to as "exceptional" or "assignable" variation.[2]

Run Charts – Graphs of data throughout time and very important tools used to assess the effectiveness of change.[3]

Control Charts – Graphs used to study how a process changes throughout time. Control charts help determine the nature of variation within a process.[4]

Mean – The average of a set of numbers. Mean is calculated by adding all the numbers in a data set and dividing by the count of numbers used in the analysis.[1]

Statistic – A characteristic of a sample that can be used to estimate the value of a population parameter.[1]

Descriptive Statistic – A type of statistic that is used to highlight the basic aspects of any given data.[5]

The Missouri Hospital Association will periodically release tips and tools to assist hospitals in achieving the Triple Aim — better health, better care, lower costs. These resources, and many more, can be accessed at www.mhanet.com/quality-and-health-improvement

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"Understanding variation is the key to success in quality and business."

– W. Edwards Deming

Inferential Statistic – A type of statistic used to make assumptions from a sample of what the population might think.[5]

Sample Standard Deviation – Involves only a sample of data from the general population and is available for analysis.[6]

Population Standard Deviation – A measure of the standard deviation of the entire population.[6]

Sample Variance – A measure of variation in a select number of items taken from a population.[6]

Population Variance – A measure of variation of the entire population.[6]

DESCRIPTIVE STATISTICS

Published in April, the first edition of the Quality Resource Brief, "Using Data to Drive Change," detailed why descriptive statistics are important in describing and summarizing the distribution of data, thus laying the foundation for quantitative analysis. Visual illustrations, such as charts and graphs, provide a picture of retrospective, current and emerging trends. This edition will specifically focus on the measures of variation.

What is a statistical test?

Measures of Variation

Measuring variation is extremely important in making statistical inference. Some of the most common measures of variability are range, variance and standard deviation. These measures are specifically used to identify the dispersion of data and help professionals assess variation within a process. Unfortunately, the performance of an organization often is based on how much variation they are willing to allow within its processes. Masaaki Imai said, "It is impossible to improve any process until it is standardized. If the process is shifting from here to there, then any improvement will just be one more variation that is occasionally used and mostly ignored. One must standardize, and thus stabilize the process, before continuous improvement can be made."[10]

Range – A measure that shows the difference between the highest and lowest number in a data set. One of the shortfalls of using range is that it can greatly be affected by outliers leading to misrepresentative results.[1, 9]

Variance – A measure that shows the spread between numbers in a data set. This measure demonstrates the distance each number in the set is from the mean. One disadvantage of using variance is that it potentially may give more weight to outliers due to the fact that squaring these numbers can skew the interpretation of data.[1, 9]

Standard Deviation – One of the most commonly used measures to identify spread, standard deviation measures the dispersion of data in respect to mean. A higher value is indicative of a higher standard deviation and vice versa.[1, 9]

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Why do I need to know about this statistical test?

A good understanding of variation can help uncover the unseen pitfalls that may only be detected by using the appropriate variation statistics. Hospitals are susceptible

to variation resulting from underlying issues in processes, systems, leadership, management and clinical practices. Using sound statistical analysis techniques to identify variation can help focus attention where it is needed most. Standardizing the aforementioned areas and consistently adhering to newly formed processes can help reduce variation, leading to predictable results. This notion was echoed by Haruki Murakami, a Japanese writer who stated, "I think certain types of processes don't allow for variation. If you have to be part of that process, all you can do is to transform — or perhaps distort — yourself through that persistent repetition, and make that process a part of your own personality."

How would I use this in a hospital setting?

RANGE

When patients seek medical care, either a nurse or other health care professional takes their vital signs before they are seen by the attending practitioner for assessment. Blood pressure is one of the four main clinical measurements that is used to determine how a patient's body is functioning. According to the National Heart, Lung, and Blood Institute of the National Institutes of Health, a 140 mm Hg or greater systolic pressure, or a 90 mm Hg or greater diastolic pressure in adults, is classified as high blood pressure. As shown in Figure 1, clinicians determine the blood pressure category by using range as the measure of variation.

