Utilizing Statistical Process Control to Assess the Progression of Self Reporting of Errors

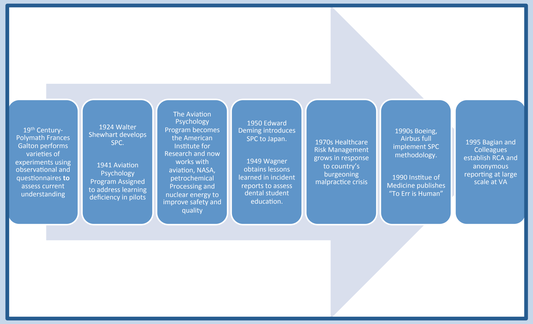
Srikanth Kurapati MD MBA, Vamsi Arabindi MD, Quavonia Chaison MSN RN-BC, Samir S Awad MD MPH
Michael E. DeBakey Veterans Affairs Medical Center and Baylor College of Medicine Department of Surgery, Houston TX

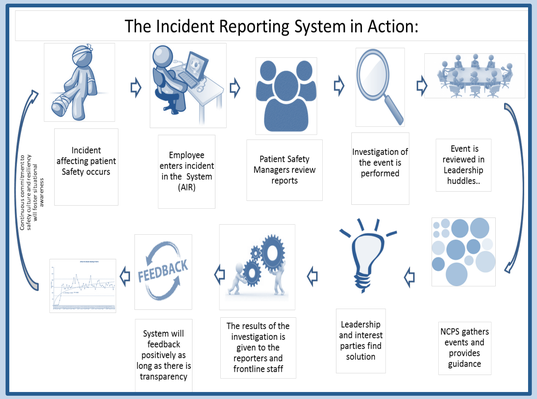
Introduction

The idea that healthcare needed to become an adaptive learning industry with low tolerance for error, while maintaining high performance was an idea whose time had come. While incident reporting provided a foundation for awareness of error, the next step in striving for performance was the introduction of situational awareness (SA). SA as a conceptual framework was once again initially introduced by the aviation industry and defined as "a person's perception of the elements in the environment within a volume of space and time, the comprehension of their meaning, and projection of their status in the near future." Early studies into aviation incidents implicated failure to gain situational awareness as the source of a significant number of pilot errors.

Ultimately, creating high performance was so critical that concepts like situational awareness moved beyond the vagaries of mission statements and catch phrases, to full on implementation. Kathleen Sutcliffe was a pioneer in this field and established the idea that healthcare institutions must become High Reliability Organizations (HRO) like their aviation and nuclear counterparts. Sutcliffe and her colleagues identified key features of HROs and specifically mentions the utility of mindfulness and situational awareness as vital for organizations to have sensitivity to current operations.

The purpose of our project is to illustrate statistical process control (SPC) as a method to study the progress of incident reporting and assess institutional situational awareness.



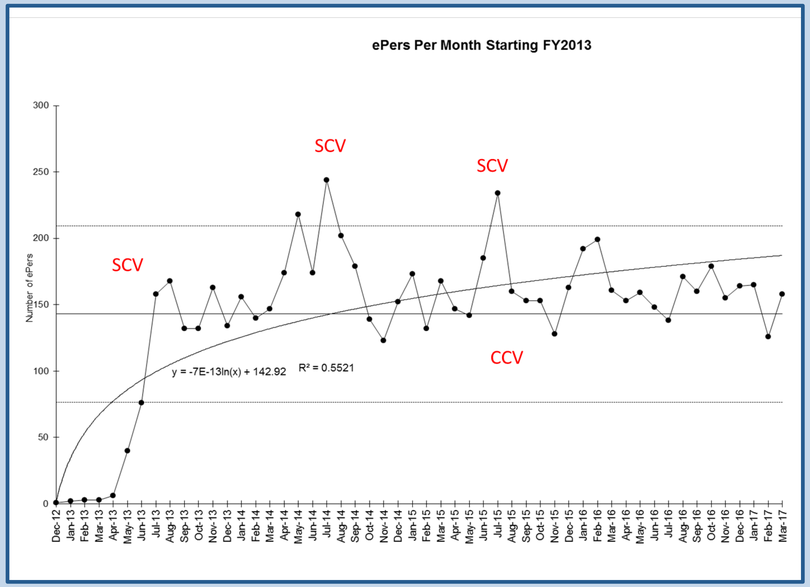


Methods

The Veterans Administration National Center for Patient Safety (NCPS) maintains a database of our institution's anonymous incident reports (AIR) reports. All AIRs from December 2012 to March 2017 were collected and trended. Critical events were tracked utilizing the Veteran Affairs Surgical Quality Improvement Program's (VASQIP) quarterly Critical Incident Tracking Notification (CITNs). VASQIP defines critical events as: death in operating room (OR), death from hemorrhage within 24hours, incorrect surgery, retained surgical item, OR fire, and OR burn.

