Example of Application of SPC/Control Charts to Monitor Coronavarius Infections

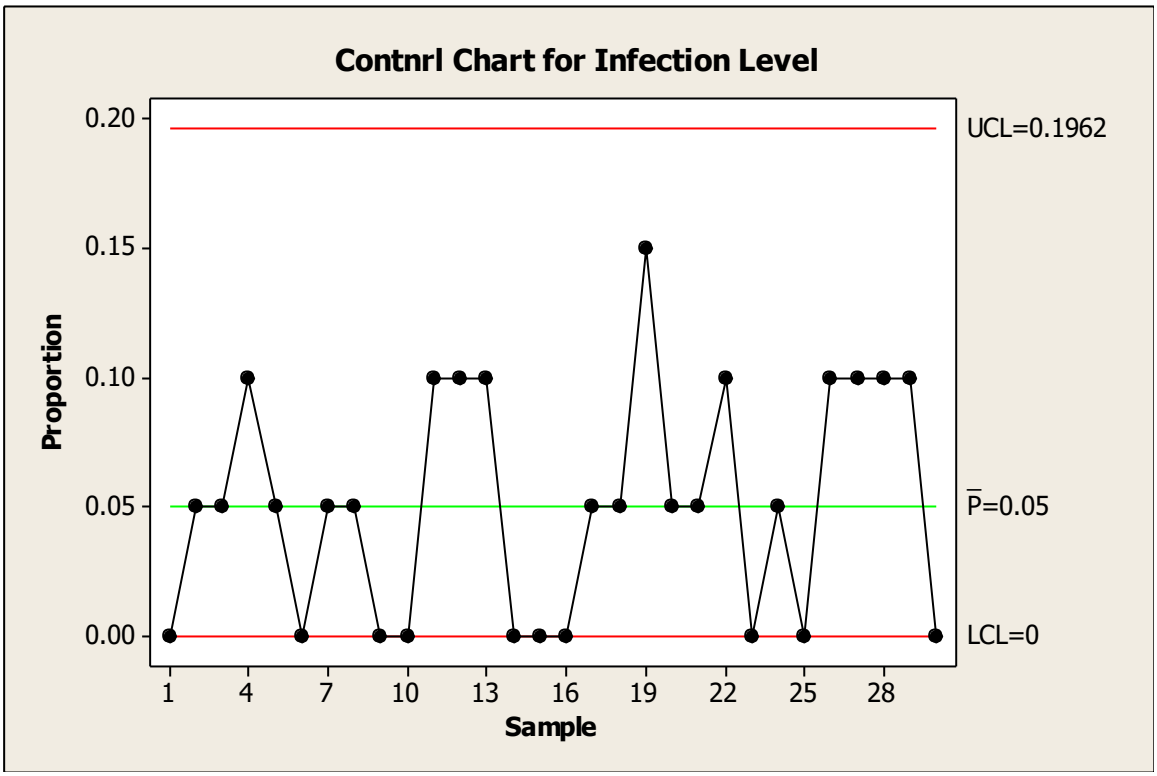
Jorge Luis Romeu, Ph.D.
Romeu@cortland.edu
https://web.cortland.edu/romeu/
Syracuse, May 1st. 2020

This example illustrates how Quality Control/SPC techniques can be used in the Monitoring of Covid-19 Infection Levels to assess the effects of Opening the Economy in possible infection spread.

Monitoring Infection Rate

Let the Acceptable *Covid-19 Infection Rate*, that limits Community Spread, be*:* **5%.** Opening the Economy requires that such Infection Rate remains under control. An *increase in Infection* would mean *restricting* again *Economic activities,* to prevent another Covid-19 Outbreak.

First, the Covid-19 regional infection level must be stable, to apply SPC methods. Assume it is. Assume a daily random sample of 20 individuals, tested for virus infection, constitutes our current testing capacity. Samples of n = 20 random individuals were taken daily, during a month. From these sampling results the parameters for the SPC Chart for Proportion Infected are: P = 0.05; Var(P) = P*(1-P)/n =0.002375. The P-Chart parameters, assuming daily samples of size n=20, have been calculated as: (LCL=Zero; UCL=0.196).

