Asian Journal of Health and Science
p-ISSN: 2980-4302
e-ISSN: 2980-4310
Vol. 4 No. 3 March, 2025

Applying Run Chart to Identify Patterns and Trends in Patient Safety Incident Reports at Cipto Mangunkusumo Hospital

Dina Sabrina Dwipayanti[1*], Sabarinah Prasetyo[2]
Universitas Indonesia
Emails: dinasabrina2108@gmail.com[1], Sabarinahprasetyo@gmail.com[2]

Abstract

Patient safety is a priority in health services. One of the efforts to improve patient safety is through the Patient Safety Incident (PSI) reporting system and analysis and solutions to these incidents. This research analyzes patient safety incidents at Cipto Mangunkusumo Hospital (CMH) from January 2022 to June 2024. Run charts were chosen to analyze the diversity of PSI data by looking at trends and patterns over time and variations in the data to identify common or specific causes and as a learning experience for other hospitals. This research is a descriptive research that analyzes PSI at Cipto Mangunkusumo Hospital. The results of the analysis show a significant increase in PSI reports at RSCM, which indicates an increase in awareness and safety culture among health workers. Although there are variations in the types of incidents, the PSI reporting system is generally stable. Further analysis using a run chart shows no significant pattern in the increase or decrease in incidents. The results of this research have implications by showing the importance of maintaining and improving the reporting culture and conducting regular data analysis for continuous improvement.

Keywords: patient safety, incident reporting, patient safety learning, run chart analysis.

INTRODUCTION

Patient safety is a global priority in healthcare in both developed and developing countries. According the World Health Organization (WHO), more than 3 million deaths each year result from unsafe healthcare, more than 50% of which are preventable, such as due to medication errors, procedural errors, healthcare to -associated infections, diagnostic errors, or patient falls during healthcare treatment. This makes morbidity and mortality from unsafe healthcare the twentieth most common harm in the world (WHO, 2020).

Most of these incidents are not caused intentionally by one or a group of healthcare workers but rather by system or process failures that cause the healthcare worker to make a mistake. Poorly designed systems can cause such errors, and the natural condition of humans working in health services is very natural to be able to experience stress in a complex environment. Therefore, understanding the causes of incidents in medical services in health services requires a systems-based approach rather than blaming one or a group of health workers (WHO, 2020).

The modern patient safety movement began in recent years. This movement gave birth to a patient safety system that encourages reducing the risk of death or injury to patients caused by health care (WHO, 2020). The system consists of reporting, data collection, analysis, and finding solutions so that health services can learn and improve for quality improvement and patient safety (Ontario, 2017) ; (Kang et al., 2021).

In Indonesia, the patient safety system has been in operation since 2006. This system encourages hospitals to report all incidents that cause injury or do not cause injury. For reporting known as Patient Safety Incident reporting (PSI) which is regulated in Indonesian Ministry of Health Regulation Number 11 of 2017 concerning Patient Safety, reporting includes incidents that are included in the prevention area or have not yet reached the patient, namely *Kondisi Potensial Cedera* (KPC) or Potential Injury Conditions which refer to conditions that have the potential to cause injury but have not yet occurred and *Kejadan Nyaris Cedera* (KNC) or Near Miss Events which are incidents that have not yet reached the patient (Hidayat et al., 2022). Meanwhile, incidents that have reached the patient are *Kejadian Tidak Cedera* (KTC) or Non Injury Events which are incidents exposed to the patient but do not cause injury, and *Kejadian Tidak Cedera* (KTD) or Adverse Events, which are incidents exposed to the patient and cause injury to the patient (Sakit, 2015).

In 2022, there was a change in the definition of the KPC incident type to KPCS which is regulated in the Decree of the Indonesian Ministry of Health NUMBER HK.01.07/MENKES/1128/2022 concerning Hospital Accreditation Standards (SNARS), namely Potentially Significant Injury Conditions (KPCS), which is a condition (other than the disease process or the patient's own condition) that has the potential to cause sentinel events. A sentinel event is an event that causes death or permanent injury to a patient that is not related to the disease. The next step after reporting, namely PSI, is analyzed to become a lesson in improvement efforts (Hidayat et al., 2022).

