

# Statistical Process Control: A Tool For Monitoring Pressure Ulcers In Malaysian Public Hospitals



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# STATISTICAL PROCESS CONTROL: A TOOL FOR MONITORING PRESSURE ULCERS IN MALAYSIAN PUBLIC HOSPITALS (NMRR NO: NMRR-18-1868-43410)

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# Introduction

- 13 Malaysian Patient Safety Goals (MPSGs)
  - To improve the safety of healthcare delivery
- MPSG No. 10 (Safety KPI No. 16) - **Incidence of Healthcare Associated Pressures Ulcers**
  - Nursing Indicator Approach (NIA) target of  $\leq 2.1\%$  of immobilized inpatients who develop pressure ulcer more than 48 hours after admission
- If incident rate is more than target
  - root cause analysis (RCA) is required
  - to identify corrective & preventive measures

# Introduction

- A local study reported
  - 11.1% patients had Pressure ulcer on admission
  - 4.4% patients developed during hospital stay
- Nursing NIA data : 2013 – 2017.
  - Incidence rate of healthcare associated pressure ulcer is fluctuating
  - Traditionally, pressure ulcer incidence is monitored monthly by plotting the rate over time.
- Major impact on patients, causing
  - Prolonged hospitalization
  - Severe morbidity
  - Reduce quality of life
  - Cost-effective



Source: Nursing National Indicator Approach (NIA) Report (2013-2017)

# What is Statistic Process Control (SPC)?

- SPC is statistical analysis of the predictability and capacity of the process to give a product that in the range of required standard/ quality
- Involve people, machines, materials, methods, management and environment working together to produce an output such as an end product

# SPC

- Chronological time series plot of measurements (averages, proportions, rate, count or other quantities)
- Upper & lower reference threshold (UCL & LCL) are also plotted. Set at  $\pm 3$  SD --> to detect meaningful changes
- Points outside the limit (out-of-control) may indicate all data not produce by the same process
  - Lack of standardization
    - (solution: subgroup the data. Eg by disciplines/departments/states)
  - Change in process
    - If bad → intervention
    - If good → may need to set new control limits

# Objectives

- This study aims to compare public hospital's performance using statistical process control (SPC) charts.

# Methodology

- Retrospective study
- Monthly incidence of Healthcare Associated Pressure Ulcer in 2017 was collected from all public hospitals from 14 states and 3 government Institutions
- Data was plotted and analyzed using SPC tools (P-chart)



