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Verification of the insulin dosage method using Abbott Alinity ci®: experience of the biochemistry laboratory, CHU Mohammed IV Oujda, Morocco

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Abstract

Introduction: The aim of our study was to evaluate the analytical performance of the insulin dosage method, which was performed by the Alinity ci® automated system in the biochemistry laboratory of the Mohammed VI University Hospital in Oujda.

Insulin acts as an essential role in regulating the body's energy supply, mainly by balancing blood sugar levels via the storage of glucose in the liver, muscles and adipose tissue.

Materials and methods: We carried out a study of the performance of the Alinity ci® automated system, assessing repeatability and reproducibility in accordance with the COFRAC GTA 04 accreditation technical guide, which meets the quality requirements of standard ISO 15 189.

Results: The results of our study show satisfactory repeatability for the three levels (Low; Medium; High) with CV1 = 2.44 %, CV2 = 1.76 %, CV3 = 1.33 %. The reproducibility of insulin was also satisfactory, with respect to the coefficient of variation (CV) for the three levels (Low, Medium, High), respectively CV1 = 3.16 %, CV2 = 5.78 %, CV3 = 2.88 %.

Conclusion: The reliability of our laboratory's insulin assay results is demonstrated by the satisfactory results obtained in our study, which comply with RICOS and FSCB recommendations.

Keywords: Insulin; Verification; Repeatability; Reproducibility; Alinity ci®

1. Introduction

Verification of analytical methods is one of the quality requirements of ISO 15 189. It consists of evaluating the performance of an analytical method using an operating protocol, then comparing it with standard reference values (RICOS, FSCB) [1]. This guarantees the reliability of laboratory results and their usefulness to the patient and the prescribing doctor. The aim of our study is to evaluate the analytical performance of insulin dosing using the Abbott Alinity ci® automated system in the biochemistry laboratory of the Mohammed VI University Hospital in Oujda.

1.1. Insulin and dosing interests

Insulin is a protein naturally produced by the pancreas in the islets of Langerhans. It comes from the precursor, preproinsulin, which is made up of four domains: signal peptide, B chain, C peptide and A chain. Mature insulin

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(composed of A and B chains) and C peptide are equimolar and ready to be released into secretory vesicles after undergoing several cleavage stages [2].

After a meal rich in carbohydrates, insulin acts as a hypoglycemic agent via the bloodstream which enables it to reach all the other organs. When insulin is present in the liver, it helps transport glucose from the blood to the hepatocytes, where it is then converted into glycogen, fatty acids and triglycerides. Insulin also promotes the assimilation of glucose and amino acids in skeletal muscle. With insulin, fatty acids are absorbed by adipose tissue, then converted into triglycerides and used as long-term energy reserves (figure 1) [3].

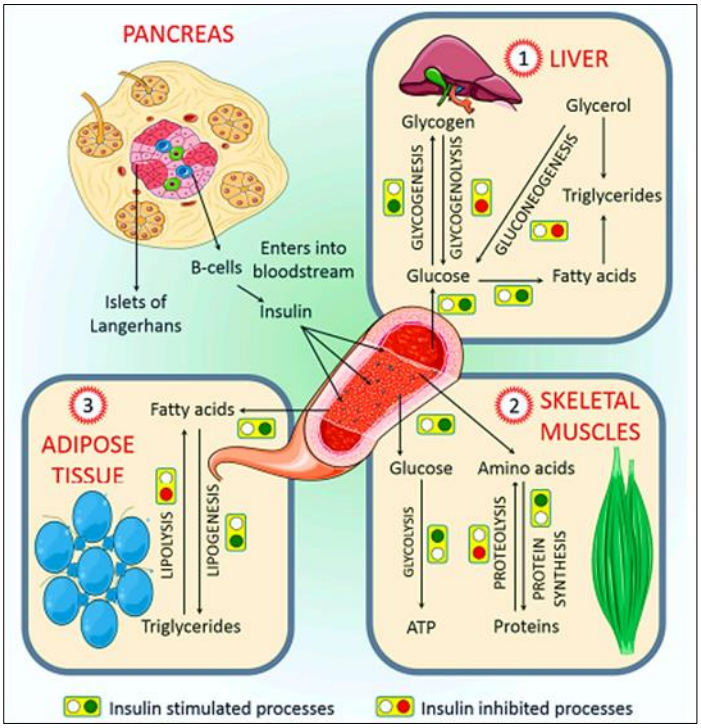

Figure 1 Major physiological roles of insulin in the liver, adipose tissue, and skeletal muscles [3]

This explains their dosage to determine the capacity of the pancreas to secrete it, which can be a sign of an insulinoma [4].