Previous research also describes the application of learning, transparency, and improvement from human error in healthcare, which is still relatively narrow, so a system of learning from error across healthcare organizations still needs to be established. To achieve high reliability in patient safety learning, incident data analysis is one of the key steps in improving patient safety (Carmack et al., 2024). The implementation of the PSI reporting system in Indonesia has also not been fully successful, and a lack of understanding, knowledge, and infrastructure are obstacles to incident reporting (Dhamanti et al., 2019). Researchers also have not found much literature related to the analysis of patient safety incidents in Indonesia that can be used as lessons learned.

Cipto Mangunkusumo Hospital (RSCM, *Rumah Sakit Cipto Mangunkusumo*), as one of the national referral hospitals, has a high commitment to patient safety. In order to achieve this goal, an effective system is needed to monitor and analyze events that can endanger patients. Run charts were chosen because they are easy to create and interpret, can provide a clear visual picture of changes in data over time, and help identify patterns and trends so that they can help to identify the presence of common causes or special causes (Perla et al., 2011).

The purpose of this research is to apply a run chart to identify patterns and trends in Patient Safety Incidents in RSCM, to detect any significant changes in PSI over time, and as a basis for conducting further analysis and taking corrective action. Thus, the results of this research are expected to contribute to efforts to improve patient safety in RSCM and can be a learning material for other hospitals.

METHOD

This research design uses a descriptive research design with a quantitative approach to see the diversity of PSI data in RSCM. This research uses secondary analysis, namely PSI data recorded in the RSCM IKP data from January 2022 to June 2024. Then, the data is divided according to the type of incident. In accordance with the standards issued by the government, all incidents, both before reaching the patient (KPC and KNC) and already reaching the patient (KTC and KTD), are reported and analyzed. The data was then divided into two periods, Period 1 (January 2022 - March 2023) and Period 2 (April 2023 - June 2024) for comparison. Univariate analysis was used to describe the number of PSI in RSCM, and bivariate analysis to explain the characteristics of the variables studied based on time, namely in the form of a run chart to describe variations, trends, and patterns in the number of PSI in RSCM. Data processing used Minitab software.

The next step is testing in accordance with the theory (Carey & Lloyd, 1995), namely:

1. Test 1 looks at the Number of Runs, which is one or more data points that are on the same side of the median line (excluding points that are exactly on the median line). To determine this test, the provisions developed by Swed and Eisenhart in 1943 are used to determine the minimum and maximum number of runs required for each data point aimed at seeing random variation in the process, which can be seen in Swed and Eisenhart's Table (table 1). If the number of runs is lower than the lower limit or higher than the highest limit, then there can be a special cause in the data. (Perla et al., 2011)
2. Test 2, looking at Process Shift, Process to assess the number of data points in 1 run; if the number of observation points is < 20 points, then 7 or more data points in one run indicate systematic variation for which there is a special cause. If the number of observation points is ≥ 20 points, then eight or more data points in one run indicate systematic variation for which there is a special cause.
3. Test 3 looks at the Trend, that is, by assessing the increase or decrease of consecutive data series; the normal standard of consecutive data points is shown in Table 2
4. Test 4, looking at Zigzag patterns, assesses whether there is a sawing pattern, i.e., 14 or more data points that form a "zigzag" pattern (up and down) in sequence; then, the data will be referred to as systematic variation data.

If one of the test conditions is met, then there is systematic variation with a special cause. However, if all test conditions are not met, then the data is a random variation with a common cause (Anhøj & Olesen, 2014).

Table 1. Swed and Eisenhart Table

Number of Observation Points	Normal Boundary Number of Runs	Number of Observation Points	Normal Boundary Number of Runs	Number of Observation Points	Normal Boundary Number of Runs
15	4 -12	24	8 - 17	33	11 - 22
16	5 - 12	25	9 - 17	34	11 - 23
17	5 - 13	26	9 - 18	35	13 - 23
18	6 - 13	27	9 - 19	36	13 - 24
19	6 - 14	28	10 -19	37	13 - 25

Number of Observation Points	Normal Boundary Number of Runs	Number of Observation Points	Normal Boundary Number of Runs	Number of Observation Points	Normal Boundary Number of Runs
20	6 - 15	29	10 - 20	38	14 - 25
21	7 - 15	30	11 - 20	39	14 - 24
22	7 - 16	31	11 - 21	40	15 - 26
23	8 - 16	32	11 - 22		

Table 2. Standard normalized number of consecutive data points

Number of data points in the graph	Standard normal number of consecutive data points
5 - 8	≤ 5
9 - 20	≤ 6
21 - 100	≤ 7

RESULT AND DISCUSSION

Based on the data recorded in PSI RSCM for the period January 2022 - June 2024, the total incidents in that period were 37,272 cases. The total incidents in period 1 were 16,990 cases and the total incidents in period 2 were 20,282 cases.

