

## The Effectiveness of Using Luer-Lok (Bd Vacutainer®) In Reducing Hemolysis Rates in Busy Emergency Departments

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### Abstract

**Introduction:** In busy emergency departments, errors made during the pre-analytical phase can cause delayed diagnosis and treatment, and prolonged follow-up periods. The most common error in the pre-analytical phase is hemolysis in blood samples. In this study, we aimed to assess the effectiveness of the Luer-Lok (BD Vacutainer®) method of taking samples in avoiding hemolysis.

**Materials and Methods:** The study was conducted at the emergency department of a tertiary healthcare facility on patients that register at level 1 or 2 of the Emergency Severity Index triage algorithm. Three sets of prospective observations were made, each lasting for five days. In the first period, hemolysis rates were determined. Following a training course on appropriate blood sampling techniques during the second period, hemolysis rates were determined again while Luer-Lok (BD Vacutainer®) was being used. Taking and processing of samples were carried out by the same personnel throughout the study. Assessment of hemolysis was performed by those that were blind to sampling. All the samples were analyzed at the laboratory located inside the emergency department.

**Results:** In total, 2,027 blood samples were sent to the emergency laboratory for analysis. The hemolysis rate was 8.1% in the first period, 5.5% in the second and 1.4% in the third. The difference in rates between the first and second periods was not statistically significant ( $p=0.0793$ ). The hemolysis rate in the third period was significantly lower compared to the other two periods ( $p=0.0001$ ).

**Conclusion:** Using Luer-Lok (BD Vacutainer®) may be effective in reducing hemolysis rates in busy emergency departments.

**Keywords:** Hemolysis busy emergency department; Luer-lok (BD vacutainer); Health care; Sampling techniques

### Introduction

Due to their nature, emergency departments are often places of panic and chaos. The working conditions augment the frequency of lapses and emergency departments are among where pre-analytical errors are made the most often [1].

Hemolysis (*in vitro* hemolysis), which is one of the most commonly made errors in the pre-analytical phase, is defined as rupture or breakdown of erythrocytes during or following blood sample and consequent release of hemoglobin and other cellular components into the plasma [2]. A sample with hemolysis is unsuitable for many types of analysis; e.g. creatinine kinase, lactate dehydrogenase (LDH), alanine amino transferase (ALT), aspartate amino transferase, (AST), potassium, coagulation tests [3]. Hemolysis in samples is observed regularly in departments that the patients spend relatively short time in, such as the emergency department [4,5].

An analysis performed by the Working Group on Laboratory Errors and Patient Safety (WG-LEPS) of the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) and the Global Pre-analytical Scientific Committee (GPSC) and involved 391 clinical laboratories has shown that, the rate of hemolysis is between 1-5%. The

departments with the highest hemolysis rates were the emergency department (53%), the pediatrics clinic (16%), and the intensive care unit (7%) [2].

When hemolysis occurs in a blood sample, usually another one has to be taken. This causes disruption in healthcare, especially in busy and busy emergency departments [6]. Considering the increase in numbers of patients calling at emergency departments globally, laboratory-based delays and errors need to be minimized.

In the present study, we aim to assess the effectiveness of the Luer-Lok BD Vacutainer® used together with intravenous (IV) catheters in reduction of hemolysis in samples, which is one of the most common errors in the pre-analytical phase.

### Materials and Methods

#### Subjects and sampling

This prospective and observational study is conducted at the emergency department of Training and Research Hospital, which functions as a central healthcare facility, serving approximately 300,000 patient's emergency department annually. The local ethics committee has approved the study.

The study involved samples are taken from patients that were being treated at the short-term follow-up/critical patient treatment area, which has a bed capacity of 21, and registered at level 1 or 2 according to the Emergency Severity Index (ESI) triage algorithm. The study was carried out in three separate periods of five days each.

In the first period, hemolysis rates were recorded in samples taken during routine patient care. The second period started with a 1 h theoretical blood sampling training course based on the principles outlined in the Guidelines on Drawing Blood, 2010, by the World Health Organization [7]. Afterwards, hemolysis rates were determined again. In the third period, all blood samples were taken using the Luer-Lok BD Vacutainer® and hemolysis rates were measured subsequently.

In order to achieve a standard throughout the three periods, all the blood samples were taken by a fixed nurse group of eight working the 08:00–16:00 shift. The samples were drawn using 20 Gauge IV catheters. The duration of tourniquet application was under 60 s. The antecubital region was used for sampling.

All the samples were analyzed by the same group of technicians working the day shift at the emergency laboratory. Samples were taken to the laboratory within 30 min. Care was taken to establish similar environmental factors (air circulation, room temperature, humidity, etc.) throughout the study periods.