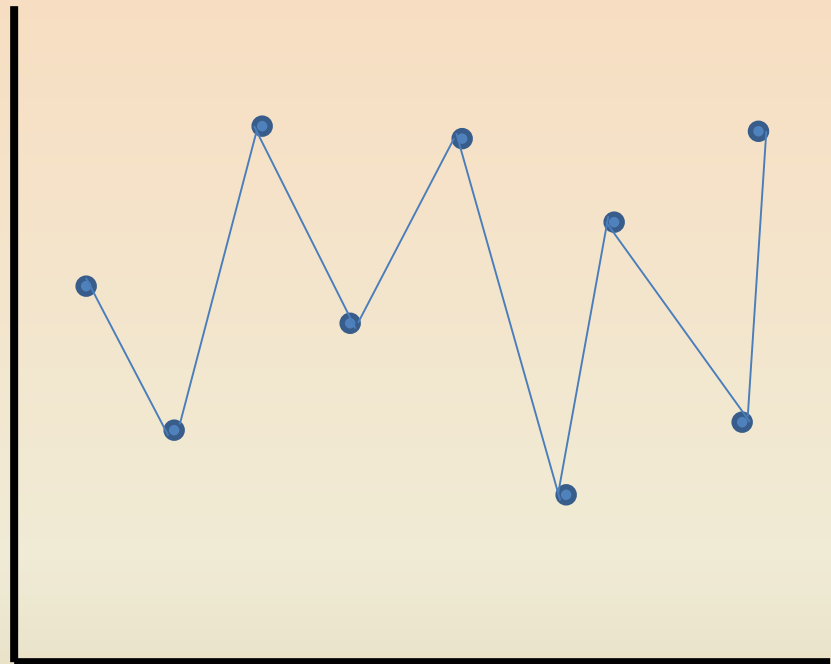
# 5 Basic step to develop control chart

## 1. Gather data



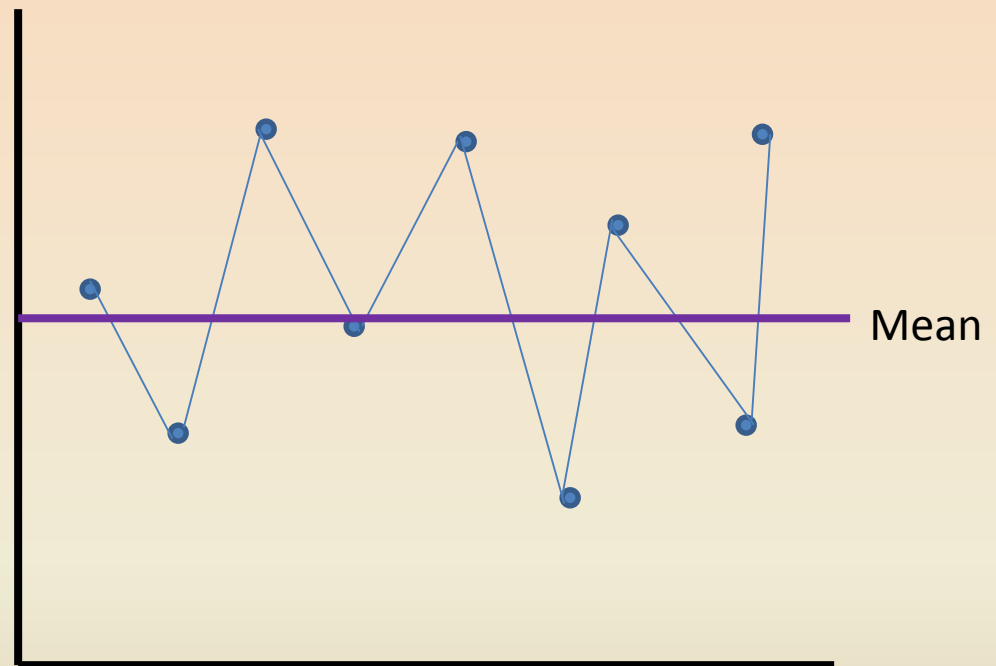
# 5 Basic step to develop control chart

1. Gather data
2. Plot data



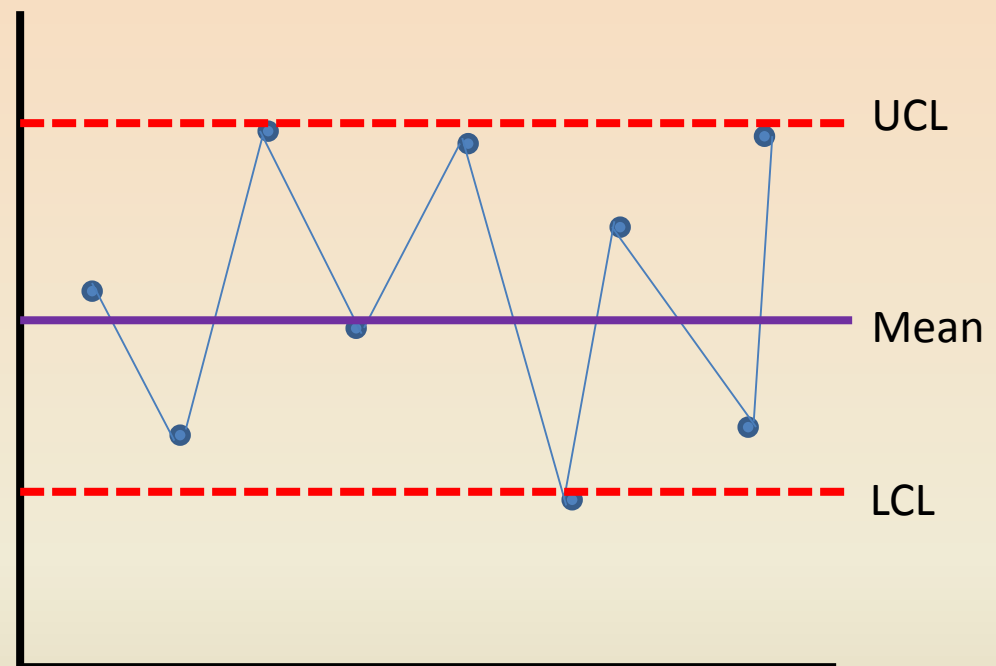
# 5 Basic step to develop control chart

1. Gather data
2. Plot data
3. Calculate the average



# 5 Basic step to develop control chart

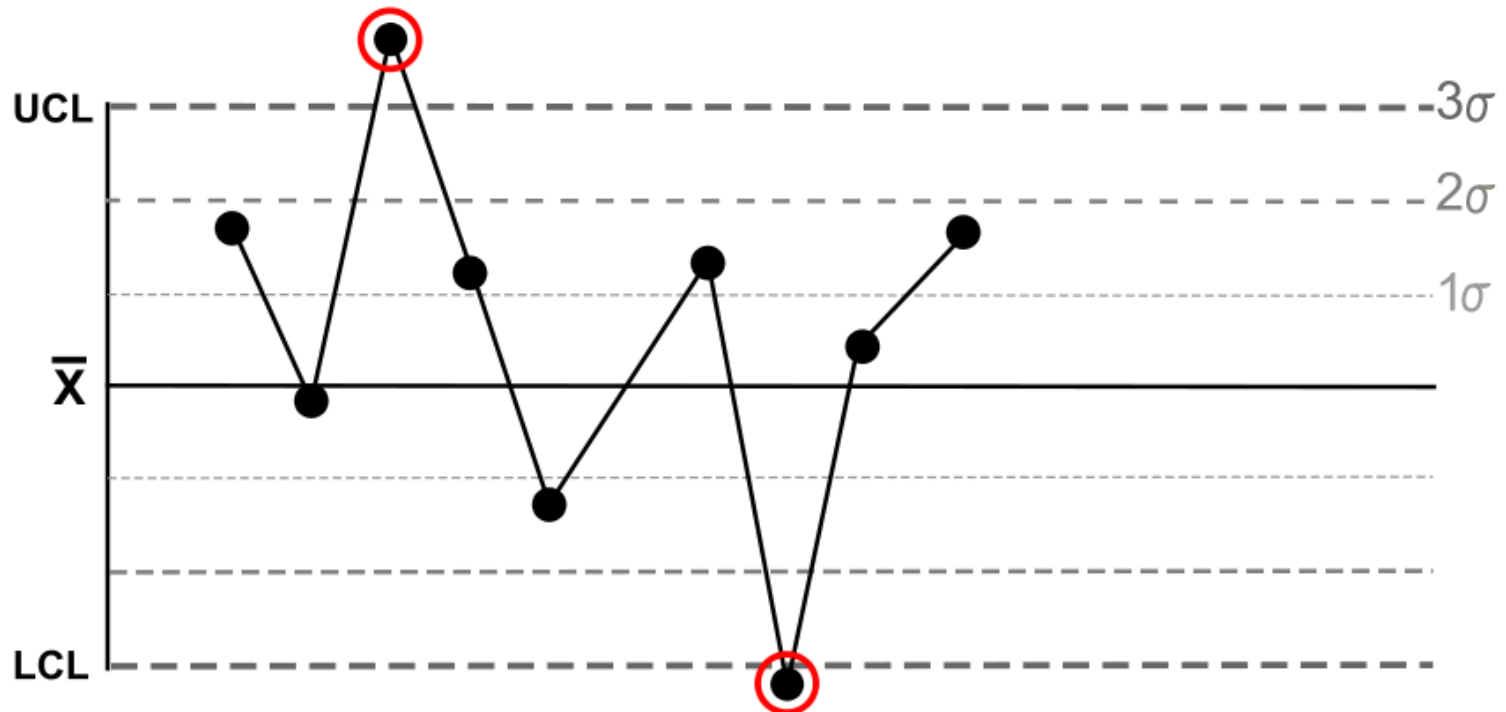
1. Gather data
2. Plot data
3. Calculate the average
4. Calculate control limits



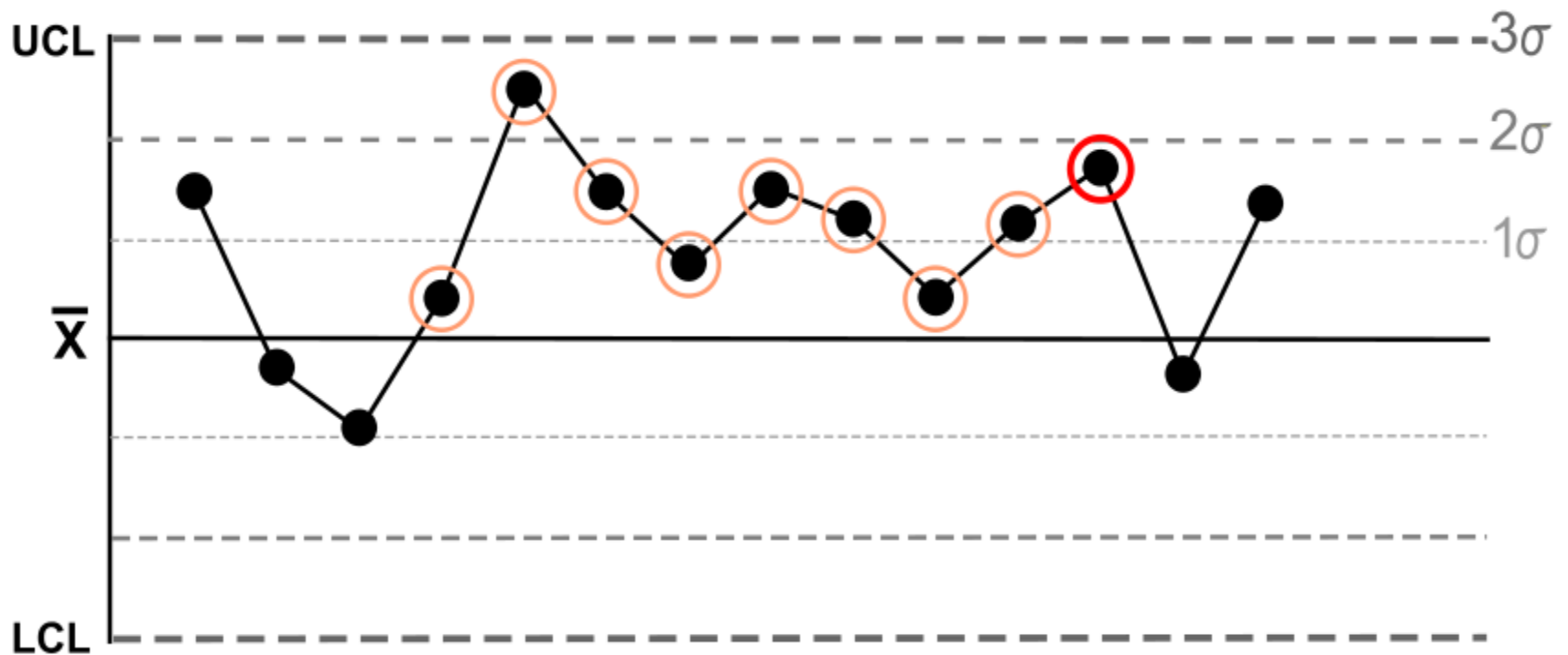
$$UCL_{local} = \bar{p} + 3 \sqrt{\frac{\bar{p}(1 - \bar{p})}{n_{local}}}$$