Based on table 3, in general, the average incidents in period 1 are higher than period 2 for all types of incidents (KPC, KNC, KTC, and KTD). This indicates a potential decrease in the overall number of incidents over time. The higher standard deviations in period 2 for KPC, KNC, and KTC indicate that the data in period 2 is more variable than in period 1. The range of counts for KPC, KNC, and KTC in period 2 is longer than in period 1.

Based on the median value of KPC in period 1, it is higher than in period 2. The median value of KNC in period 1 is lower than in period 2. The median value of KTC and KTD in period 1 is also higher than in period 2.

Table 3. Types of Patient Safety Incidents January 2022 - June 2024.

Exposure to patients	Incident Type		Period 1 (January 2022 - March 2023)					Period 2 (April 2023 - June 2024)				
			Mean	median	Standard deviation	min	max	Mean	median	Standard deviation	Min	Max
Before reaching the patient	A	KPC	54.6	50	20.8	30	96	42.4	38	30.11	14	137
	B	KNC	1032.4	969	158.8	836	1314	1275.7	1217	171.9	1034	1609
Has reached the patient	C	KTC	20.9	18	9.0	9	42	17.6	16	10.93	6	48
	D	KTD	24.7	24	10.3	12	49	16.5	17	4.78	9	23

Run charts were chosen to analyze the data by looking at trends and patterns over time and variations in the data to identify any common or special causes. To look at variations in the data, four tests were performed on all incident types in 2 different periods. i.e., Test 1 looks at the Number of Runs, Test 2 looks at Process Shift, Test 3 looks at the Trend, and Test 4 looks at the Zigzag pattern. If one of the test conditions is met, then there is systematic variation with a specific cause. However, if all the test conditions are not met, then the data is a random variation with a common cause.

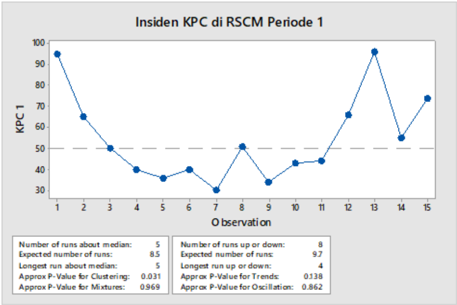

Figure 1. Incidence of KPC in RSCM Period 1

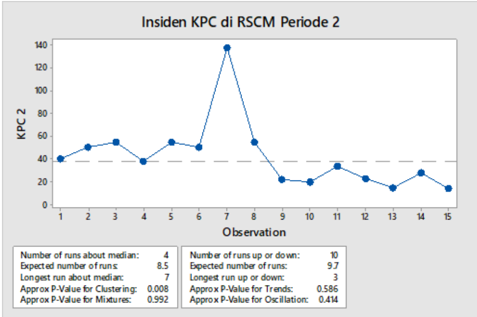

Figure 2. Incidence of KPC in RSCM Period 2

The pattern and variation of KPC in period 1, Test 1 shows that the observation points total 15 points, then the normal boundary conditions are the lower limit of 4 and the upper limit of 12. Based on the graph, the number of runs is 5, so in test 1 data, there is a random variation with common causes. Test 2, the number of points in 1 run is not more than 7, so it can be said to be a random variation with common causes. Test 3: There is no increasing or decreasing Trend, so it can be said that the data varies randomly, which has a common cause. Test 4, there is no zigzag pattern ≥ 14. Then, the pattern and Trend of KPC in period 1 can be said to have random variations with common causes.

Patterns and variations of KPC in period 2, Test 1, the number of runs is 4, so in Test 1 data, there is random variation with common causes. Test 2, the number of points in 1 run is not more than 7, so it can be said to be a random variation with common causes. Test 3: There is no increasing or decreasing Trend, so it can be said that the data varies randomly, which has a common cause. Test 4, there is no zigzag pattern ≥ 14. Then, the pattern and Trend of KPC in period 2 can be said to have random variation with common causes.

