ORIGINAL ARTICLE

Pneumatic tube transport system for blood samples: Evaluation of its effect on hemolysis

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ABSTRACT

Background-Aim. The purpose of this study is to evaluate the effect of pneumatic tube system transport on hemolysis of blood samples. **Methodology**. 100 blood samples were transported from the emergency department to the hospital laboratory both manually by hospital staff and with the pneumatic tube system. The hemolysis index and serum chemistry studies were performed on the blood samples. **Results**. The results of the measurements showed no significant difference between the two methods of transport. However, other studies indicated otherwise. **Conclusions**. All laboratories should investigate their blood specimen's quality to hemolysis when transported through the pneumatic tube system (PTS), as the characteristics of the PTS may vary from hospital to hospital.

Keywords: pneumatic tube system, hemolysis

Citation

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INTRODUCTION

Rapid sample delivery systems, usually pneumatic tube system (PTSs), have been installed in hospitals to transport blood specimens from the phlebotomy site to the core laboratory and deliver patient reports to clinicians (Figure 1).

Figure 1. Carrier for transporting speciments in pneumatic tube system

The use of rapid sample delivery systems can significantly reduce the turnaround times (TATs) of results, which account for approximately 40% in the laboratory median TATs [1]. However, the transport method including sudden acceleration/decelerations, changes in air pressures, movement of blood in the test tube and vibrations, may affect the quality of samples [2]. Rapid transport of blood samples in pneumatic tube systems may cause red blood cell breakdown (hemolysis) and may affect blood results [3]. Hemolysis of blood samples may necessitate repeated phlebotomy and may cause inaccuracy and delays in completing laboratory tests that are needed for clinical decision-making [4]. Thus, considering the blood specimen's quality, Soldi and colleagues stressed that all

laboratories should investigate their blood specimen's susceptibility to hemolysis when transported through the PTSs [5].

The aim of this study was to evaluate, the effect of the pneumatic tube system on hemolysis of blood samples, specifically the changes to the levels of 3 sensitive indicators, lactate dehydrogenase (LDH), potassium and creatinine and to validate this transport system in our hospital.

MATERIALS AND METHODS

We obtained duplicate samples from 100 samples arrived at the Emergency Department of our hospital. In the study, the collection of the blood specimens, was taken from a single vein with an injection, performed by a single expert phlebotomist. Immediately after the venipuncture, all vacuum tubes were gently inverted five times as recommended by the manufacture. After that, to other one of the two tubes from each volunteer, two different transport procedures were alternatively applied.

Transport procedure I: Diagnostic blood specimens were kept in vertical, closure-up position, and hand carried by our laboratory personnel at room temperature from the phlebotomy service (emergency department) which is located on the ground floor to the core clinical laboratory located on the second floor in our hospital. The mean time was 7 min.

Transport procedure II: The PTS in our hospital connects the emergency department and the central laboratory (and other 2 stations distributed over 4 floors), a distance which is approximately 30 meters. The system generates two different speeds, 3 m/sec and 6m/sec. In this study the carrier was running at the maximum speed of 6 m/sec. The carriers are made of polycarbonate in 86mm diameter and 220mm long. (Figure 1) and on the arrival at a station are decelerated by a soft air cushion and dropped gently into a receiving bin. There is no detectable changer in temperature of the insert or contents during transportation. Transport time from the phlebotomy service to the core lab is 5 sec.

In the laboratory, all sample pairs were centrifuged in the same batch at 3500rpm for 10 min. Hemolysis index was determined with spectrophotometry. Hemolysis was indicated if the index was more than 2. This is the threshold level optimized for our laboratory above which there is visible hemolysis, and analytes affected by hemolysis are therefore inaccurate. Other quantitative clinical biochemical measurements included potassium, creatinine, lactate dehydrogenase (LDH) and aspartate aminotransferase (AST).