Statistical Process Control (SPC) was initially pioneered by Walter Shewhart in the 1920s and further expanded to industrial-scale quality control by Edward Deming. In applying SPC to our event report system, our aim was to study its progression from fledgling to establishment. This was performed by graphing number of reports per month over time. The area under the curve represents an aggregate of institutional learning.

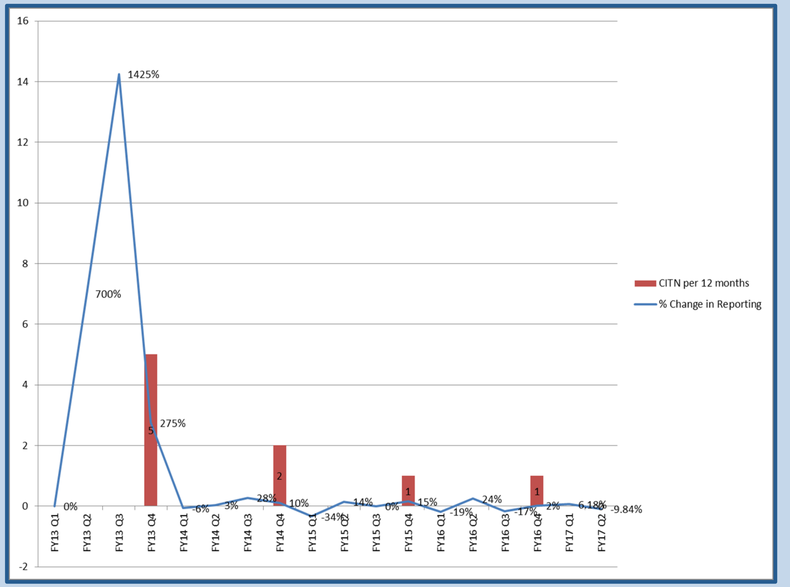
From here, the graph was interpreted for special cause variation (SCV) and common cause variation (CCV). Special Cause Variation represents effects external to a production process, whereas common cause variation represents the inherent variability of a process. Shewhart provided a set of guiding principles upon which to infer data trends with his eponymous "Shewhart's Rules". From here, once a significant variation event is noted, the trend is studied to determine its significance.



Results

The first special cause variation (SCV) revealed the growth of the AIR. There was an exponential increase in AIRs in the first fifteen months from 1 report per month to 168 reports in the 9th month (1425% increase). The results then plateaued over time (1st year-1017, 2nd year-1634, 3rd year-1938), (common cause variation). A logarithmic regression was performed for progression of AIRs per month yielding the equation $y = -7E\text{-}13\ln(x) + 142.92$ R^2 0.55

The highest number of surgical critical events were observed early in the self-reporting process and significantly decreased over time (1st year-5, 2nd year-2, 3rd year-1, 4th year-1, 5th year-0). The number of AIRs and critical events were found to be negatively inversely related with a Pearson coefficient of -0.4.



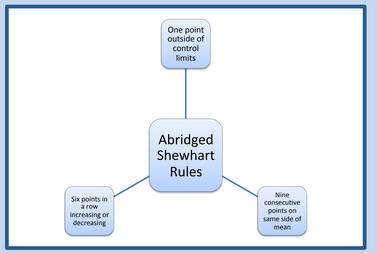
Discussion

Establishing and assessing something as complex as situational awareness can be challenging. To date, most studies use survey data or observational markers. We introduce statistical process control as a viable and straightforward method to assess incident reporting. Furthermore, by temporal correlation with surgical critical events, we introduce a concrete method to study institutional situational awareness.

To date, there is very little evidence demonstrating the efficacy of AIRs in establishing situational awareness. In fact, there is scarce data regarding the appropriate number of incident reports and most Quality and Safety managers take the approach, "more is more". Furthermore, efforts at increasing reporting is often aimed at incentivizing reporting without a clear goal and implication of its benefits. By understanding those points which are special cause variation versus common cause, an institution can better understand the efforts aimed at increasing reporting.