Figure 1: Healthy Blood Pressure Recommendation

Blood Pressure Category	Systolic mm Hg (upper #)		Diastolic mm Hg (lower #)
Normal	less than **120**	and	less than **80**
Prehypertension	**120 – 139**	or	**80 – 89**
High Blood Pressure (Hypertension) Stage 1	**140 – 159**	or	**90 – 99**
High Blood Pressure (Hypertension) Stage 2	**160** or higher	or	**100** or higher
Hypertensive Crisis (Emergency care needed)	Higher than **180**	or	Higher than **110**

Source: American Hospital Association

VARIANCE

In the health care industry, it is essential to assess processes and systems that drive outcomes to ensure that an organization is performing at its highest standards. One of the most important roles of any professional tasked with performance improvement is the ability to identify areas with the greatest variation and working to reduce this variation by engaging individuals who drive that process. Using proven techniques for reducing variance can result in the required consistency, alignment and standardization which ultimately leads to superior results that may be sustained indefinitely.[4, 9]

It is quite clear that every system or process has some form of variation; some may be attributed to the system itself, which evidently is the common cause of variation,

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or as a result of a rare accidental occurrence referred to as a special cause variation.[6] It is important to understand the type of variation before embarking on any performance improvement activities, as each requires a different approach.[7] Common cause variation focuses on the entire process, as opposed to a special cause variation, where the focus is on one specific instance. Analysts often can predict the outcome of a common cause variation because the data is expected to fall within a given range. However, a special cause variation has no range, which leads to unpredictability.

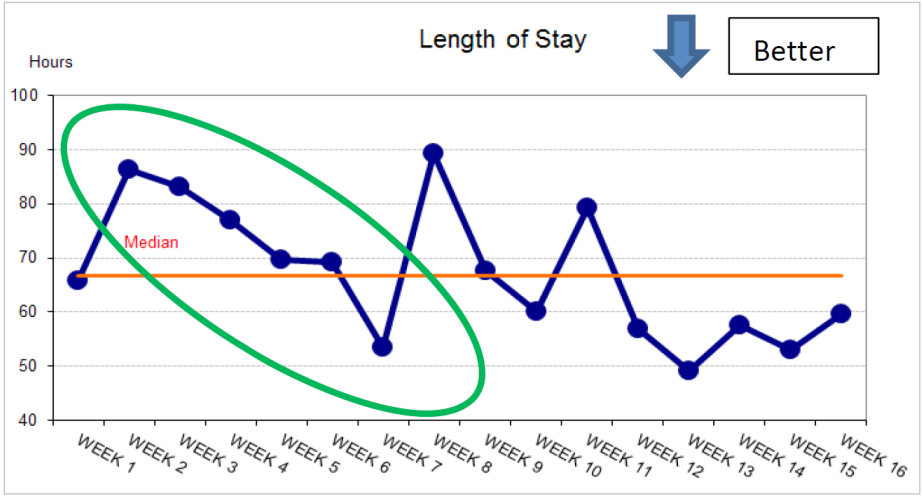
Common cause variation is always a result of errors that are predictable.[2] For instance, a nurse may fail to scan a patient's medication before dispensing. Some might have better accuracy, but very few will be able to perform this task 100 percent of the time without error. Errors that result from common causes will predictively vary around the performance rate, e.g., nurses should have a 98 percent scanning rate. The only way to effectively mitigate this type of error is to improve the process, rather than focus on the individual.

Special cause variation results from unpredictable errors.[2] For example, a recent graduate from nursing school is placed on a busy day shift medical surgery unit. Likely, the number of times that she fails to scan a patient's medications before dispensing will be high until she obtains more training, coaching and experience. Therefore, the number of times the nurse scans a patient's medication before dispensing is highly unpredictable. In this case, the root cause of the problem is not the process, but the individual.