RESULTS AND DISCUSSION

Pneumatic tube systems allow rapid and convenient transport of blood specimens to clinical laboratories and are widely used in modern hospitals. However, there is a growing attention to blood specimen quality affected by the PTS.

To the best of our knowledge, few studies have investigated the effect of PTS on hemolysis. Fernades and colleagues [6], reported there was no significant difference in the hemolysis rate between specimens delivered by a PTS and those delivered by human courier. Sodi and colleagues [5], investigated the level of hemolysis in commonly used sample types such as plain serum samples and serum with gel samples transported through the PTS. They concluded

that plain serum samples are more susceptible to hemolysis compared with serum with gel samples, suggesting that gel may confer some protection against hemolysis. Tiwari and colleagues, on the other hand studied the influence of speed of sample transportation by pneumatic tube system on the degree of hemolysis [7] and reported that at short distance and slow speed phase there was no hemolysis in the PTS arm. However, in the Steige and colleagues study, hemoglobin, LDH and potassium of the blood specimens would alter when sent through their PTS [8].

From the published studies, it is apparent that differences exist in different PTSs. Therefore, PTS should be evaluated prior to use for transport of whole blood specimens. It was the aim of this study to assess the influence of the PTS in our hospital on the levels of serum potassium, LDH, AST and hemolysis index measured in serum with gel samples running the highest speed of 6 m/sec.

Hemolysis is defined as the release of intracellular components of erythrocytes and other blood cells into the extracellular space blood [9]. Thus, it invalidates the measurement of tests such as potassium, LDH, AST. Hemolysis may be caused by in vivo factors such as hemolytic anemia or blood transfusions or in vitro factors such as osmotic, physical, mechanical or chemical factors. Hemolysis also may be caused by high speed, rapid acceleration, or rapid deceleration during sample transport in a pneumatic tube system [10].

In this study there was no significant difference in hemolysis index between the two methods of delivery (Figure 2). The hemolysis index was measured spectrophotometrically on the Dimension RxL Max Integrated Chemistry System of Siemens Diagnostics. The measurements that exceed the hemolysis threshold were 27% with the pneumatic tube system and 25% with the human courier. There were also, no significant changes in the measurements of serum blood parameters such as potassium, LDH and AST (Figure 3).