Prior studies have sought to establish event reporting's efficacy in a similar manner as aviation, nuclear power, petrochemical industry. These studies are inherently flawed. While healthcare shares the similar goal of becoming HROs as these industries, it differs in complexity of production outcomes. Production of health differs greatly from production of automobiles. Diagnosing patients, performing surgery, providing empathy, are all examples of a network of goals that must coalesce to provide high quality care. To appropriately assess an incident reporting system, assessment must move away from linear outcomes such as number of reports or fall rate, and instead must survey the greater shared goal of improved situational awareness.

Our approach can be easily implemented by programs in all phases of their reporting culture. In the beginning, many institutions struggle to incentivize and generate quality reports. Fears of repercussion and blame must be assuaged. Those programs in the middle of their journey can use our model to arrive at an estimate number of reports through a similar control chart. They can perform a similar analysis with little statistical training and correlate with similar critical events to assess the progression of their institution's situational awareness.



Conclusion

SPC analysis can be applied to anonymous incident reporting to study the progression of situational awareness. The natural course of an AIR program begins slowly, but as feedback to reporters increases, reporting and situational awareness increases exponentially as demonstrated by our model. The result is a significant improvement in institutional situational awareness.

References

1. Flanagan JC. The critical incident technique. *Psychol Bull*. 1954;51(4):327-358.
2. Sorenson L. Computerized incident reporting: an example of healthcare IT for the 21st century. *J Healthc Risk Manag*. 2001;21(2):15-20.
3. Donaldson MS, Corrigan JM, Kohn LT. *To err is human: building a safer health system*. National Academies Press; 2000.
4. Bagian JP, Gosbee J, Lee CZ, Williams L, McKnight SD, Mannos DM. The Veterans Affairs root cause analysis in action. *Jt Comm J Qual Improv*. 2002;28(10):531-545.
5. Bagian JP, Lee C, Gosbee J, et al. Developing and deploying a patient safety program in a large healthcare delivery system: you can't fix what you don't know about. *Jt Comm J Qual Improv*. 2001;27(10):522.
6. Singh H, Giardina TD, Peterson LA, et al. Exploring situational awareness in diagnostic errors in primary care. *BMJ Qual Saf*. 2012;21(1):30-38.
7. Christianson MK, Sutcliffe KM, Miller MA, Iwashyna TJ. Becoming a high reliability organization. *Crit Care*. 2011;15(6):1.
8. Sutcliffe KM. High reliability organizations (HROs). *Best Pract Res Clin Anaesthesiol*. 2011;25(2):133-144.
9. Pham JC, Girard T, Pronovost PJ. What to do with healthcare incident reporting systems. *J Public Health Res*. 2013;2(3):27.
10. Rubin HR, Pronovost P, Diette GB. The advantages and disadvantages of process-based measures of health care quality. *Int J Qual Health Care*. 2001;13(6):469-474.
11. Thor J, Lundberg J, Ask J, et al. Application of statistical process control in healthcare improvement: systematic review. *Qual Saf Health Care*. 2007;16(5):387-399.
12. Ogrinc GS, Headrick L. Fundamentals of health care improvement: A guide to improving your patients' care. Joint Commission Resources; 2008.
13. Jamali AS, JinLin L. False alarm rates for the Shewhart control chart with interpretation rules. *WSEAS Transactions on Information Science and Applications*. 2006;3(7):238-241.
14. Norri-Sederholm T, Paakkonen H, Kurola J, Saranto K. Situational awareness and information flow in prehospital emergency medical care from the perspective of paramedic field supervisors: a scenario-based study. *Scand J Trauma Resusc Emerg Med*. 2015;23(1):4.
15. Mullan PC, Macias CG, Hsu D, Alam S, Patel B. A novel briefing checklist at Shift Handoff in an Emergency Department improves situational awareness and safety event identification. *Pediatr Emerg Care*. 2015;31(4):231-238.
16. Gillespie BM, Gwinner K, Fairweather N, Chaboyer W. Building shared situational awareness in surgery through distributed dialog. *J Multidiscip Healthc*. 2013;6:109-118
17. Niroula A, Smith DG, Naglak M. Situational awareness of medical residents: an OSCE observation and evaluation. *Am J Respir Crit Care Med*. 2016;193:1.
18. Anderson JG, Ramanujam R, Hensel DJ, Sirio CA. Reporting trends in a regional medication error data-sharing system. *Health Care Manag Sci*. 2010;13(1):74-83.
19. Hwang JI, Lee SI, Park H. Barriers to the operation of patient safety incident reporting systems in Korean general hospitals. *Healthc Inform Res*. 2012;18(4):279-286.
20. Atherton T. Description and outcomes of the DoctorQuality incident reporting system used at Baylor Medical Center at Grapevine. *Proc (Bayl Univ Med Cent)*. 2002;15(2):203.