# Statistical Control Rules

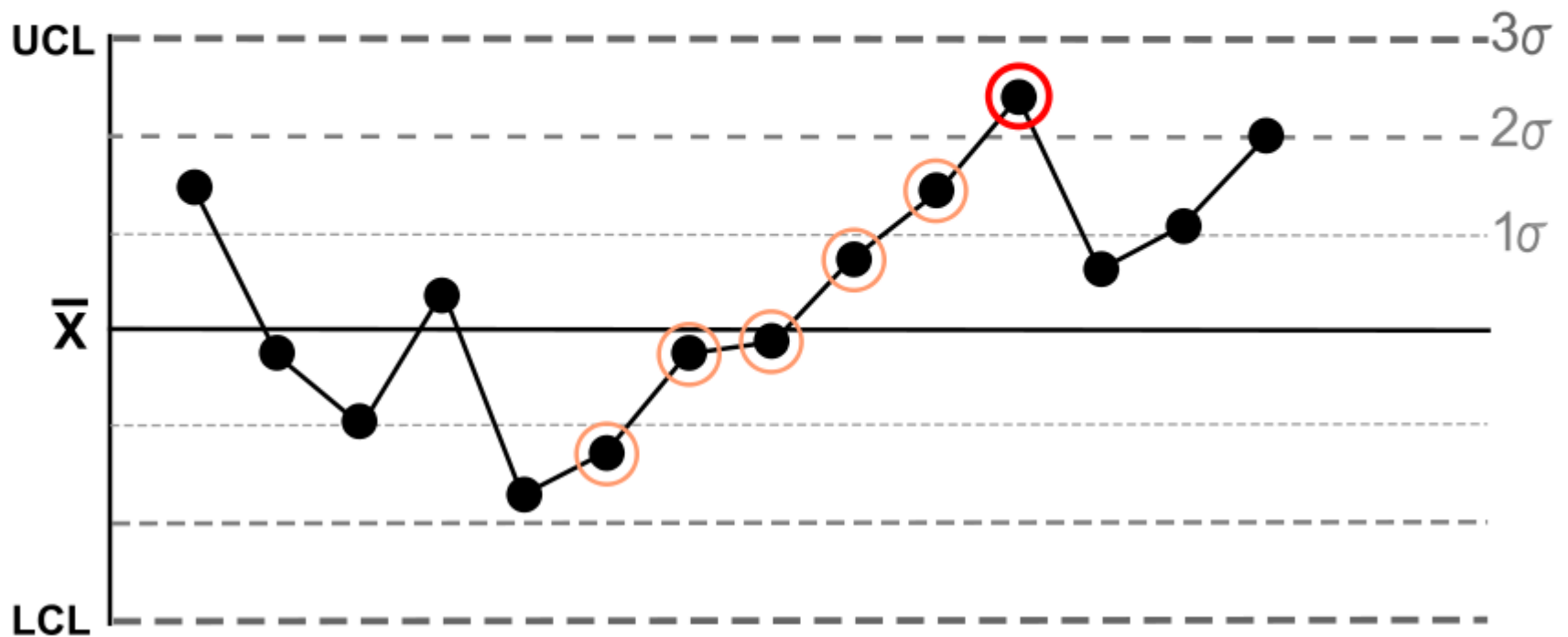
**Rule 1:** One point is more than 3 standard deviations from the mean



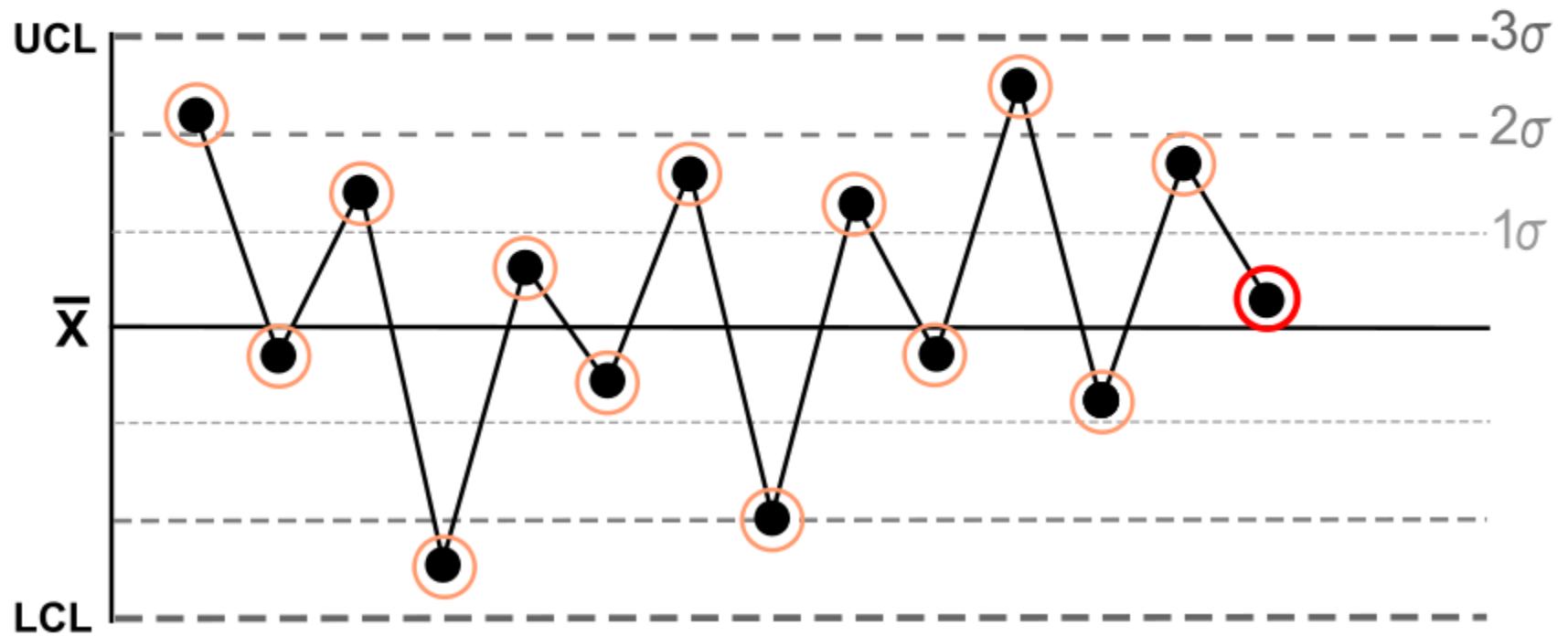
**Rule 2:** 8 (or more) points in a row are on the same side of the mean



