The Effect of Pneumatic Tube Systems on the Hemolysis of Biochemistry Blood Samples

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Introduction: Pneumatic tube systems (PTSs) are widely used in many hospitals because they lead to reduced turnaround times and cost efficiency. However, PTSs may affect the quality of the blood samples transported to the laboratory. The aim of this study was to investigate the effect of the PTS used in our hospital on the hemolysis of the biochemical blood samples transported to the laboratory.

Methods: A total of 148 samples were manually transported to the laboratory by hospital staff, 148 samples were transported with the PTS, and 113 were transported with the PTS without use of sponge-rubber inserts (PTSws). Hemolysis rates and the levels of biochemical analytes for the different transportation methods were compared.

Results: No significant difference was found between the samples transported manually and with the PTS with regard to hemolysis rate and the levels of biochemical analytes. However, the samples transported with the PTSws showed a significant difference compared with the samples transported manually and with the PTS with regard to hemolysis rate and potassium and lactate dehydrogenase levels. The percentages of the samples that exceeded the permissible threshold for the hemolysis among the samples transported manually, with the PTS, and with the PTSws were 8%, 10%, and 47%, respectively.

Discussion: A PTS can be used safely for transporting biochemistry blood samples to the laboratory. However, a sponge-rubber insert that holds sample tubes must be used with the PTS to prevent the hemolysis of blood samples.

Key words: Pneumatic tube system; Sponge-rubber; Hemolysis; Blood samples

Pneumatic tube systems (PTSs) are widely used in many hospitals for the transport of blood samples from wards or clinics to laboratory areas by hospital staff. A PTS provides a number of advantages, including rapid and safe transport of the blood specimens to the laboratory, reduced turnaround times, cost efficiency, and reduced labor requirements.[1,2] However, a PTS may affect the quality of blood samples because of factors such as high transportation speeds, length of the system, sudden acceleration/deceleration, changes in air pressure, sudden changes in the direction of the transport containers, movement and vibrations of blood samples in the tubes, and lack of cushioning.[3-5] Several studies have shown that a PTS has an effect on blood gas samples,[6] hematology and coagulation parameters,[7] and clinical biochemical analytes.[8]

The PTSs used in hospitals may vary in terms of transportation speed, length of the system, and the number of transfer stations. Therefore, these systems may have different effects on the blood samples transported to the laboratory. In this study, we investigated the effect of the PTS used in our hospital on the hemolysis of the biochemical blood samples transported to the laboratory.

Methods

SAMPLE COLLECTION AND ANALYSIS

This study was performed at Mustafa Kemal University Medical School Hospital Blood Taking Unit (BTU) between May 10-27, 2016. Blood samples were collected from donors between 9 and 12 AM after an 8- to 12-hour fasting period. All blood samples were collected by the same expert phlebotomist from a single vein using Vacutainer tubes. The blood samples were collected into 8.5-mL BD Vacutainer SST II Advance tubes (Becton, Dickinson &

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TABLE

Relation between method of transport of blood specimens and results of laboratory analytes

Parameters	PTSws (n = 113), mean ± SD	Manual (n = 148), mean ± SD	PTS (n = 148), mean ± SD	*P* value
Hemolysis, No. (%)	53 (47)[b]	15 (10)[a]	12 (8)[a]	**.000**
Alanine aminotranferase (U/L)	19.36 ± 10.23	18.34 ± 8.02	18.02 ± 7.8	.448
Aspartate aminotranferase (U/L)	20.25 ± 6.06[b]	18.3 ± 5.5[a]	18.9 ± 5.6[ab]	**.019**
Bilirubin, total (mg/dL)	0.51 ± 0.23	0.54 ± 0.23	0.55 ±0.22	.405
Creatinine (mg/dL)	0.72 ± 0.12	0.70 ± 0.11	0.71 ± 0.13	.442
Potassium (mmol/L)	4.6 ± 0.38[b]	4.42 ± 035[a]	4.47 ± 0.38[a]	**.001**
Lactate dehydrogenase (U/L)	234 ± 54[b]	211 ± 49[a]	208 ± 65[a]	**.001**
Urea nitrogen (mg/dL)	12.66 ± 5.33	11.92 ± 3.52	11.81 ± 3.89	.510
Sodium (mmol/L)	138,4 ± 2	137 ± 1.6	137.5 ± 1.9	.39
Glucose (mg/dL)	94.37 ± 10.73	91.49 ± 11.63	92.93 ± 11.86	.285

PTS, Pneumatic tube system; *PTSws,* pneumatic tube system without sponge-rubber inserts; *SD,* standard deviat.

Bold values represent significant difference and $P < .05$. a,b: Different letters are used in the same line indicate the significant difference between two groups whereas the same letters in the same line indicate no significant difference. Groups with "ab" designators indicate that there is no significant difference between a or b with ab in the same line; $P < .05$.

Co, Franklin Lakes, NJ) and transported to the laboratory by the hospital staff manually, by PTS, and by PTS without sponge-rubber inserts (PTSws).

A total of 409 blood samples were analyzed in the study. Of these, 148 samples were transported to the laboratory by the hospital staff manually, 148 samples were transported with the PTS, and 113 were transported with the PTSws. Blood samples transported to the laboratory were analyzed immediately after being centrifuged at 3500 rpm for 10 minutes. An Abbott ARCHITECT c8000 autoanalyzer (Abbott Laboratories, Lake Bluff, IL) was used for the assessment of potassium (K), sodium, glucose, creatinine, alanine aminotransferase, urea nitrogen, total bilirubin, aspartate aminotransferase (AST), and lactate dehydrogenase (LDH) levels and hemolysis index. Hemolysis was established if the index was greater than 0.3 g/L, the threshold level optimized for our laboratory, above which hemolysis is visible, leading to inaccurate test results.[9]

Throughout the study, the internal quality control values of the analytes ranged between ±2 standard deviations (SDs). The hospital information system was used to exclude patients from the study whose preliminary diagnosis was obesity, diabetes, kidney failure, liver diseases, hematologic diseases, or pregnancy. The study was approved by the Mustafa Kemal University Local Ethics Committee.

PNEUMATIC TUBE SYSTEM

The PTS used in our hospital (Swisslog Compact Station, Swisslog Healthcare, Westerstede, Germany) runs at a constant speed of 5 m/sec. The distance of the PTS between the BTU and the central laboratory is approximately 170 m. The carrier is made of high-resistant polycarbonate with a diameter of 86 mm and a length of 220 mm. The tube carrier contains removable sponge rubber. Sponge rubber includes 7 rings at both ends of tube carriers, which allows us to transport 14 tubes per carrier.

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS 21 for Windows (IBM Corp, Armonk, NY). The Kolmogorov-Smirnov test was used to test normality. Statistical analysis of the transformed data was performed by one-way analysis of variance, and the Duncan test was used to evaluate the significance of differences between groups as post-hoc. Biochemistry parameters were expressed as mean ± SD. Numeric values for hemolysis were tested with the χ^2 test ($P < .05$).

Results

Our results indicated no significant difference between the samples transported manually and with the PTS in terms of hemolysis rate and the levels of biochemical analytes. However, in terms of hemolysis rate and the K and LDH levels, the samples transported with the PTSws showed a significant difference compared with the samples transported manually and with the PTS. Moreover, the AST level was significantly higher in the samples