Run Charts

According to the Institute for Healthcare Improvement, run charts show a visual of observed patterns throughout a period of time, thus helping improvement professionals make necessary adjustments.[3] Run charts help teams create sound solutions by identifying trends to help decide when changes truly are improvements, and eventually giving direction regarding the value of certain changes. In a hospital setting, run charts can be used for trending the length of stays for patients undergoing elective joint replacement surgery to determine if any changes to care are warranted. Figure 2 below gives an example of a run chart depicting length of stay. Ideally, the data points should trend below the median.

Figure 2: Length of Stay Run Chart



Source: Informing Ecological Design, 2016

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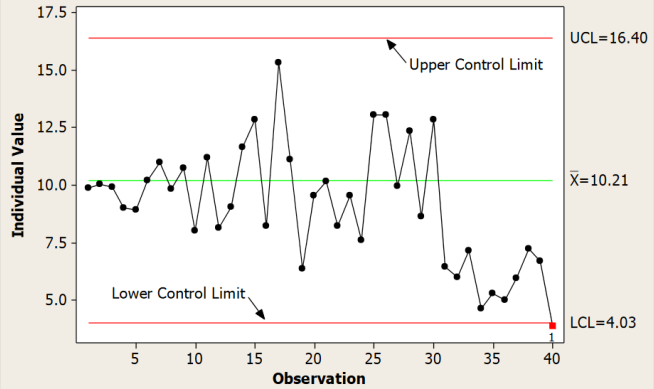
Control Charts

Control charts are some of the most powerful tools used in health care. They help professionals better understand process volatility, thus helping them devise effective strategies to address any gaps that may be identified.[3] In a hospital setting, control charts can be used to measure lab processing times for a particular lab procedure to identify quality improvement areas. Retrospective data is typically used to set the upper and lower control limits and is where the analyst may identify any unusual trends.[4, 14] As indicated in Figure 3, a new process change was implemented on observation day 31, resulting in a process improvement of reduced lab processing time. At this point, the analyst may need to use this reduced time to set new control limits to monitor for sustainability in the future.

Figure 3: Lab Processing Times



Source: Statistical Methods in Healthcare

STANDARD DEVIATION

Standard deviation is one of the most commonly used measures of variability. It provides a good perspective of the variation of any data set with respect to location from the mean.[1] If the data has a greater spread, the greater the standard deviation and vice versa. In the health care industry, standard deviation can be used to estimate the variation of any process under review. For example, if a hospital performance improvement specialist is working on improving the door-to-doctor time for two different hospitals within the same system, the first thing that he/she may want to do is find the average time for each location. If both locations have the same average time of 15 minutes, the next step would be to calculate their individual standard deviation, as it will be the key determinant of which hospital has the least variation. If Hospital A has a standard deviation time of five minutes and Hospital B 10 minutes, a best practice would be for Hospital B to learn how Hospital A is able to perform at that rate. In this example, Hospital A has less variability, because on average, the door-to-doctor time deviates from the average time by five minutes, while it deviates by 10 minutes in Hospital B. Overall, the lower the standard deviation the better because it is indicative of less variation.

How do I calculate a statistical test?

CALCULATING RANGE IN EXCEL

Open an Excel spreadsheet, click on the cell where the outcome should be displayed. Start the calculation by inserting an equal sign "=," followed by the calculation to be performed.

- "=Max (Select "MAX" from the menu option, highlight the cells to calculate, then press "Enter" on keyboard.)"
- "=Min (Select "MIN" from the menu option, highlight the cells to calculate, then press "Enter" on keyboard.)"
- Subtracting the MAX from the MIN value provides the range.

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CALCULATING SAMPLE STANDARD DEVIATION IN EXCEL

Open an Excel spreadsheet, click on the cell where the outcome should be displayed. Start the calculation by inserting an equal sign "=," followed by the calculation to be performed.

- "=STDEV (Select "STDEV" from the menu option, highlight the cells to calculate, then press "Enter" on keyboard.)"