**Rule 3:** Six (or more) points in a row are continually increasing (or decreasing)

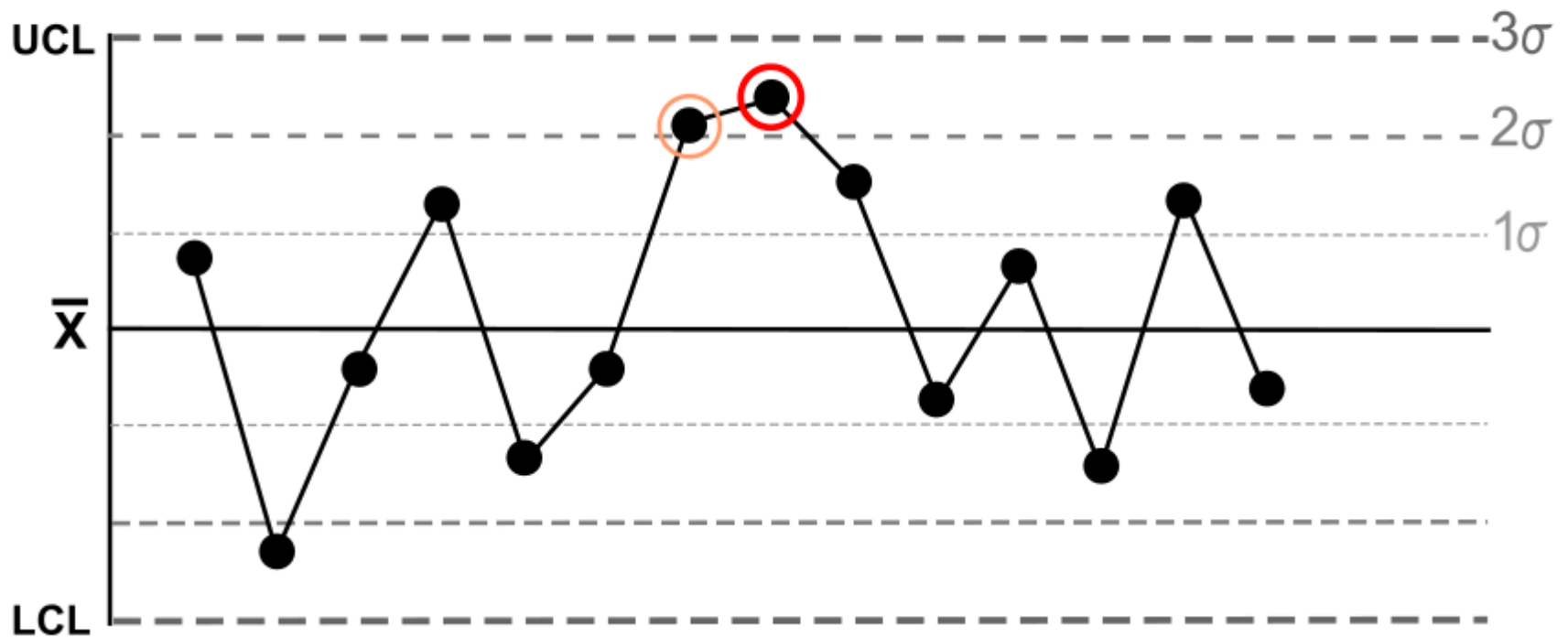


**Rule 4:** Fourteen (or more) points in a row alternate in direction, increasing then decreasing





**Rule 5:** Two (or three) out of three points in a row are more than 2 standard deviations from the mean in the same direction

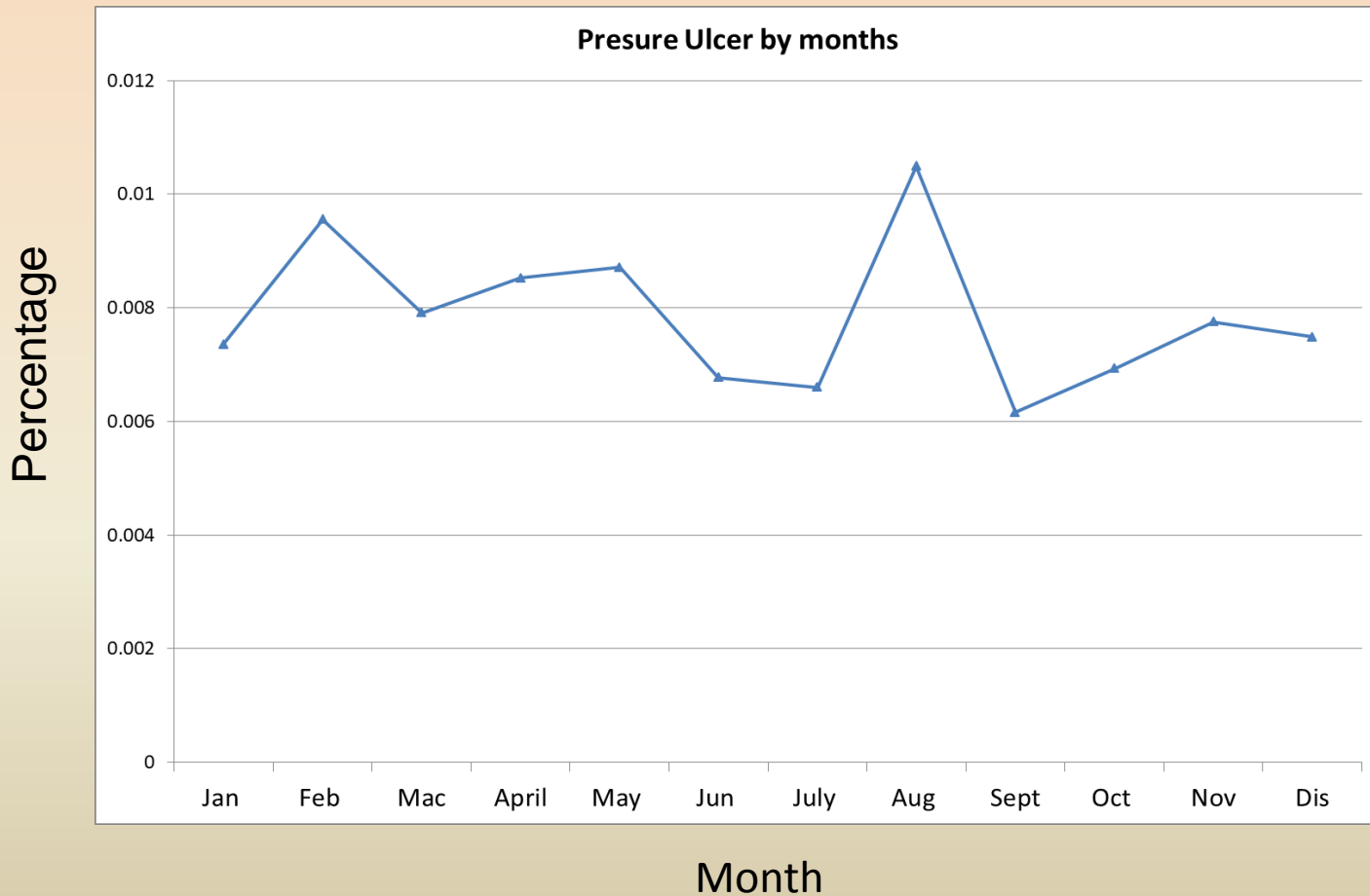


# FINDING

- Pressure Ulcer data:
  - Numerator: 1,989
  - Denominator: 273,619
- Annually statistic shows that all states **achieved** target KPI that is  $\leq 2.1$ 
  - **Average Of Incidence** In Percentage is between 0.20%-1.67%
- 3 hospital/ Institution: range of control limit are **too narrow** which high risk of Type I error
- 3 hospital/ Institution: range of control limit are **too wide** which high risk of Type II error

