



## ANALYSIS OF QUALITY CONTROL FOR POTASSIUM TESTING AT KASIH IBU HOSPITAL LABORATORY IN SURAKARTA

### ANALISIS PENGENDALIAN KUALITAS UJI KALIUM DI LABORATORIUM RUMAH SAKIT KASIH IBU SURAKARTA

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#### Abstract

Laboratory testing plays a crucial role in supporting patient diagnosis and monitoring; therefore, accurate and precise results are essential through the implementation of quality control (QC). Potassium level testing is one of the key parameters requiring robust quality control because it is closely linked to patients' clinical conditions. This study aims to analyze the implementation of QC in potassium level testing using the EasyLyte device at the Kasih Ibu Hospital Laboratory in Surakarta. The research method used was quantitative descriptive with an observational approach using secondary data from QC results for the period from September to November 2025. Analysis was performed by calculating the mean, standard deviation (SD), coefficient of variation (CV), and evaluating the Westgard rules. The results showed that the CV values for normal and abnormal controls were within acceptable limits ( $\leq 5\%$ ), and no violations of any Westgard rules were found. This indicates that the test results have good precision and there are no deviations, either random or systematic. Overall, the analytical system is in control and the instrument performance is stable. Thus, potassium testing using the EasyLyte instrument meets quality requirements and is suitable for use in laboratory services, while still requiring QC monitoring as well as routine maintenance and calibration.

**Keywords :** Quality Control, Potassium, Westgard, Precision.

#### Abstrak

Pengujian laboratorium memainkan peran penting dalam mendukung diagnosis dan pemantauan pasien; oleh karena itu, hasil yang akurat dan tepat sangat penting melalui implementasi kontrol kualitas (QC). Pengujian kadar kalium merupakan salah satu parameter kunci yang membutuhkan kontrol kualitas yang kuat karena terkait erat dengan kondisi klinis pasien. Studi ini bertujuan untuk menganalisis implementasi QC dalam pengujian kadar kalium menggunakan alat EasyLyte di Laboratorium Rumah Sakit Kasih Ibu di Surakarta. Metode penelitian yang digunakan adalah deskriptif kuantitatif dengan pendekatan observasional menggunakan data sekunder dari hasil QC untuk periode September hingga November 2025. Analisis dilakukan dengan menghitung rata-rata, standar deviasi (SD), koefisien variasi (CV), dan mengevaluasi aturan Westgard. Hasil menunjukkan bahwa nilai CV untuk kontrol normal dan abnormal berada dalam batas yang dapat diterima ( $\leq 5\%$ ), dan tidak ditemukan pelanggaran aturan Westgard. Hal ini menunjukkan bahwa hasil pengujian memiliki presisi yang baik dan tidak ada penyimpangan, baik acak maupun sistematis. Secara keseluruhan, sistem analitik terkendali dan kinerja instrumen stabil. Dengan demikian, pengujian kalium menggunakan instrumen EasyLyte memenuhi



persyaratan kualitas dan cocok untuk digunakan dalam layanan laboratorium, namun tetap memerlukan pemantauan QC serta perawatan dan kalibrasi rutin.

**Kata Kunci :** *Quality Control*, Kalium, Westgard, Presisi.

## 1. INTRODUCTION

Laboratories are healthcare units that play a crucial role in aiding the diagnosis of diseases, monitoring treatment outcomes, and evaluating patient conditions through the analysis of human biological samples (Anggarsari *et al.*, 2022). Globally, approximately 60–70% of clinical decisions are based on laboratory test results; therefore, the quality of these results is critical to patient safety and the appropriateness of the therapy provided (World Health Organization, 2011). Consequently, laboratory test results must exhibit high precision and accuracy to provide the objective information that healthcare professionals rely on to make appropriate clinical decisions (Kurniawan, 2023).

Errors in laboratory testing still occur frequently and can occur during the pre-analytical, analytical, or post-analytical stages. Several studies indicate that the laboratory testing process is not yet entirely free of errors due to the involvement of human factors and operational systems at every stage of testing (Dugad *et al.*, 2022). The highest incidence of errors occurs during the pre-analytical stage, accounting for 60–70% of total laboratory errors; however, errors in the analytical and post-analytical stages still impact test results (Sinha *et al.*, 2024).

Improving the quality of laboratory services requires the implementation of a standardized quality management system to ensure that the test results produced are reliable and consistent (Saparingga, 2020). One of the efforts made to maintain the quality of laboratory testing is through Internal Quality Control (IQC) activities conducted periodically using control materials (Jannah *et al.*, 2024). IQC aims to improve the accuracy and reliability of laboratory test results so as to minimize errors in the testing process (Pratama *et al.*, 2025). One important component of IQA is Quality Control (QC), which is used to evaluate test results statistically (Jemani, & Kurniawan, 2019).