2. Material and methods

2.1. Biological principle of the assay method

After exposing the sample, paramagnetic microparticles coated with anti-insulin antibody and acridinium-labelled anti-insulin antibody conjugate to form a reaction mixture, and then incubated. Insulin present in the sample binds to insulin antibody-coated microparticles and acridinium-labelled insulin antibody conjugate. The resulting chemiluminescent reaction is then measured in relative units of light (URL) [5].

2.2. Verification process

Our study was carried out in the biochemistry laboratory of the Mohammed VI University Hospital in Oujda over a period of 39 days. Insulin was tested for analytical performance on the Abbott Alinity ci automated system, following the reproducibility and repeatability protocol described in the COFRAC GTA 04 accreditation technical guide.

In our study, we chose the insulin-specific control as the sample because of the rapid degradation of insulin. Three sample levels (Low, Medium and High) were used, each tested 30 times to assess repeatability. Then, over a period of 39 days, we assessed reproducibility by running the control daily at the three levels: low, medium and high.

The standard deviation (SD), mean and coefficient of variation (CV) are processed by BYG Informatics EVM statistical software during the evaluation process, and then compared with the standard values of the learned societies (FSCB and RICOS).

3. Results

3.1. Repeatability

Repeatability is defined as the analysis of an identical sample under identical conditions, such as the same operator, the same batch of reagents, the same instrument and the same calibration in the shortest possible time [6].

The repeatability results shown in Table 1 show satisfactory repeatability for all three levels (Low; Medium; High), as follows: CV1 = 2.44 %, CV2 = 1.76 %, CV3 = 1.33 %.

The coefficients of variation for each level remain lower than the reference values (SFBC and RICOS).

Table 1 Insulin repeatability results on the Abbott Alinity i® in comparison with reference values (SFBC and RICOS S)

Levels	N	Mean	Standard deviation (SD)	CV%	CV% (SFBC)	CV% (RICOS)
Low	30	8.19 µUI/ml	0.200 µUI/ml	2.44 %	7.50 %	7.91 %
Medium	30	38.59 µUI/ml	0.680 µUI/ml	1.76 %	6.00 %	7.91 %
High	30	122.47 µUI/ml	1.632 µUI/ml	1.33 %	6.00 %	7.91 %

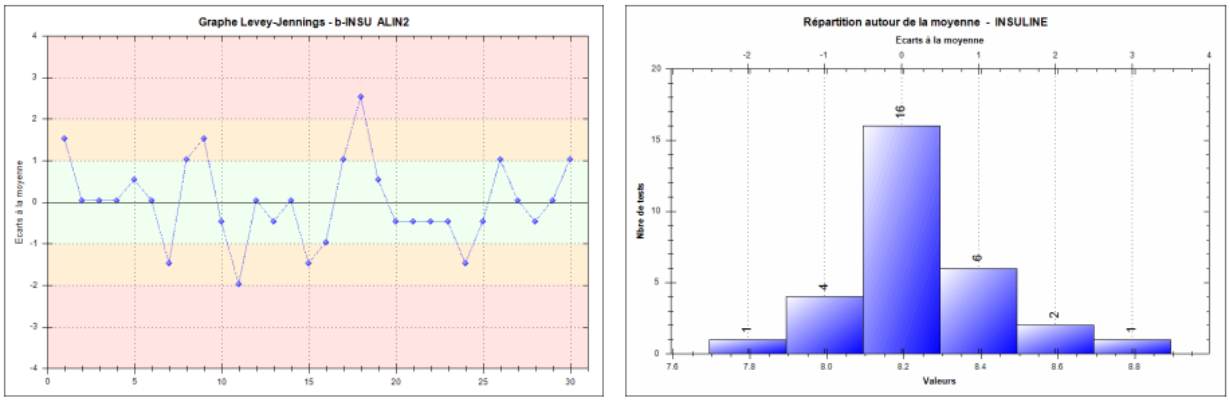

Figure 2 Low level of repeatability of insulin: Levey Jennings graph and distribution around the mean