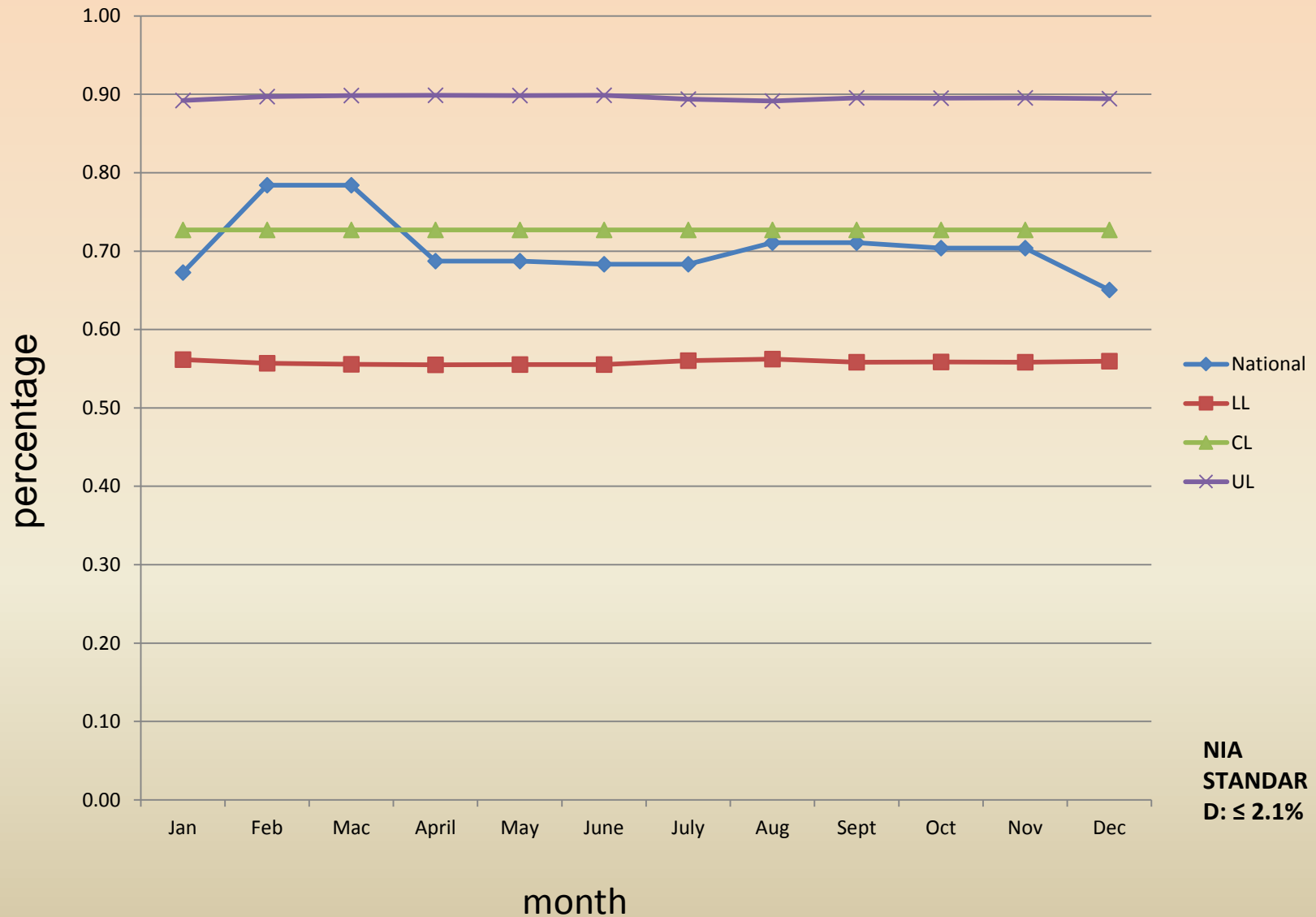
- Traditionally, pressure ulcer are monitored using incidence rate over time chart.

### National performance: Incidence of Pressure Ulcer in Year 2017



Is the pressure ulcer performance within the appropriate range (in control)?