QC evaluations are typically conducted using Levey–Jennings charts and Westgard rules to detect deviations in control results caused by both random and systematic errors (Jannah *et al.*, 2024). The application of Westgard rules in QC activities aims to detect control values outside the control limits early on so that analytical errors can be identified immediately (Miftahul Jannahti Putri, 2025).

One of the parameters frequently tested in clinical laboratories is potassium. Potassium is a positively charged ion that plays a crucial role in maintaining the body's fluid and electrolyte balance and supports nerve function and muscle activity, including that of the heart muscle (Usfa *et al.*, 2023). Elevated potassium levels in the blood, or hyperkalemia, can cause serious disturbances in the cardiovascular system, ranging from arrhythmias to cardiac arrest (Agiro *et al.*, 2025). Conversely, decreased potassium levels, or hypokalemia, can lead to muscle weakness, heart rhythm disturbances, and changes in the electrocardiogram (Luo *et al.*, 2024).

Therefore, research is needed to analyze the implementation of Quality Control in potassium testing at the Kasih Ibu Hospital Laboratory in Surakarta using the EasyLyte instrument with the application of Westgard rules. Previous studies have generally focused on evaluating QC results descriptively or on different analytes and instruments, with limited emphasis on the longitudinal stability of potassium testing using routine laboratory data. In addition, many studies report QC performance only in terms of compliance with acceptable limits, without providing a more detailed interpretation of analytical stability over time.

This study aims to address this gap by analyzing QC data over a three-month period using Westgard multirule criteria ( $1_{2S}$ ,  $1_{3S}$ ,  $2_{2S}$ ,  $R_{4S}$ ,  $4_{1S}$ , and  $10_x$ ) to assess both precision and stability of the analytical system. The novelty of this study lies in its focus on periodic evaluation of potassium QC data in a real-world laboratory setting, combined with a comprehensive interpretation of control chart patterns to identify potential analytical variations. This approach is expected to provide a clearer



understanding of instrument performance stability and contribute to strengthening laboratory quality assurance practices.

## 2. RESEARCH METHOD

This study employed a quantitative descriptive design with an observational approach to analyze the results of quality control (QC) testing for potassium at the Kasih Ibu Hospital Laboratory in Surakarta. The study was conducted from September to November 2025 using secondary data obtained from routine internal quality control (IQC) records documented in the laboratory logbook.

The dataset consisted of 91 QC data points for each control level (normal and pathological), collected once daily using the EasyLyte Electrolyte Analyzer, which operates based on the ion-selective electrode (ISE) method. Commercial control sera with two concentration levels (normal and pathological) were used according to standard laboratory procedures.

Data analysis was performed descriptively by calculating the mean, standard deviation (SD), and coefficient of variation (CV). Furthermore, evaluation was conducted using Levey–Jennings control charts and Westgard multirules ( $1_{2s}$ ,  $1_{3s}$ ,  $2_{2s}$ ,  $R_{4s}$ ,  $4_{1s}$ , and  $10_x$ ) to detect both random and systematic errors and to assess analytical performance. Data processing and analysis were carried out using Microsoft Excel. This study was approved by the Ethics Committee of Muhammadiyah University Purwokerto, approval number KEPK/UMP/174/III/2026.

## 3. RESULT AND DISCUSSION

This study evaluated the precision and analytical performance of potassium testing using the EasyLyte Electrolyte Analyzer through Internal Quality Control (IQC) data obtained from September to November 2025 at the Kasih Ibu Hospital Laboratory in Surakarta. The analysis included mean, standard deviation (SD), coefficient of variation (CV), as well as evaluation using Levey–Jennings charts and Westgard multirules.

**Table 1. Potassium control test results**

Month	Control	Mean	SD	CV	Maks CV
September	Normal	3,83	0,11	2,9	≤ 5%
	Abnormal	5,63	0,07	1,2	≤ 5%
October	Normal	3,71	0,07	1,9	≤ 5%
	Abnormal	5,54	0,05	0,9	≤ 5%
November	Normal	3,70	0,08	2	≤ 5%
	Abnormal	5,51	0,09	1,6	≤ 5%

Based on Table 1, in September 2025, the mean value for the normal control group was 3.83 mmol/L with an SD of 0.11 and CV of 2.9%, while the abnormal control group showed a mean of 5.63 mmol/L, SD 0.07, and CV 1.2%. In October, the normal control mean was 3.71 mmol/L, SD 0.07, CV 1.9%, and the abnormal control mean was 5.54 mmol/L, SD 0.05, CV 0.9%. In November, the normal control mean was 3.70 mmol/L, SD 0.08, CV 2%, while the abnormal control mean was 5.51 mmol/L, SD 0.09, CV 1.6%. The results of the potassium test controls indicate that the precision of the test is classified as good because it does not exceed the 5% limit.