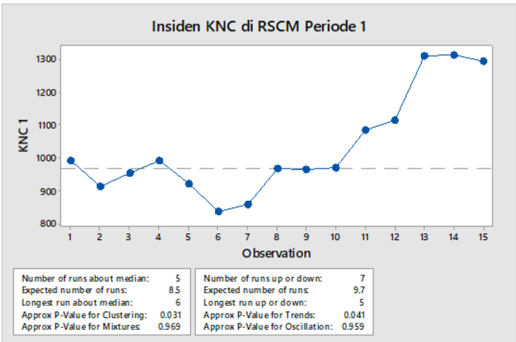

Figure 3. Incidence of KNC in RSCM Period 1

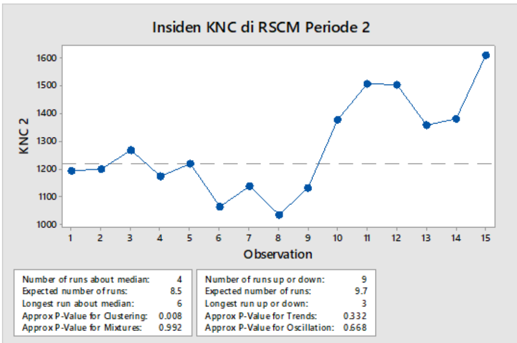

Figure 4. Incidence of KNC in RSCM Period 2

Patterns and variations of KNC in period 1, Test 1, based on the graph, the number of runs is 5, so in test 1 data, there is a random variation with common causes. Test 2, the number of points in 1 run is not more than 7, so it can be said to be a random variation with common causes. Test 3: There is no increasing or decreasing Trend, so it can be said that the data varies randomly, which has a common cause. Test 4, there is no zigzag pattern ≥ 14. Then, the pattern and Trend of KNC in period 1 can be said to have random variations with common causes.

Patterns and variations of KNC in period 2, Test 1, the number of runs is 5, so there is random variation with common causes. Test 2, the number of points in 1 run is not more than 7, then it can be said to be a random variation with a common cause. Test 3: There is no increasing or decreasing Trend, so it can be said that the data varies randomly, which has a common cause. Test 4, there is no zigzag pattern ≥ 14. Then, the pattern and Trend of KNC in period 2 can be said to have random variation with common causes.

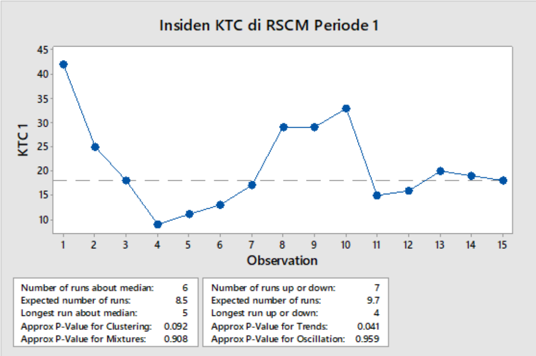

Figure 5. Incidence of KTC in RSCM Period 1

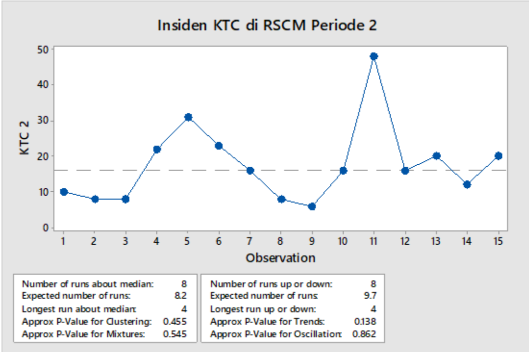

Figure 6. Incidence of KTC in RSCM Period 2

Patterns and variations of KTC in period 1, Test 1, based on the graph, the number of runs is 6, so in test 1, the data has a random variation with common causes. Test 2, the number of points in 1 run is not more than 7, so it can be said to be a random variation with common causes. Test 3: There is no increasing or decreasing Trend, so it can be said that the data varies randomly, which has a common cause. Test 4, there is no zigzag pattern ≥ 14. Then, the pattern and Trend of KTC in period 1 can be said to have random variation with common cause.