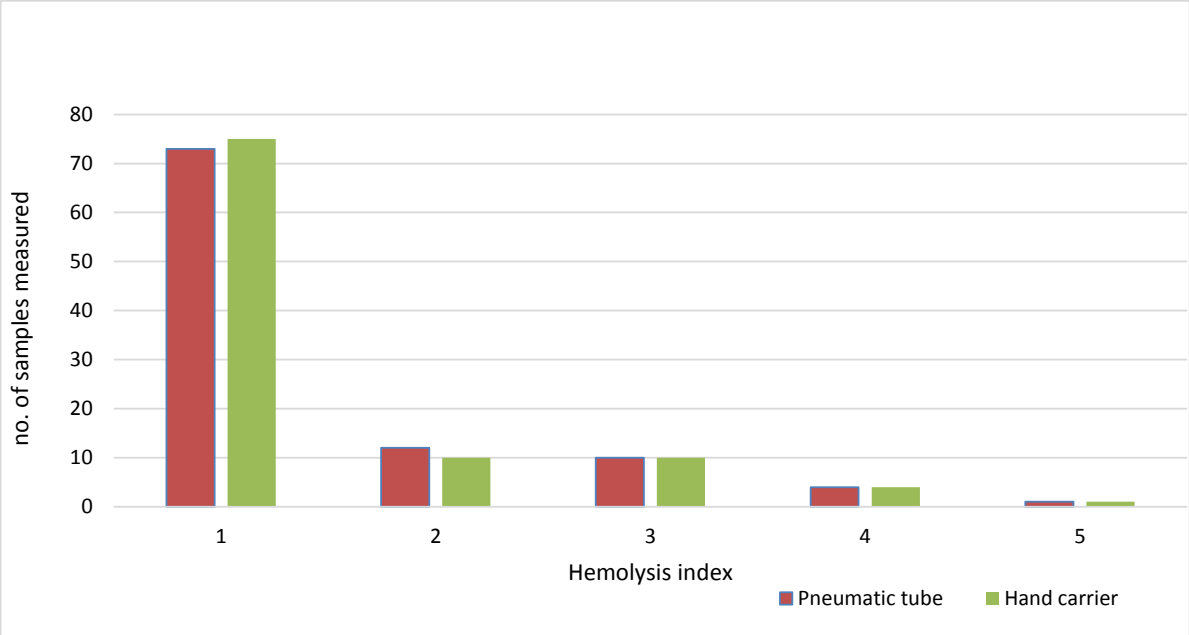

Figure 2. Hemolysis index in two different methods of transport of biological samples.

Parameters	Pneumatic tube system (n=100)	Manual (n=100)
Hemolysis (number[%])	27	25
Potassium (nmol/L)	4.3 (4.1-5.0)	4.4 (4.2-5.1)
Creatinine (mg/dL)	0.80 (0.70-0.90)	0.90 (0.80-1.00)
Aspartate aminotransferase (AST) (U/L)	19 (16-24)	22 (18-25)
Lactate dehydrogenase (U/L)	195 (160-220)	205 (170-234)

Figure 3. Relation between method of transport of blood specimens and results of laboratory tests.

CONCLUSIONS

In conclusion, we have shown that the use of a pneumatic tube delivery system for transporting blood samples from the Emergency department to the clinical laboratory in our hospital does not affect the quality of the samples measured. The use of PTS increases work efficiency and decreases turnaround times (TATs). However, this difference between studies may have been caused by different characteristics of the pneumatic tube systems. Therefore, hospitals should validate their PTS before use and address factors that may affect the accuracy of laboratory results. Prudent quality control measures may include monitoring the hemolysis index of the samples transported by the pneumatic tube system and evaluating the physical parameters of the system that may contribute to hemolysis.

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Σωληνωτό ταχυδρομείο μεταφοράς δειγμάτων αίματος: Αξιολόγηση της επίδρασης του στην αιμόλυση

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ΠΕΡΙΛΗΨΗ

Εισαγωγή-Σκοπός. Ο σκοπός αυτής της μελέτης είναι να αξιολογηθεί η επίδραση της μεταφοράς των βιολογικών δειγμάτων μέσω του σωληνωτού ταχυδρομείου, στην αιμόλυση των δειγμάτων αυτών.

Υλικό-Μέθοδος. 100 δείγματα αίματος μεταφέρθηκαν από το Τμήμα Επειγόντων περιστατικών του νοσοκομείου στο εργαστήριο με δυο τρόπους: χειροκίνητα από το προσωπικό του νοσοκομείου και μέσω του σωληνωτού ταχυδρομείου. Στη συνέχεια, μετρήθηκε ο δείκτης αιμόλυσης στα προαναφερόμενα δείγματα. **Αποτελέσματα**. Τα αποτελέσματα των μετρήσεων δεν έδειξαν σημαντική διαφορά ανάμεσα στους δυο τρόπους μεταφοράς δειγμάτων. Ωστόσο, άλλες μελέτες καταλήγουν σε διαφορετικά συμπεράσματα.

Συμπεράσματα. Θα πρέπει να γίνεται διερεύνηση, στα εργαστήρια, ως προς την αιμόλυση των δειγμάτων, όταν αυτά μεταφέρονται μέσω του σωληνωτού ταχυδρομείου, καθώς τα χαρακτηριστικά του (π.χ. ταχύτητα) μπορεί να ποικίλλουν από νοσοκομείο σε νοσοκομείο.

Λέξεις ευρετηρίου: σωληνωτό ταχυδρομείο, αιμόλυση βιολογικών δειγμάτων.

Παραπομπή

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