The stability of the CV values across September, October, and November suggests that there were no significant fluctuations in analytical performance. This condition may be influenced by several factors, including consistent calibration procedures, proper instrument maintenance, and adherence to standard operating procedures (SOP) by laboratory personnel. In addition, stable environmental conditions such as temperature and humidity may also contribute to maintaining analytical consistency.

These findings are consistent with previous studies reporting that a Coefficient of Variation (CV) for potassium testing below 5% falls within the category of good precision. Those studies indicated that the potassium CV ranged from 2.19% to 2.21%, thereby meeting precision criteria as it remained below the established threshold (Shinta *et al.*, 2025).

**Table 2. Results of quality control analysis of potassium examination**

Month	Control	Westgard					
		1 <sub>2s</sub>	1 <sub>3s</sub>	2 <sub>2s</sub>	R <sub>4s</sub>	4 <sub>1s</sub>	10 <sub>x</sub>
September	Normal	-	-	-	-	-	-
	Abnormal	-	-	-	-	-	-
October	Normal	-	-	-	-	-	-
	Abnormal	-	-	-	-	-	-
November	Normal	-	-	-	-	-	-
	Abnormal	-	-	-	-	-	-

Based on the results of data analysis using Microsoft Excel on quality control data for potassium level testing with the EasyLyte instrument during the period from September to November, it was found that all control data, both at normal and abnormal levels, did not violate the Westgard rule criteria (1<sub>2s</sub>, 1<sub>3s</sub>, 2<sub>2s</sub>, R<sub>4s</sub>, 4<sub>1s</sub>, and 10<sub>x</sub>). This is evidenced by the absence of values exceeding the established control limits ( $\pm 2$  SD or  $\pm 3$  SD), as well as the absence of deviation patterns indicating violations of the Westgard multirule criteria. These findings indicate that no significant random or systematic errors occurred during the analytical process. Specifically, the absence of 1<sub>3s</sub> and R<sub>4s</sub> violations suggests that there were no large random errors, while the absence of 2<sub>2s</sub>, 4<sub>1s</sub>, and 10<sub>x</sub> violations indicates that no systematic shifts or trends were detected. Therefore, the analytical process can be considered to be under statistical control, and the performance of the instrument remained stable throughout the study period.

These findings align with previous studies indicating that the absence of violations of the Westgard rules signifies that the testing process is under control and meets laboratory quality criteria. The results of this study indicate that all control data did not exceed the  $\pm 2$  SD limits, thus the accuracy and precision of the testing were deemed good. Furthermore, the absence of violations of the Westgard rules in the electrolyte testing indicates that the method has good precision and the test results are reliable (Natasari, 2023).

The absence of Westgard rule violations in this study can be scientifically explained by several factors, namely the stability of instrument performance, the consistency of the calibration process, and the routine implementation of quality control. The Westgard rules are designed to detect random errors and systematic errors; therefore, if no violations are found, it can be interpreted that neither type of error occurred significantly during the examination period (Momeni-Boroujeni & Pincus, 2018). Additionally, the absence of violations of rules such as 2<sub>2s</sub>, R<sub>4s</sub>, or 10<sub>x</sub> indicates that there are no trends or shifts in the control results, meaning the analytical system is in a stable condition (Gruber et al., 2024).

However, although the results indicate optimal performance, it is important to note that the absence of Westgard rule violations does not completely eliminate the possibility of errors. Minor undetected variations may still occur, particularly if the number of control measurements is limited or if there are external influencing factors. Factors that can influence QC results include operator error, sample volume inaccuracies, uncalibrated equipment, and environmental factors such as temperature and humidity. Therefore, routine quality control, equipment maintenance, and periodic calibration remain necessary to ensure the consistency and accuracy of test results.

#### 4. CONCLUSION

Based on the findings, quality control (QC) testing of potassium levels using the EasyLyte instrument at the Kasih Ibu Hospital Laboratory in Surakarta from September to November 2025 demonstrated that precision values were within acceptable limits ( $CV \leq 5\%$ ), and no violations of the Westgard rules were observed, indicating that the analytical system was under control and the instrument performance was stable. However, this study was limited by the use of secondary data from a single laboratory and a relatively short observation period, which may restrict the generalizability of the findings. Despite these limitations, this study provides practical evidence of the stability of potassium testing through routine QC evaluation using Westgard multirules and contributes to



strengthening laboratory quality assurance practices, while emphasizing the need for further studies with more comprehensive analytical approaches.