The pattern and variation of KTC in period 2, Test 1, the number of runs is 6, so there is a random variation with common causes. Test 2, the number of points in 1 run is not more than 7, then it can be said to be a random variation with a common cause. Test 3, there is no increasing or decreasing Trend, so it can be said that the data varies randomly, which is a common cause. Test 4, there is no zigzag pattern ≥ 14. Then, the pattern and Trend of KTC in period 2 can be said to have random variation with common cause.

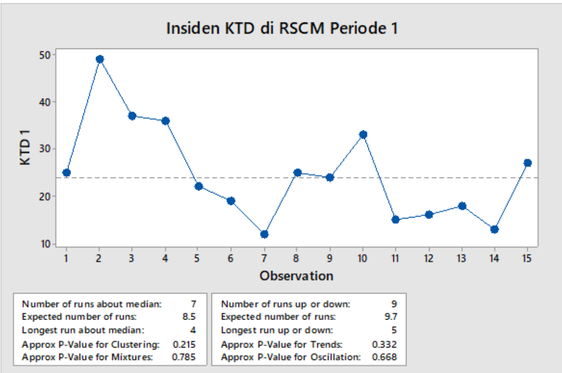

Figure 7. Incidence of KTD in RSCM Period 1

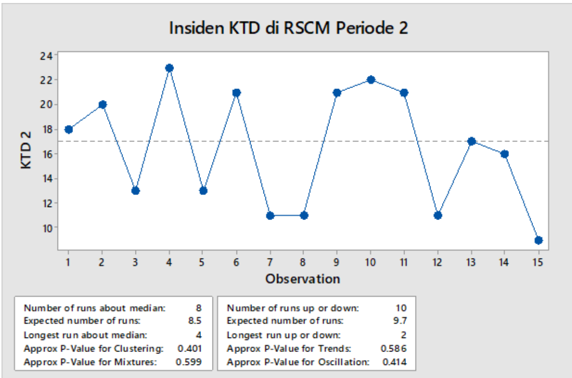

Figure 8. Incidence of KTD in RSCM Period 2

Pattern and variation of KTD in period 1, Test 1, based on the graph, the number of runs is 7, so in test 1, the data has a random variation with common causes. Test 2, the number of points in 1 run is not more than 7, so it can be said to be a random variation with common causes. Test 3: There is no increasing or decreasing Trend, so it can be said that the data varies randomly, which has a common cause. Test 4, there is no zigzag pattern ≥ 14. Then, the pattern and Trend of KTD in period 1 can be said to have random variation with common causes.

Pattern and variation of KTD in period 2, Test 1, the number of runs is 6, so there is random variation with common causes. Test 2, the number of points in 1 run is not more than 7, then it can be said to be a random variation with a common cause. Test 3, there is no increasing or decreasing Trend, so it can be said that the data varies randomly, which is a common cause. Test 4, there is no zigzag pattern ≥ 14. Then, the pattern and Trend of KTD in period 2 can be said to have random variation with common causes.

The four tests that have been conducted, namely the run test, shift test, trend test, and zigzag test, consistently show the same results for all event types and periods. This indicates that:

a. The number of runs obtained is within the expected range for randomly varying data.
b. The maximum run length does not exceed the specified limit, indicating the absence of a significant flocking pattern.
c. There was no clear increasing or decreasing Trend, either linearly or non-linearly.
d. There is no noticeable zigzag pattern, indicating no sudden change in direction.

PSI reporting is one of the systems created to reduce the risk of adverse events in health services (WHO, 2020). PSI is expected to be a learning system from every event that causes injury or is preventable. In addition to reporting, the patient safety learning system refers to the analysis of incidents and the potential benefits of using the system. Monitoring patterns and trends in PSI can be an indicator of patient safety improvement, learning, and preventing adverse events from happening again (Ontario, 2017).

Based on the total incidents from period 1 to period 2 indicate an increasing trend in the incidence of incidents in RSCM. An increase in the number of incidents does not necessarily mean a decrease in service quality. An increase in incident reporting can also contribute to an increase in the number of recorded incidents. A research in a government hospital in Malaysia found 9,431 reports, or an average of 786 reports per month, in 2019 (Khalid et al., 2022). In Indonesia, the number of PSI reports in 2019 was 7,465 reports, or 622 reports per month (Kustini, 2024). This shows the high number of PSI reported at RSCM. An increase in the volume of PSI reporting is positively correlated with safety culture; a high level of reporting is associated with a more positive safety culture, meaning that the higher volume of reporting indicates that staff are increasingly aware of the importance of reporting patient safety incidents (Hutchinson et al., 2019).