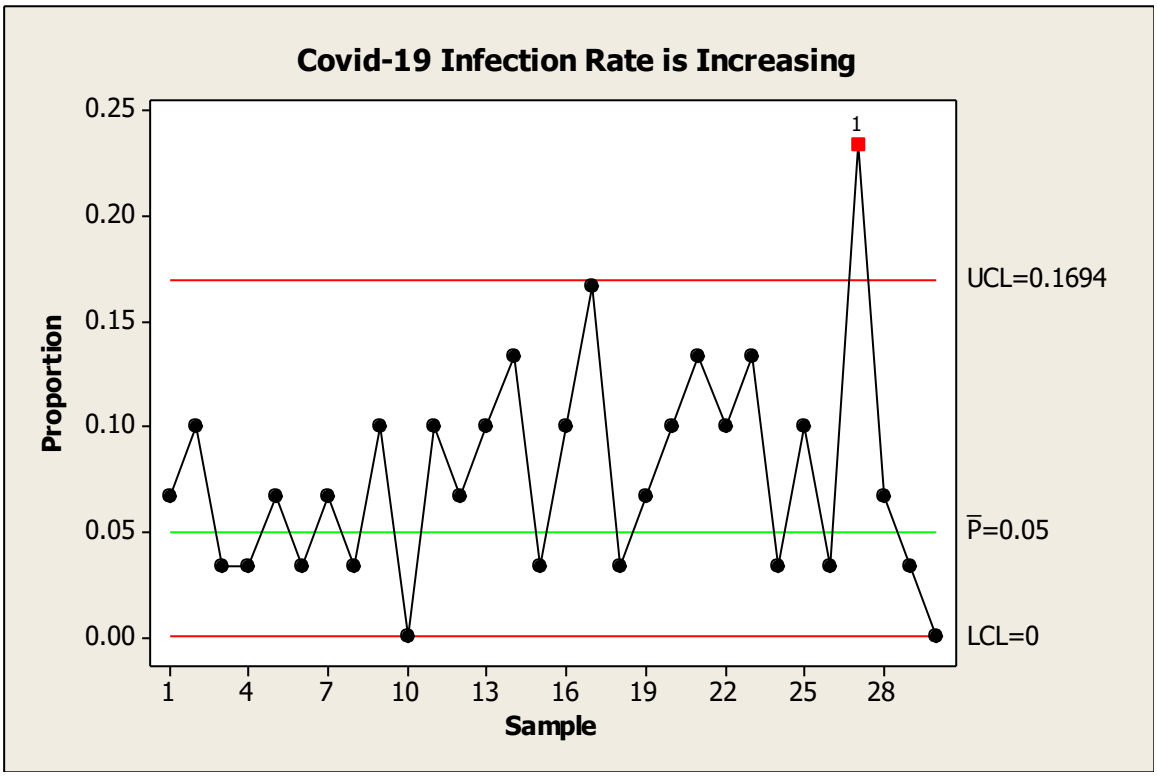


With these values we build a P-Chart and start Monitoring, on a daily basis, infections in the region: As long as the daily Proportion of Infections in the SPC Chart remains within the Upper and Lower Control

Limits, we are OK. If a daily data point falls outside these Limits, immediately check the situation, as the infection rate has increased (data points can only fall outside, by being greater than the UCL=0.1962).

If the region can afford to increase Covid-19 testing to n=30 persons/day, the new parameters would be: P = 0.05; Var (P) = P*(1-P)/n = 0.00158; The P-Chart parameters become: (LCL=Zero; UCL=0.1694).