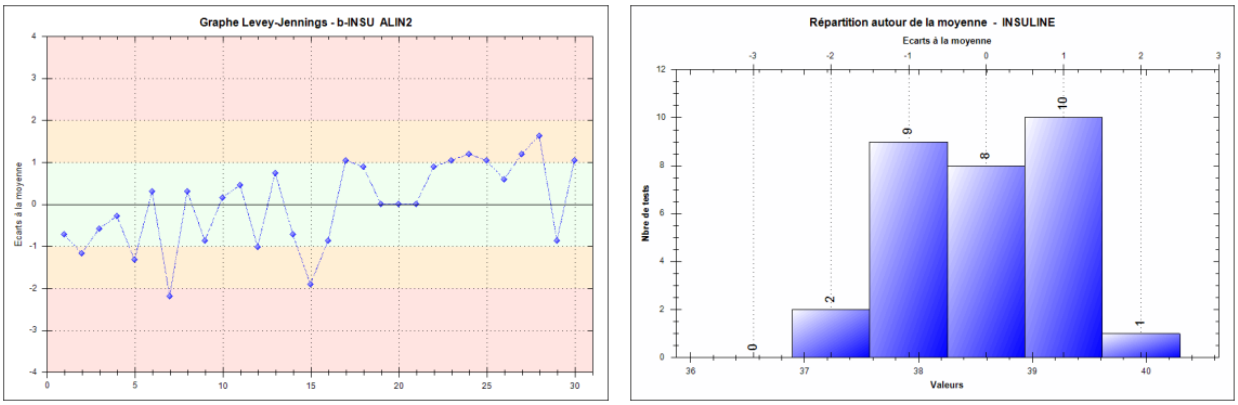

Figure 3 Medium Level of Repeatability of insulin: Levey Jennings graph and the distribution around the mean

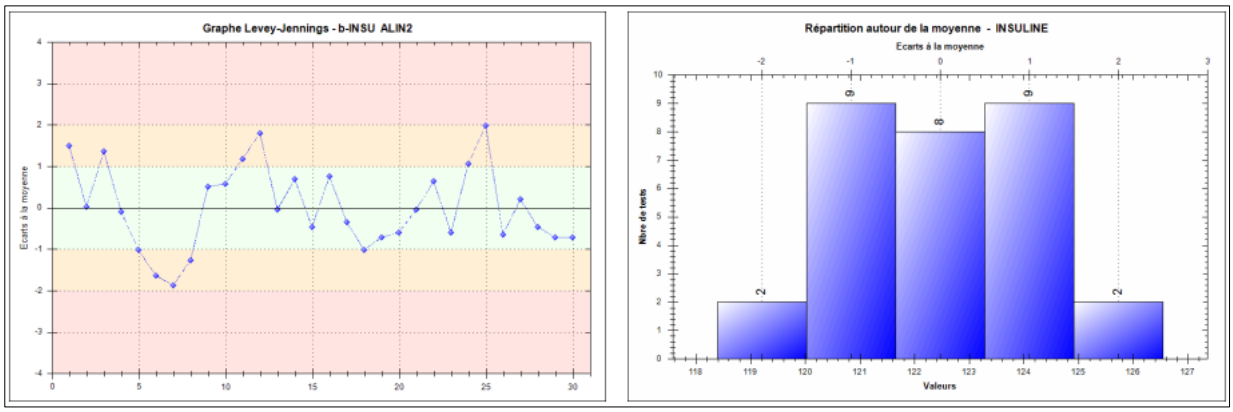

Figure 4 High Level of repeatability of insulin: Levey Jennings graph and the distribution around the mean

3.2. Reproducibility

Reproducibility is also known as the intermediate precision of a method, and is measured to assess the impact of changing factors (operator, time, reagent lots or calibrations) on the results of the assay method [6].

Table 2 shows the results of satisfactory insulin reproducibility, in relation to the coefficient of variation (CV) in the three levels (Low, Medium, High), respectively CV1 = 3.16%, CV2 = 5.78%, CV3 = 2.88%.

Compared with the reference values set by SFBC and RICOS, the coefficients of variation for each level remain lower.