The large number of incident reports that have not reached the patient (KPC and KNC) may also indicate that staff are increasingly aware and proactive in reporting potential patient safety threats in the prevention area. This is a positive development, as it indicates an improved patient safety culture in the hospital (Feng et al., 2022) ; (Shin & Won, 2021).

Based on Table 3, in the KPC incident, there was a decrease in the median value in period 2 compared to period 1; RSCM followed the change in the definition of KPC at the beginning of 2023. This shows that the decrease does not fully reflect the actual decrease in incidence but can be caused by changes in the way of reporting, in this case, a change in the definition of KPC, so that there are some KPC incidents that are not included in the new criteria.

For incidents that have already reached the patient, namely KTC and KTD, these incidents are reported after the harm has reached the patient, either without injury or causing injury or death. Based on Table 3, there is a decrease in the median value in period 2. This decrease may indicate an improvement in patient safety aspects related to KTC and KTD, but it may also indicate that staff are not reporting. Monitoring incidents that have reached the patient (KTC and KTD) is important because of their impact on patients. It can also provide learning about the quality of care and opportunities for improvement (Isaksson et al., 2022). A reduction in adverse events can translate into staff efforts to reduce deaths, unintended complications, and also higher medical costs attributable to health care (Lin & Fang, 2021). However, previous studies have also shown that staff roles influence reporting, with staff being aware of incidents but not reporting them. Meanwhile, hospitals are encouraged to create an environment and culture that supports safety priorities (Dhamanti, 2015).

Based on the run chart analysis that has been carried out on the patterns and variations of KPC, KNC, KTC, and KTD in periods 1 and 2, it can be seen that there are no significant patterns found in all types of events (KPC, KNC, KTC, and KTD) in both period 1 and period 2. The variations that occur tend to be random and are caused by common factors inherent in the system or process being observed.

The process that generates KPC, KNC, KTC, and KTD data tends to be stable and under control. The variations that occur are a normal part of the process. There is no indication of any special or root factor that causes a significant increase or decrease in these events. This gives the impression that the prevention efforts made so far seem to be effective in maintaining process stability, but this needs to be explored further. From several studies, the increase and decrease in incident reporting are influenced by several factors; an increase in incident reporting can be due to motivation or encouragement from the hospital to report, or an increase in incidents, a decrease in the number of reports can be due to improvements or reluctant staff to report, a non-punitive system, maintaining confidentiality, timeliness of reporting, awareness and understanding of staff about the reporting system can affect the number of incident reports (Dhamanti, 2015) ; (Puthumana et al., 2021).

Run charts are easy to use to quickly identify patterns and trends, especially for continuous data. However, it is less effective for highly variable data. A previous research related to trend analysis of PSI in Korea from 2017 - 2019 with 16,215 cases to analyze using multi-nominal logistic regression, variables used such as patient age, incident reporter, hospital size, PSI location, PSI type, and medical department and also factors that may trigger sentinel events (Shin & Won, 2021). These two methods can complement each other. For example, run charts can be used to identify initial patterns in the data and regression analysis can be used to build a more formal model to confirm those patterns and make predictions.

CONCLUSION

The conclusion of this research based on data analysis of patient safety incidents (PSI) reported at the RSCM from January 2022 to June 2024 shows a significant increase in PSI reporting, which reflects an increase in awareness and safety culture among health workers. The redefinition of KPC in early 2023 affected the number of recorded incidents, requiring careful interpretation. No consistent pattern was observed in KPC, KNC, KTC, and KTD incidents in both periods, with variations likely influenced by many factors. The stability of PSI data, as shown in the run chart analysis, indicates that existing preventive measures have been effective. Future research should apply advanced statistical methods, such as logistic regression, to identify key risk factors and predict trends in incidence, thus contributing to the continuous improvement of patient safety. These findings highlight the importance of data-driven decision making in improving service quality, emphasizing the need for continuous monitoring and targeted interventions at the RSCM.