If, in addition, the Covid-19 Infection Rate starts to increase, the Control Chart will capture it as:



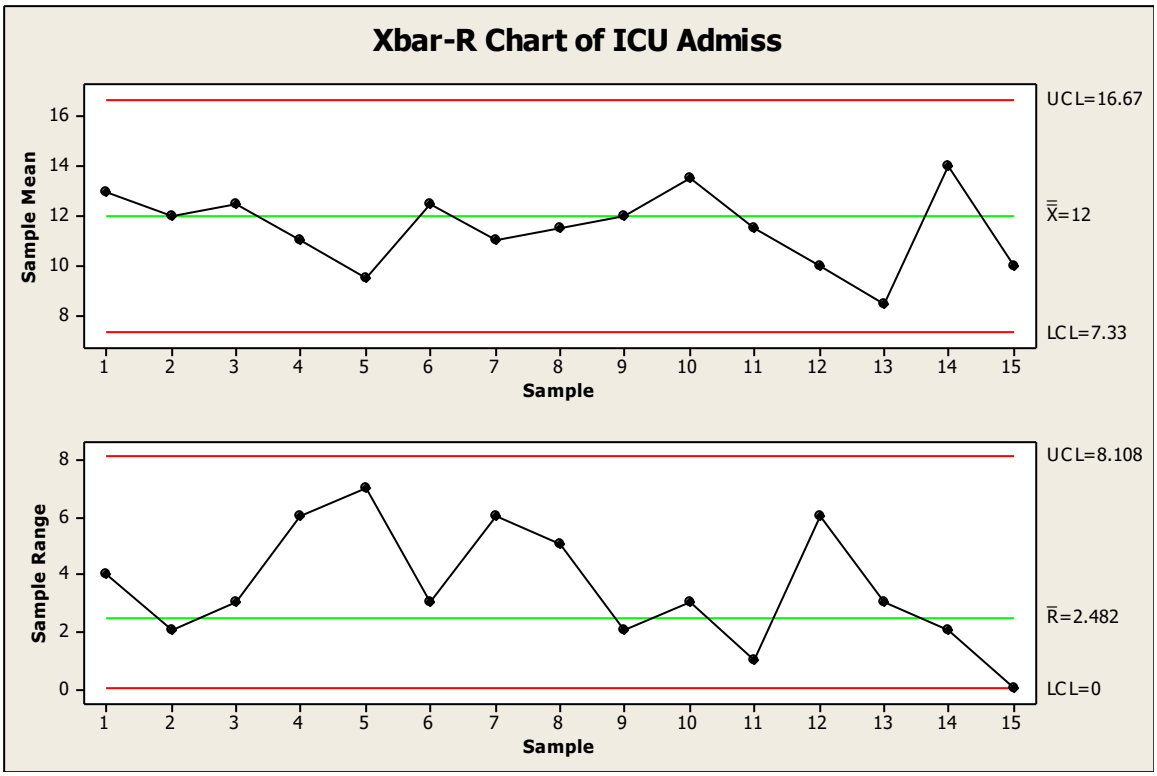
The Control Chart Monitoring the conditions under which the region has opened up is advising that the Covid-19 Infection Rate has risen. Elements such as Social Distancing, use of masks, workplace redesign etc. should be reviewed and the Opening should be constrained until the Infection Rate returns to the specified safety limits.

Monitoring ICU Capacity

The second element monitored by NYS authorities to determine whether to keep open a County, or to have a lock-down is the number of ICU beds (admissions) currently in use. When this number goes up, it is an indication that infection has increased and it is time to change the procedures.

Assume that, when the County infection level is stable and under control, the number of ICU patients is distributed Normal, with Mean 12 and Std-Dev = 2.2. The ICU has a capacity of 20 beds. Thence, these numbers are below the thresh-hold of 80% required by state health authorities to keep County open.

Assume that we have taken the admissions one month (30 days) and that we process them in groups of two consecutive days, for a Mean/Range Process Control chart:



We see, from the Chart, how the level of ICU admission (capacity) is stable about Mean=12. We can also see how the variability of ICU admission activity (about R=2.48) is also stable. The X-Bar Chart Upper Control Limit (UCL= 16.67) and Range UCL (=8.11) show the maximum values under stability. As soon as either of these two UCL are violated (by increasing admissions), it is a sign that the process stability has become compromised and it is time to review. For chart construction see *Quality Control Charts/Romeu*.

Bibliography

Acheson, J. Quality Control and Industrial Statstics (5th Edition). Irwin, 1986

Romeu, J. L. Quality Control Charts. RAC START Sheet. Volume 11, Number 4. https://web.cortland.edu/matresearch/QCChartsSTART.pdf