Table 2 Insulin reproducibility results on the Abbott Alinity i® in comparison with reference values (SFBC and RICOS S)

Levels	N	Mean	Standard deviation (SD)	CV%	CV% (SFBC)	CV% (RICOS)
Low	30	12.69 µUI/ml	0.402 µUI/ml	3.16 %	10.00 %	10.55 %
Medium	30	55.57 µUI/ml	3.214 µUI/ml	5.78 %	8.00 %	10.55 %
High	30	110.16 µUI/ml	3.170 µUI/ml	2.88 %	8.00 %	10.55 %

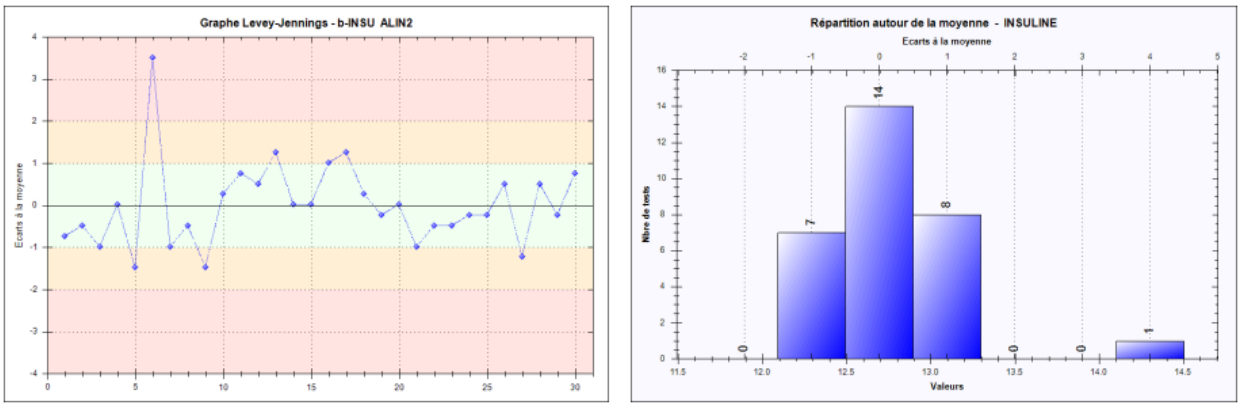

Figure 5 Low level of reproducibility of insulin: Levey Jennings graph and distribution around the mean

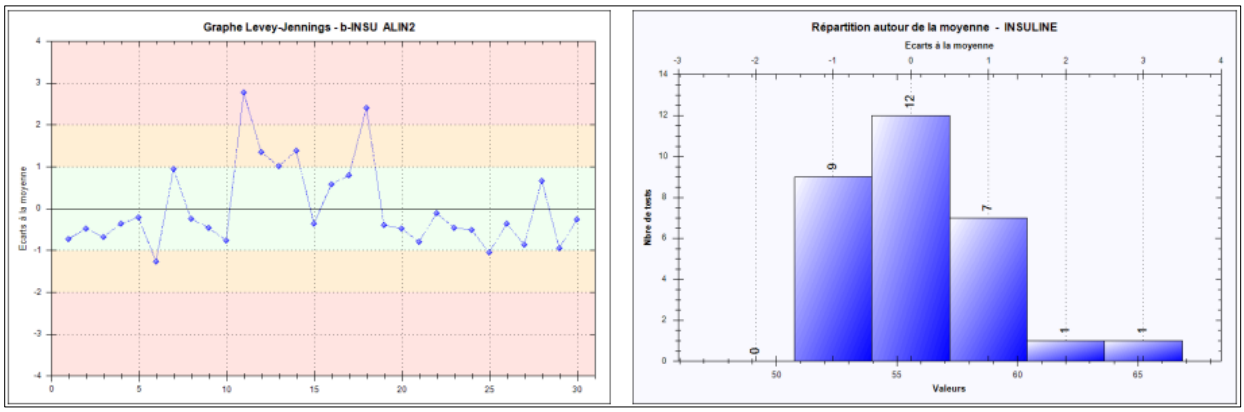

Figure 6 Medium level of reproducibility of insulin: Levey Jennings graph and distribution around the mean