## 5. REFERENCES

- Agiro, A., Mu, F., Cook, E., Greatsinger, A., Chen, J., Zhao, A., Louden, E., Colman, E., Desai, P., & Chertow, G. M. (2025). Hyperkalemia and the Risks of Adverse Cardiovascular Outcomes in Patients With Chronic Kidney Disease. *Journal of the American Heart Association*, *14*(1), 1–11. <https://doi.org/10.1161/JAHA.124.035256>
- Anggarsari, D. N., Ni'mah, A. L., & Malichatin, H. (2022). Peningkatan Mutu Laboratorium dalam Aspek Keselamatan dan Kesehatan Kerja pada Laboratorium. *Jurnal Laboratorium Khatulistiwa*, *6*(1), 1. <https://doi.org/10.30602/jlk.v6i1.981>
- Dugad, D. V., Deshmukh, D. S., Bhosale, D. A., Chaudhari, D. P. S., Bhanap, D. P., Sawant, D. R., Bindu, D. R., & Awake, D. P. (2022). Pre-Analytical And Post-Analytical Errors In The Clinical Laboratory : A Systematic Review. *Journal of Pharmaceutical Negative Results*, *13*(9), 8540–8550. <https://doi.org/10.47750/pnr.2022.13.S09.1004>
- Gruber, L., Hausch, A., & Mueller, T. (2024). Internal Quality Controls in the Medical Laboratory : A Narrative Review of the Basic Principles of an Appropriate Quality Control Plan. *Diagnostics*, *14*.
- Jannah, H. M., Widyantara, A. B., & Rahmawati, Y. (2024). Analisis Hasil Quality Control Pemeriksaan Profil Lipid di Laboratorium Rumah Sakit Umum Daerah Wonosari. *Jurnal Kesehatan Cendikia Jenius*, *1*(3).
- Jemani, & Kurniawan, M. R. (2019). Analisa Quality Control Hematologi Di Laboratorium Rumah Sakit An-Nisa Tangerang. *Binawan Student Journal*, *1*(2), 80–85.
- Kurniawan, R. F. (2023). Pengurangan Frekuensi Sockout Reagen Di Laboratorium Patologi Klinik Rumah Sakit Universitas Indonesia Melalui Penerapan QCC (Quality Control Circle). *Journal Syntax Idea*, *6*(1), 245–261.
- Luo, Y., Hao, J., Su, Z., Huang, Y., Ye, F., Qiu, Y., Liu, Z., Chen, Y., Sun, R., & Qiu, Y. (2024). Prevalence and Related Factors of Hypokalemia in Patients with Acute Ischemic Stroke. *International Journal of General Medicine*, *17*, 5697–5705. <https://doi.org/10.2147/ijgm.s492025>
- Miftahul Jannahti Putri, W. U. R. (2025). Evaluasi Hasil Control (QC) Pemeriksaan Hemoglobin Dan Trombosit Berdasarkan Westgard Rules Dan Six Sigma Di Rumah Sakit AMC Muhammadiyah. *Mamuju: Malahayati Nursing Journal*, *7*(9), 3849–3859.
- Momeni-Boroujeni, A., & Pincus, M. R. (2018). Systematic Error Detection in Laboratory Medicine. In G. S. Zaman (Ed.), *Quality Control in Laboratory*. IntechOpen. <https://doi.org/10.5772/intechopen.72311>
- Natasari, D. (2023). Analisis Hasil Quality Control (Qc) Pemeriksaan Natrium Dan Kalium Di Rs Pku Muhammadiyah Kota Yogyakarta. *Universitas' Aisyiyah Yogyakarta*.
- Pratama, F. P., Hartati, D., & Bastian. (2025). Analisis Hasil Quality Control Pemeriksaan Elektrolit Berdasarkan Aturan Westgrad Dilaboratorium Rumah Sakit. *Journal of Medical Laboratory and Science*, *5*(1). <https://doi.org/10.36086/medlabscience.v5i1>
- Saparingga, H. (2020). Ketelitian dan Evaluasi Grafik Kontrol Levey-Jennings Pemeriksaan Kadar Asam Urat Menggunakan Pooled Sera. *UNISA Yogyakarta*, 1–17.
- Shinta, S. D., Amalia, A. A., & Hadi, W. S. (2025). Analisis Hasil Quality Control Pemeriksaan Elektrolit Tubuh Menggunakan Grafik Levey-Jennings. *Jurnal Insan Cendekia*, *12*(2), 135–160.
- Sinha, S., Kumar, S., & Haque, M. (2024). Preanalytical Errors in Clinical Laboratory Testing at a Glance : Source and Control Measures. *16*(3). <https://doi.org/10.7759/cureus.57243>
- Usfa, M. Da, Hasni, D., Birman, Y., & Febrianto, B. Y. (2023). Hubungan Asupan Kalium dengan Hipertensi pada Perempuan Etnis Minangkabau. *Jurnal Gizi*, *12*(2), 52. <https://doi.org/10.26714/jg.12.2.2023.52-63>
- World Health Organization. (2011). *Laboratory Quality Management System Handbook*.