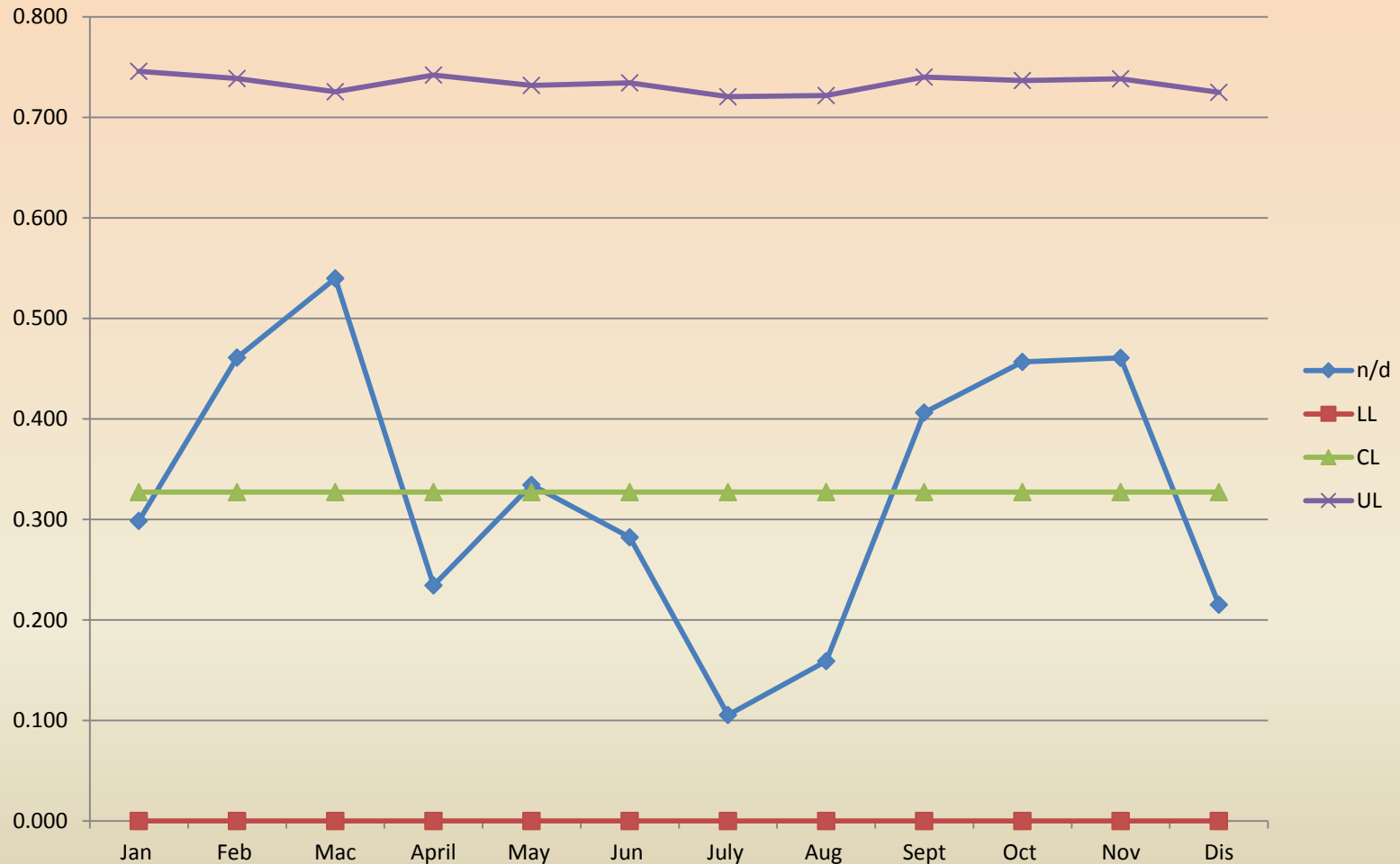
# National performance 2017



State/ Institution	Average Of Incidence In Percentage	Lower Limit (LL)	Upper limit (UL)	Range
A	0.62	0.00	1.93	1.93
B	0.46	0.00	1.12	1.12
C	0.34	0.00	0.90	0.90
D	0.33	0.00	0.73	0.73
E	0.91	0.00	1.43	1.43
F	0.20	0.00	0.72	0.72
G	0.85	0.09	1.62	1.53
H	0.80	0.00	2.94	2.94
I	1.67	0.00	6.47	6.47
J	0.85	0.00	4.52	4.52
K	1.01	0.00	1.89	1.89
L	0.65	0.00	1.12	1.12
M	0.95	0.00	1.79	1.79
N	0.43	0.00	1.26	1.26
P	0.43	0.00	1.16	1.16
Q	1.20	0.00	1.86	1.86
R	0.64	0.28	1.00	0.72
S	0.81	0.00	5.81	5.81
T	1.62	0.00	5.99	5.99