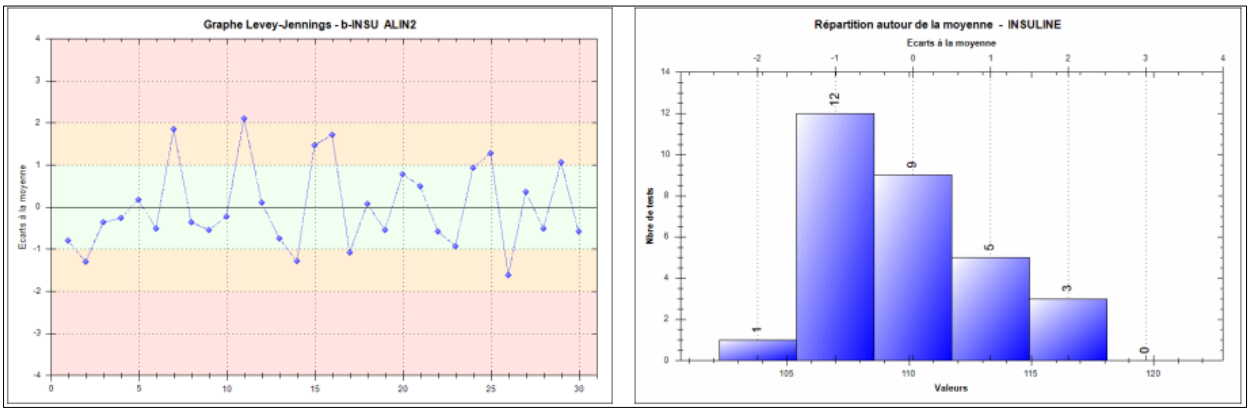

Figure 7 High level of reproducibility of insulin: Levey Jennings graph and distribution around the mean

The levey-jennings graph of reproducibility and repeatability highlights the precision of the analytical performance of the insulin parameter by showing the dispersion of the set of independent measurements around its central values (figure 2-7).

4. Discussion

Insulin therapy for diabetics requires precise, regular insulin dosing, both to maintain the safety and efficacy of treatment and to reduce the risk of hypoglycemia in children and the elderly people [7].

Insulin resistance generally manifests itself in subjects with type 2 diabetes as hyperinsulinemia, as muscle cells and adipocytes remain unable to respond to blood insulin levels, leading to poor carbohydrate absorption [8].

In rare cases, hyperinsulinemia may be due to insulinoma, a tumor of the pancreatic cells, or to uncontrolled proliferation of these cells (nesidioblastosis) [3].

According to the literature, there are three categories of insulin analysis methods: immunological tests, chromatographic tests and electrochemical biosensor [9].

Immunoanalysis is a system based on antigen-antibody reactions, with extremely high levels of sensitivity and specificity. As a result, it has been widely used to assess drug concentration, monitor drug therapy, and assay disease-specific hormones and proteins [10].

Chemiluminescence immunoassay (CLIA) is a hormone-specific assay based on immunochemical reactions [11].

The verification process involves a comprehensive assessment of the performance characteristics of qualitative and quantitative methods, namely the specificity, sensitivity, efficacy, linearity, repeatability, reproducibility and accuracy [12]. In contrast, our study focuses on just two parameters of the verification process, repeatability and reproducibility.

The aim of repeatability is to determine the optimum performance and correct operation of the system, including the use of instruments and reagents. Reproducibility assesses the reliability of a method's results under varying conditions [13].

Our study demonstrates the reliability of insulin assay results, with satisfactory coefficients of variation values that meet both the quality requirements issued by the supplier and the SFBC specifications (Tables 1 and 2). All the coefficients of variation in terms of repeatability and reproducibility were lower than the reference values (SFBC and RICOS), which is not consistent with the results obtained by Ivana Lapic and al in 2022 [14]. This revealed that Alinity i's immunological analysis of insulin did not meet the precision criteria issued by the manufacturer.

To avoid this discrepancy between laboratories, ISO 15189 requires each laboratory to verify its methods before implementing them. To ensure that the results produced are reliable and encourage prescribing doctors to make the right decision [15].

Based on the results obtained in our study, the analytical method for the determination of insulin by Alinity i was judged to be accurate.

The central laboratory of the CHU Mohammed VI of Oujda has implemented a quality strategy that includes a method verification procedure and an accreditation process as part of its commitment to quality. The implementation of this type of study is of vital importance in establishing a solid accreditation process for the analyses carried out in our laboratory, thus ensuring the reliability and accuracy of the results obtained [16], [17].

5. Conclusion

Insulin dosing is essential both for assessing the secretory status of the pancreas and for monitoring insulin therapy and insulin resistance. Accordingly, our study to assess the analytical performance of insulin dosing in terms of repeatability and reproducibility revealed satisfactory results.

Laboratories are involved in quality control procedures to ensure the protection of staff (doctors and technicians) by producing reliable test results. This enables the attending doctor to make an accurate medical diagnosis. And as a result, patients are protected against misdiagnosis based on erroneous results.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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