CALCULATING POPULATION STANDARD DEVIATION IN EXCEL

- "=STDEVP (Select "STDEVP" from the menu option, highlight the cells to calculate, then press "Enter" on keyboard.)"

CALCULATING VARIANCE IN EXCEL

Open an Excel spreadsheet, click on the cell where the outcome should be displayed. Start the calculation by inserting an equal sign"=," followed by the calculation to be performed.

Sample variance

- "=VAR (Select "VAR" from the menu option, highlight the cells to calculate, then press "Enter" on keyboard.)"

Population variance

- "=VARP (Select "VARP" from the menu option, highlight the cells to calculate, then press "Enter" on keyboard.)"

What tests can be calculated in Excel?

All of the aforementioned measures of variation can be calculated in Excel. Excel has the functions capable of performing the analysis when the correct commands are used. To conduct more advanced and complex statistical analysis, use the Analysis ToolPak. Using basic Excel without add-ons greatly limits what calculations an analysist can perform. To load and activate the Analysis ToolPak, use these three simple steps.

1. Click the "File" tab, "Options," and then click the "Add-Ins" category.
2. In the "Manage" box, select "Excel Add-Ins" and then click "Go."
3. In the "Add-Ins" box, check the "Analysis ToolPak" check box, and then click "OK."

Note: If Analysis ToolPak is not listed in the Add-Ins Available box, click "Browse" to locate this option. If you are prompted that the Analysis ToolPak is not currently installed on your computer, click "Yes" to install it.

There are other statistical analysis software programs that can conduct complex analysis, but they come with a high price tag. Depending on the type and level of analysis conducted or required, each organization can determine the program that best fits their needs and strategy. Research and non-research-based hospitals may have different programs, as each has its own unique needs.

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Where are the data available to run these tests?

Hospitals have internal and external data sources that can be used to do the necessary analysis to drive their strategy. First, ensuring the data is accurate is of pivotal

importance, because it can make or break any organization. Using readily available data derived from databases within a hospital is always important, as it can help performance improvement professionals review and identify notable variance or gaps. This will help address and resolve any issues found in a timely fashion. This data also can aid in real-time tracking of any interventions, giving the improvement teams knowledge of the stability of the process. External data sources are extremely important because they give organizations a platform to evaluate how their performance compares to others within their respective geographical regions, state and nation. For example, the Hospital Industry Data Institute, the Missouri Hospital Association's data company, houses data that hospitals may use to perform analysis as needed. Members with access to HIDI's database can see their trended data along with visuals that can help them in their improvement efforts and strategic planning.[11] MHA also hosts the transparency website, Focus on Hospitals, where hospitals can derive valuable information to aid their improvement efforts.[12] Other national databases like Hospital Compare are valuable resources that show how each hospital compares to others within the nation. CMS performs an analysis of its hospital outcome measures annually to determine measure trends and variation.[13] Using both internal and external data to conduct the appropriate measures of central tendency and variation can help organizations understand their performance, thus helping them to reposition accordingly.

MHA widely uses descriptive statistics, i.e., central tendency and variation, to identify gaps in statewide aggregate data for various programs, such as the Hospital Engagement Network, price and quality transparency initiative, immersion pilot projects, and the Medicare Rural Hospital Flexibility Program. This analysis helps us understand or identify the existence of variation, thereby helping determine an organization's best course of action. The ability to identify the type of variation helps the organization develop the most suitable intervention required.

Data derived from multiple sources is analyzed and made available to individual hospitals through publications, the HIDI platform, and Focus on Hospitals. HIDI's platform provides member hospitals with rich data, allowing individual hospitals the ability to run customized reports for further analysis as needed.

MHA shares state aggregate data during statewide and regional meetings, and through other avenues, to give hospitals a good perspective of the state's performance benchmarked with the nation. Highlighting successes helps motivate hospitals to continue the pursuit of high and reliable performance. Addressing the challenges and using them as opportunities for improvement creates a solid foundation. Reducing variation within the processes and systems ultimately results in improvement that can be sustained indefinitely, leading to highly-reliable organizations.

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