Use of Control Charts as a Quality Control Tool for Monitoring of Microbiological Infection Risk during Surgery: An Expository Case

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Dear Editor

Prevention of microbiological infection of a surgical wound is an important quality attribute that should be monitored regularly to ensure compliance with good operation practices.[4] Shewhart charts provide an indispensable tool to assess the surgical site infection (SSI) state, deliver early warning for any deviations from the existing process, and give measurable mean for evaluation of any change and improvement made in the surgery processing operations.[5] Several types of researches have been conducted to apply control charts for monitoring SSI in different studies. Trending charts that were used include p-chart, cumulative sum, and exponentially weighted moving average.[6-10]

Expository case study

Control charts have been used in various situations in different industries and services notably health care and pharmaceutical fields.[11-14] The present case demonstrated the use of conventional or Laney modified u-chart after diagnosis check for data spreading to avoid elevated false alarm rate using Minitab® 17.1.0 as demonstrated earlier in other research works.[15,16] The WHO data of SSI rates on yearly basis were selected from three different countries that fall within the WHO European region (WHO EURO). These chosen countries with its WHO data are listed in Table 1.[17] Constructed trending charts data were based secondarily on European Health for All database (HFA-DB) for Figures 1-3[17] only. Figure 3 was made using the classical type of attribute chart as data dispersion has passed the diagnostic test. Red dots in the control charts represent years of unusual rates of SSI, where warning points in the upper side (above the green line) represent high-risk periods.

While red points of the lower side show opportunities for improvements. SSI % in Bulgaria was the highest with initial abnormal values followed by gradual falling in the rate interrupted by a freakish rise in 1 year with SSI rate range of about 0.8%. Armenian SSI % is relatively lower than the previous one with a somewhat similar pattern, but steeper declines with no interrupting rise SSI rate and range of approximately 1.2%. German SSI trend was the most stable one although it slightly tends to increase with time due to shift in SSI % mean. With the exception of the last 6 years of the Armenian SSI %, German SSI trend is the lowest with a range of about 0.1%. Accordingly, the control limit range of the three countries is 0.50%, 0.55%, and 0.26%, respectively.
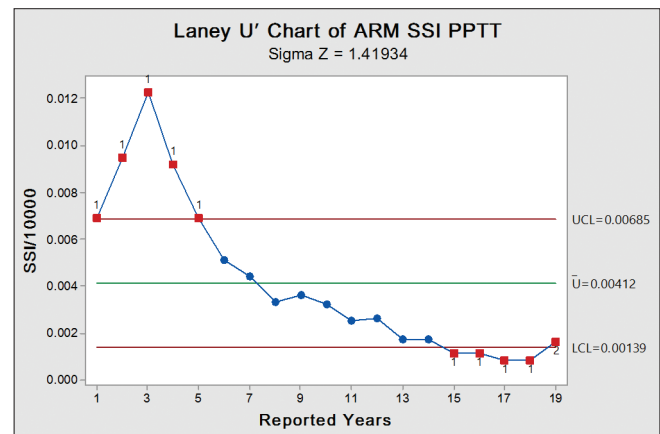

Figure 1: Armenian yearly rate (as patient per 10,000) of surgical site infection demonstrated as trending chart with upper control limit, lower control limit, and mean. Source of data: National Health Information Analytic Center, Ministry of Health of the Republic of Armenia[17]

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Table 1: Data of selected European countries for SSI % charting according to the WHO database[17]

Country full name	Armenia	Bulgaria	Germany
Short abbreviation	ARM	BGR	DEU
CIS	√		
Members of the European Union (EU member)		√	√
I - EU member before May 2004 (EU15)			√
II - EU member after May 2004 (EU13)		√	
SEEHN members		√	

SSI: Surgical site infection, CIS: Commonwealth of independent states, SEEHN: South-eastern Europe Health Network, BGR: Bulgarian
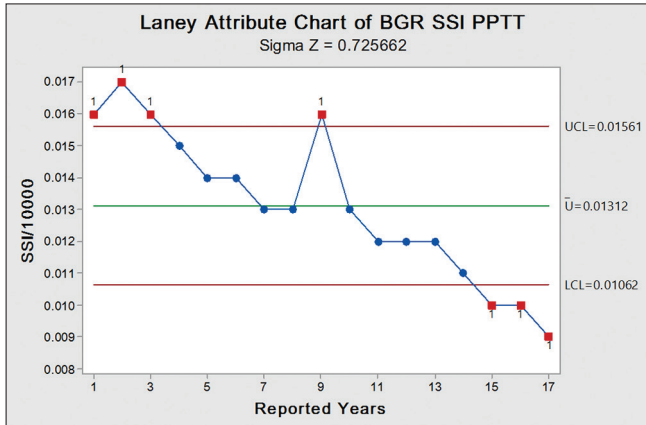

Figure 2: Bulgarian yearly rate (as patient per 10,000) of surgical site infection demonstrated as trending chart with upper control limit, lower control limit, and mean. Source of data: European Health for All database[17]
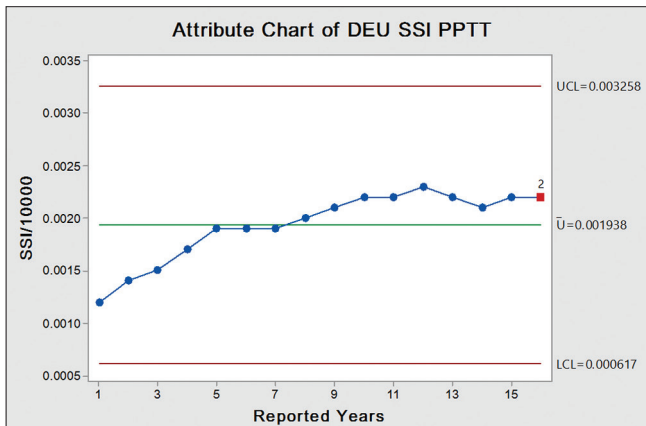

Figure 3: German (DEU) yearly rate (as patient per 10,000) of surgical site infection demonstrated as trending chart with upper control limit, lower control limit, and mean (Source of data: Federal Statistical Office, Hospital statistics - diagnostic data of the hospital patients special evaluation by the Federal Statistical Office)[17]

CONCLUSION

Implementation of statistical process control (SPC) in the health-care industry generally and hospitals specifically is crucial as quality control monitoring tool of SSI to ensure patient safety and health. Medical staff should be aware of using SPC and regular trending must be assigned for those who are well trained in statistics and control charts to ensure on-time review and control of the process. Thus, any excursion could be spotted, investigated, and contained in a timely manner. The use of statistical software programs facilitates the process of online visualization of the current states of SSI to facilitate the establishment of correction(s) before any true out-of-control cases emerge. Further, improvement is required in controlling of SSI cases, especially in two European countries in this case - although general trend line is decreasing - and a retrending will be necessary to measure the degree of stability and enhancement achieved, in addition to allocating assignable causes of variability quantitatively to correct and isolate them from common causes of process variations.

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