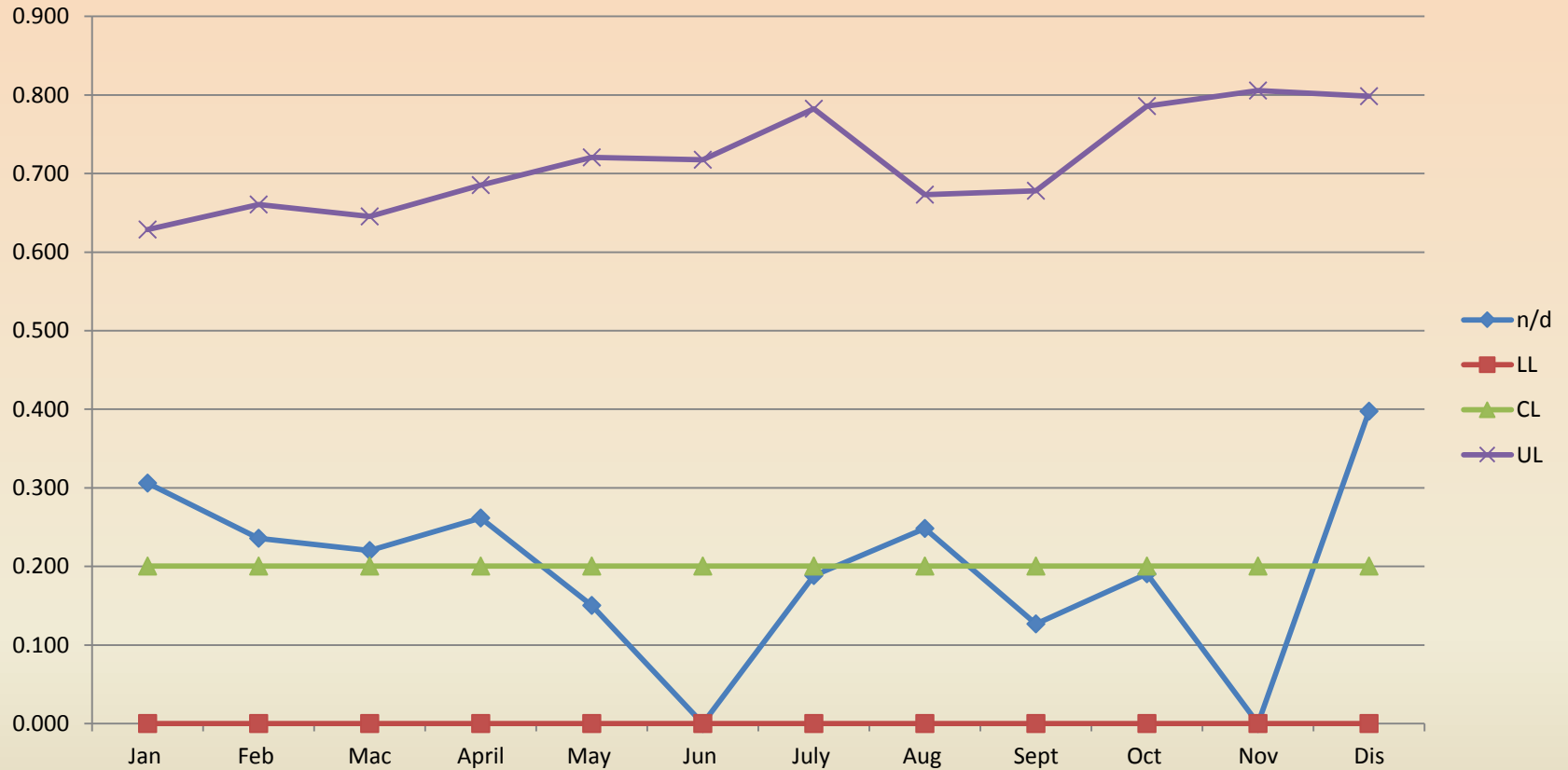
Limit of range are **too narrow**

# State / Institution D



Control limit range: 0.73

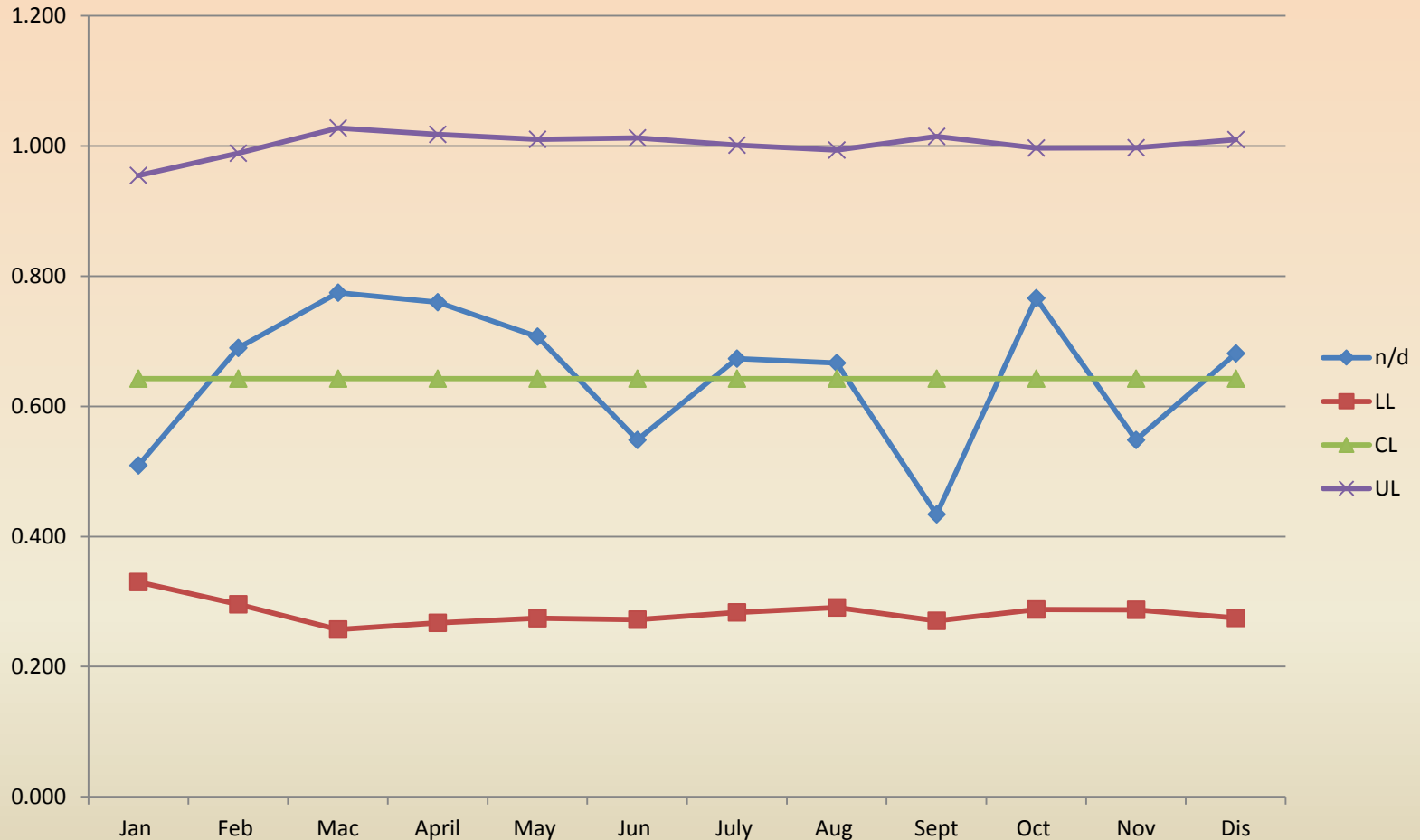
# State / Institution F



Control limit range: 0.72



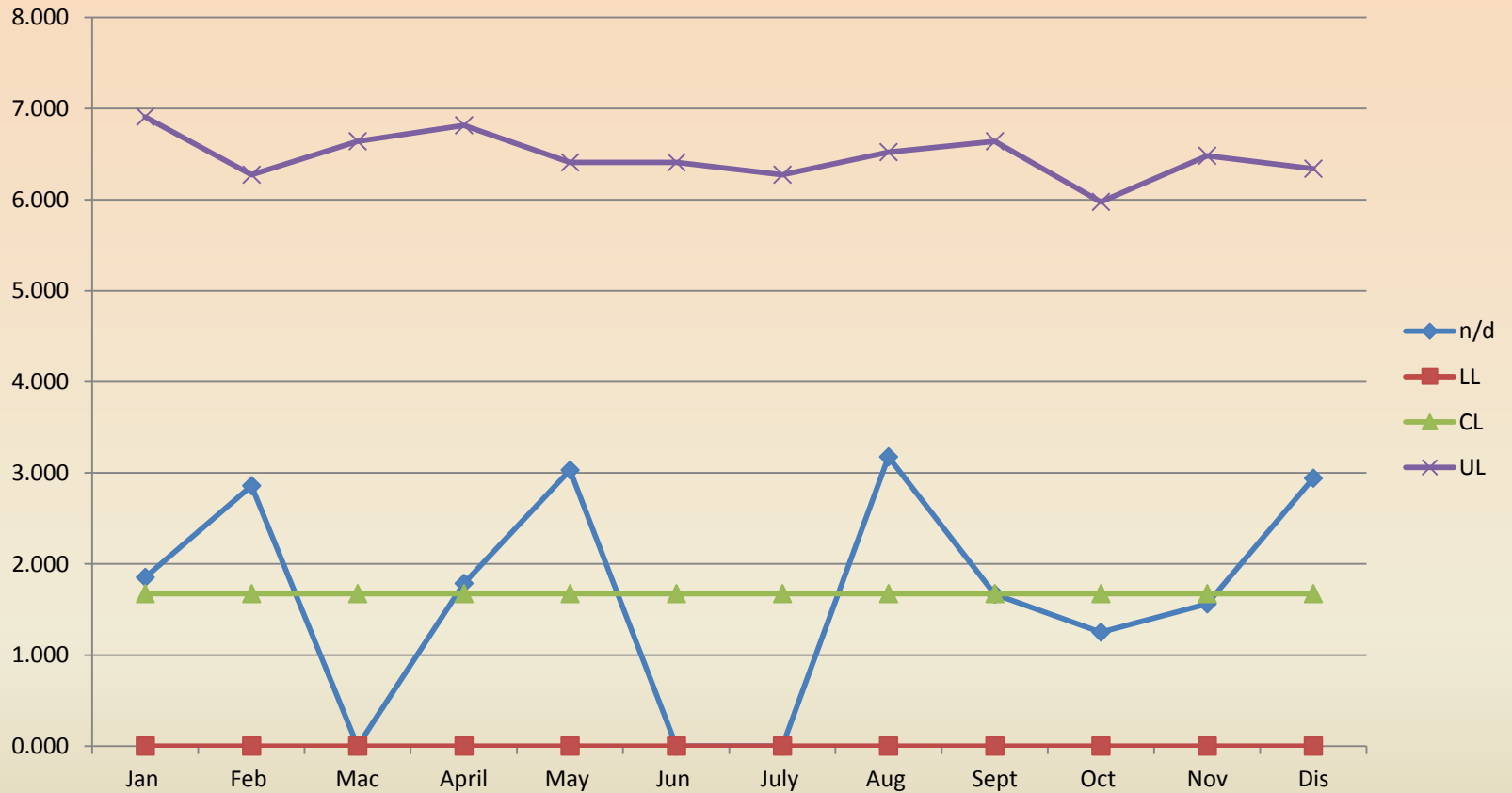
# State / Institution R



Control limit range: 0.72

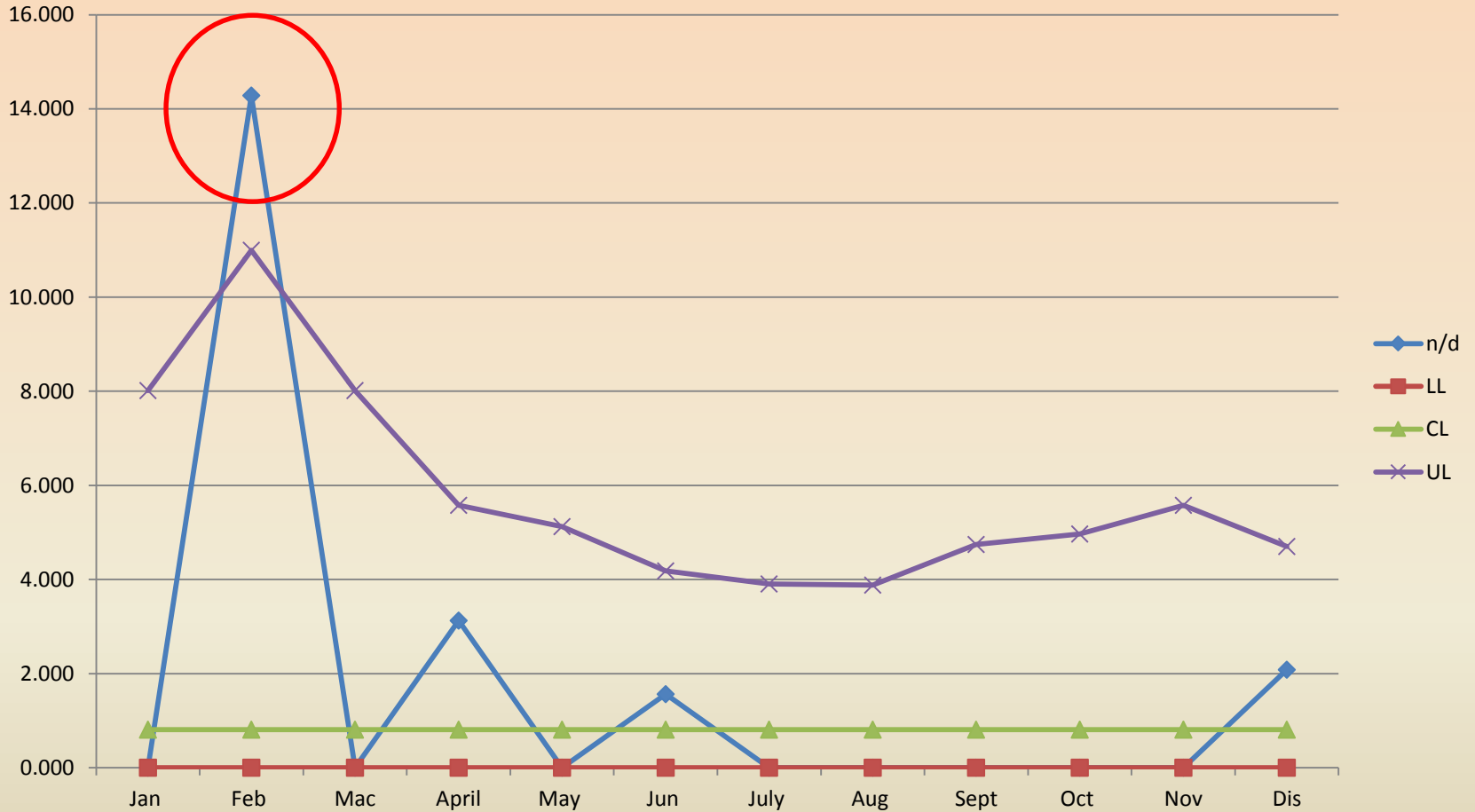
Limit of range are **too wide**

# State / Institution I



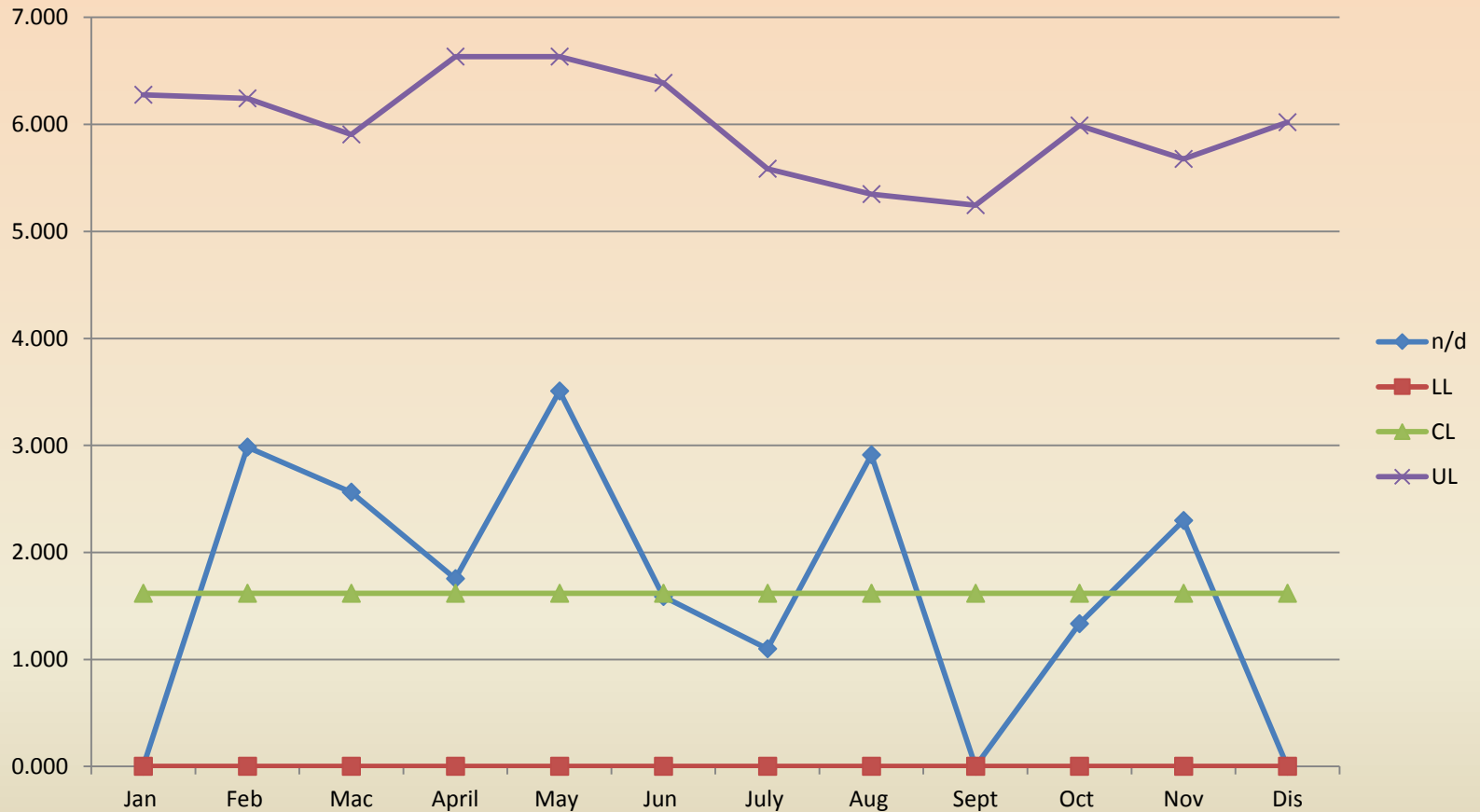
Control limit range: 6.47

# State / Institution S



Control limit range: 5.81

# State / Institution T



Control limit range: 5.99

# DISCUSSION

- Generally, all states/institutes achieved the target KPI of  $\leq 2.1\%$  of incidence of Healthcare Associated pressure ulcers (HAPU), however there are shortfall in quality observed in hospitals/ institutions. The average ranged from 0.72-5.99.
- Within some states, there were few points that indicate the process was "out-of-control". The range variation was dependent on the number of incidence in each state/ institution.

# DISCUSSION

- Based on route cause analysis, the finding is derived from people, working process, management and environment
- Quality data is important to reflect true picture of performance
- Action can be taken immediately based on findings
- Disaggregation of monthly data collection is an important step to achieve effective continual quality improvement.

# RECOMMENDATION

- SPC is an alternative method to facilitate managers in early identification of out-of-control performance
- Can increase the standard if the outcome is achieved continuously
- Nursing Indicator Approach (NIA) standard may be considered based on the range of control limit and number of incidence in each states/ institute



# CONCLUSION

- This paper provides an overview of SPC application in monitoring pressure ulcer performance in public hospital in Malaysia
- Control charts can help managers, process improvement practitioners, and researchers to use objective data and statistical thinking to make appropriate decisions and quality improvement.

# Acknowledgement

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