REFERENCES

Anhøj, J., & Olesen, A. V. (2014). Run charts revisited: a simulation research of run chart rules for detection of non-random variation in health care processes. *PLoS One*, *9*(11), e113825. https://doi.org/10.1371/journal.pone.0113825

Carmack, A., Valleru, J., Baka, D., Henderson, M., McCarter, S., Walsh, J., & Randall, K. (2024). Building a Learning Management Framework for Patient Safety: Lessons From a Large Multistate System. *Patient Safety*, *6*(1). https://doi.org/10.33940/001c.121145

Dhamanti, I. (2015). Comparison of Four Methods To Detect Adverse Events in Hospital. *Comparison of Four Methods To Detect Adverse Events in Hospital*, *38*(2), 139–146.

Dhamanti, I., Leggat, S., Barraclough, S., & Tjahjono, B. (2019). Patient safety incident reporting in Indonesia: an analysis using World Health Organization characteristics for successful reporting. *Risk Management and Healthcare Policy*, 331–338.

Feng, T., Zhang, X., Tan, L., Liu, D., Dai, L., & Liu, H. (2022). Near miss research in the healthcare system: a scoping review. *JONA: The Journal of Nursing Administration*, *52*(3), 160–166. DOI: 10.1097/NNA.0000000000001124

Hidayat, M., Miskadi, M. S., & Murtikusuma, R. P. (2022). *Keselamatan Pasien, Keselamatan dan Kesehatan Kerja*. Penerbit P4I.

Hutchinson, A., Young, T. A., Cooper, K. L., McIntosh, A., Karnon, J. D., Scobie, S., & Thomson, R. G. (2019). Trends in healthcare incident reporting and relationship to safety and quality data in acute hospitals: results from the National Reporting and Learning System. *BMJ Quality & Safety*, *18*(1), 5–10. doi: 10.1136/qshc.2008.031997

Isaksson, S., Schwarz, A., Rusner, M., Nordström, S., & Källman, U. (2022). Monitoring preventable adverse events and near misses: number and type identified differ

depending on method used. *Journal of Patient Safety*, *18*(4), 325–330. DOI: 10.1097/PTS.0000000000000921
Kang, S., Ho, T. T. T., & Lee, N.-J. (2021). Comparative studies on patient safety culture to strengthen health systems among Southeast Asian countries. *Frontiers in Public Health*, *8*, 600216.
Khalid, K. H., Yamamoto, E., Hamajima, N., & Kariya, T. (2022). Rates and factors associated with serious outcomes of patient safety incidents in Malaysia: an observational research. *Global Journal on Quality and Safety in Healthcare*, *5*(2), 31–38. https://doi.org/10.36401/JQSH-21-19
Kustini, T. Y. (2024). Pengaruh Pengetahuan Perawat tentang Budaya Keselamatan Pasien terhadap Pelaporan Insiden Keselamatan Pasien. *Journal of Management Nursing*, *3*(3), 360–368. https://doi.org/10.53801/jmn.v3i3.186
Lin, Y.-K., & Fang, X. (2021). First, do no harm: Predictive analytics to reduce in-hospital adverse events. *Journal of Management Information Systems*, *38*(4), 1122–1149. https://doi.org/10.1080/07421222.2021.1990619
Ontario, H. Q. (2017). Patient safety learning systems: a systematic review and qualitative synthesis. *Ontario Health Technology Assessment Series*, *17*(3), 1.
Perla, R. J., Provost, L. P., & Murray, S. K. (2011). The run chart: a simple analytical tool for learning from variation in healthcare processes. *BMJ Quality & Safety*, *20*(1), 46–51. https://doi.org/10.1136/bmjqs.2009.037895
Puthumana, J. S., Fong, A., Blumenthal, J., & Ratwani, R. M. (2021). Making patient safety event data actionable: understanding patient safety analyst needs. *Journal of Patient Safety*, *17*(6), e509–e514. DOI: 10.1097/PTS.0000000000000400
Sakit, K. K. P. R. (2015). Pedoman Pelaporan Insiden Keselamatan Pasien (IKP)(Patient Safety Incident Report). *Komite Keselamatan Pasien Rumah Sakit*, *25*.
Shin, S., & Won, M. (2021). Trend analysis of patient safety incidents and their associated factors in korea using national patient safety report data (2017~ 2019). *International Journal of Environmental Research and Public Health*, *18*(16), 8482. https://doi.org/10.3390/ijerph18168482