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Impact of serum-clot contact time on lactate dehydrogenase and inorganic phosphorus serum levels

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A B S T R A C T :

Objectives: The aim of this study is to determine the longest acceptable serum-clot contact time before centrifugation in lactate dehydrogenase and inorganic phosphorus analysis.
Materials and methods: The LDH and inorganic phosphorus serum levels from 103 adults were analyzed at three different storage times. The three measures were done immediately (T0), after a 2-h serum-clot contact (T2) and after a 4-h serum-clot contact (T4). A paired two-tailed Student *t*-test evaluated the impact of the serum-clot contact time on the serum levels. Another approach using analytical reproducibly and intra-individual variability was used. Furthermore, we have compared the mean percentage deviation to the measurement uncertainty.
Results: The LDH serum level is not significantly impacted by the three different studied serum-clot contact times.

The immediate Phosphorus serum level is not significantly different from the 2-h serum-clot contact condition. However, after a 4-h serum-clot contact, the phosphorus serum level is significantly lower than the immediate phosphorus serum level. Considering the reference change value approach, an acceptable mean variation was shown for inorganic phosphorus serum level after a 4-h serum-clot contact time. After a 4-h serum-clot contact, LDH and phosphorus mean percentage deviation are below our measurement uncertainties.
Conclusion: This study evidences that in our daily practices a 4-h serum-clot contact time for LDH and inorganic phosphorus analysis is acceptable.

1. Introduction

Clinical laboratory services are a vital part of healthcare systems [1]. The preanalytical phase is a critical step in the testing process. The time between blood collection and centrifugation is one of the many important factors [2,3] that may influence the reliability of test results and, thereby, affect the diagnostic outcome, follow-up, or even the therapeutic management of patients [4].

Under ISO 15189, an accredited medical laboratory must control the pre-analytical process, including the time between venipuncture and centrifugation [5]. Lactate dehydrogenase (LDH) and inorganic phosphorus are two biochemical analytes which are strongly influenced by serum-clot contact time before centrifugation [6].

In the context of consolidated laboratory networks, transport conditions and delay in transport are important variables. [7] The stability of the specimen dictates conditions for transport from remote collection sites (satellite draw stations) to the testing location.

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When an uncentrifuged whole blood specimen is sent to the laboratory for testing, it must reach the laboratory in time to be processed with serum/plasma separation occurring within the time necessary to protect the stability of the analytes [8].

The product information for the Siemens Healthcare Diagnostics lactate dehydrogenase assay states that serum or plasma should be physically separated from red blood cells as early as possible with a maximum limit of two hours from collection time [8]. The product information for the Siemens serum inorganic phosphorus assay states that serum or plasma should be separated from cells within one hour [9]. These two target times are difficult to adhere to in routine clinical practice.

The aim of this study was to determine the longest acceptable serum-clot contact time before centrifugation for lactate dehydrogenase and inorganic phosphorus analysis. This study should help laboratories to define the acceptable pre-centrifugation delay for determination of LDH activity and phosphorus concentration in serum.

2. Materials and methods

2.1. Subjects and samples collection

Blood specimens were collected from 103 donors (45 men, 58 women; mean age 63 years [SD 16 years], range 18–90)) from June to August 2016. Each donor was informed of the purpose of this investigation and signed a consent form before blood was collected. Venipunctures were performed after 12 h of fasting. For each donor, three serum tubes of capacity 4.5 mL with clot activator (Vacuette*, Greiner Bio-One GmbH, Kremsmunster, Austria, REF 454027) were collected.

Venipunctures in the median cubital vein were carefully done to avoid hemolysis, using a 22-gauge needle. The cubital fossa was cleaned before tourniquet application. The tourniquet was applied between 7.5 and 10 cm above the puncture site. The tourniquet application time was as short as possible, with a maximum of 1 min.

Collection and mixing of tubes were performed according to the manufacturer's recommendations by gently inverting the tubes five times.

After collection, all tubes were left in the upright position for 30 min at room temperature.

(22 ± 2 °C) before centrifugation.

The first tubes (T0) were then centrifuged and sera were analyzed immediately. The second tubes (T2) were stored at room temperature (22 ± 2 °C) for 2 h then centrifuged and sera analyzed. The third tubes (T4), were stored at room temperature (22 ± 2 °C) for 4 h.

then centrifuged and sera analyzed.

Centrifugation (ThermoScientific SL16R centrifuge, Waltham, MA, USA) was performed according to Greiner Bio-One recommendations: 2000*g* for 10 min at 20 °C.

Haemolysed samples were excluded from study..

3. Analytes and instruments

Lactate dehydrogenase activiry and inorganic phosphorus concentration were determined using a Siemens Dimension RXL Max analyzer (Siemens HealthCare Diagnostics, Newark, DE, USA). Our laboratory is accredited under ISO 15189 [10] for theses two analytes (Accreditation N°8–3100).

The LDH method is standardized according to the International Federation of Clinical Chemistry (IFCC) lactate dehydrogenase primary method procedure at 37 °C [11].

The phosphorus method is a modification of the classical phosphomolybdate method of Fiske and Subbarow [12].

Sera were analyzed every day during the study period. The same reagent lots were used. Quality control was performed before and after each series of analyses. The instrument was calibrated prior to use with manufacturers reagents and calibrators.

4. Statistical analysis

The Student *t*-test and GraphPad Prism 7.01 (GraphPad Software, La Jolla, CA, USA) were used for statistical analyses. The first two time points (T0 and T2) and the first and third time points (T0 and T4) were compared using a paired two-tailed Student *t*-test in order to determine whether the effects of sample storage time before centrifugation of 2 h and 4 h were statistically significant. A p value of 0.05 was considered to be significant.

Following recommendations of Simundic et al. [13], another approach was also used. This approach included consideration of the analytical reproducibility CV_A (determined at the initial installation of the equipment) and biological variations CV_I (found in the database of Ricos et al. [14,15]). The clinically significant change in consecutive results from an individual, taking into consideration both analytical and biological variations, was calculated for each test using the reference change value (RCV) equation as follows:

$$RCV = 2^{1/2} \times Z \times (CV_A^2 + CV_I^2)^{1/2},$$

where: Z is a constant depending on the probability used for significance. Z=1.96 is most commonly used, corresponding to $P < 0.05$.

The mean percentage deviation between T0 (no storage) and T4 (4 h serum-clot contact time before centrifugation) was compared to the reference change value (RCV). If the mean percentage deviation of an analyte exceeds the RCV, then this difference is judged to be clinically significant and is taken as proof of the influence of serum-clot contact time before centrifugation on the