The presence or absence of hemolysis was determined visually by laboratory technicians that were single-blind to the sampling procedure.

**Statistical analysis**

Frequency data were presented as rates. Group comparisons for categorical variables were performed using chi-squared test. All the hypotheses were constructed as two-tailed and an alpha critical value of 0.05 was accepted as the threshold for significance.

**Results**

A total of 2,027 blood samples were sent to the emergency laboratory for analysis during the study. The number of samples per study period, as well as the number and rate of rejected samples due to hemolysis are given in Table 1.

Period	Number of samples, n	Number and rate of rejected samples due to hemolysis, n (%)
1	716	58 (8.1%)
2	681	38 (5.5%)
3	630	9 (1.4%)

**Table 1:** Number of samples and rates of hemolysis in each study period.

After the nurses that has been taking the samples were trained on drawing blood, the rate of rejected samples due to hemolysis decreased compared to the first study period; however, the difference was not statistically significant (p=0.0793) (Table 2).

When the Luer-Lok BD Vacutainer® was used for taking samples in the third period, the rate of rejected samples due to hemolysis was significantly lower than those of the other two periods (p<0.0001 for both) (Table 2).

Number and rate of rejected samples due to hemolysis, n (%)		p value
Period 1	Period 2	0.0793
58 (8.1%)	38 (5.5%)	
Period 1	Period 3	<0.0001
58 (8.1%)	9 (1.4%)	
Period 2	Period 3	<0.0001
38 (5.5%)	9 (1.4%)	

**Table 2:** Comparison of hemolysis rates between the study periods.

**Discussion**

A number of studies have shown that the hemolysis rates in blood samples at the emergency department are considerably higher compared to other healthcare units [8]. A sample with hemolysis can lead to erroneous laboratory results. Such samples can disrupt the outcome of 39 different laboratory tests [9]. The American Society for Clinical Pathology recommends that the hemolysis rates are kept under 2% in practice [10].

Under the working conditions of emergency departments with a high influx of patients in particular, the most common five errors causing improper sampling are as follows: sample labeling errors, errors in sampling from the cannula, intravenous sampling errors, sample traumas leading to hemolysis and clot formation due to insufficient use of anticoagulants [11].

The presence of hemolysis in blood samples usually necessitate subsequent sampling, which in turn can lead to delayed diagnosis and treatment of patients at congested emergency departments [9]. In addition to diagnostic impediment, erroneous sampling causes loss of work force, elevated costs, and communication problems between doctors and nurses [2].

Applying punctures whilst sampling instead of using IV catheters is a recommended method for preventing hemolysis. When drawing blood samples, many nurses and emergency department personnel prefer the IV pathway. Most of these healthcare workers avoid a secondary puncture to save time and maintain the comfort of the patient [12]. Also, extra punctures mean higher risk of needle accidents, infections and transmission of other harmful agents for the personnel. Multiple punctures can lead to minor injuries in patients as well [13].

Several methods have been investigated in order to minimize hemolysis, especially in the pre-analytic phase. One of such methods involves the Luer-Lok (BD Vacutainer®), which has a lock mechanism and typically limits transmission. The logic behind how this application reduces hemolysis is that the Luer-Lok Access Device (LLAD) allows blood collection from an IV catheter, facilitating direct draw of sample from the catheter to a detachable tube. In addition, the one-piece transfer device of the LLAD provides a secure connection that enables sufficient blood flow. It also minimizes the potential for blood exposure and hazardous transmission.

Romero et al. [14] have compared three different collection systems and found that there is no significant difference between the Holdex®, the BD Vacutainer® and ordinary syringes. In an emergency department setting, Orem et al. [15] have investigated the influence of

a rapid-clotting serum tube, the BD Vacutainer® Rapid Serum Tube (RST™) and the Luer-Lok on hemolysis. In contrast, they have shown that when using Luer-Lok (BD Vacutainer®), hemolysis decreases by up to 50% ( $p < 0.05$ ). In another study carried out in an emergency department, Postigo et al. [15] have found that using the Luer-Lok (BD Vacutainer®) catheter adaptor together with a partially pressured tube reduces hemolysis rates from 27.8% to 0.6%. Furthermore, Kaplan et al. [15] have compared sampling with syringes and the Luer-Lok in a study involving 50 cases at the emergency department, and have concluded that the Luer-Lok leads to a reduction in hemolysis. Involving another collection system, Lippi et al. [16] have tested a similar tube holder apparatus (Greiner Holdex®) in the emergency department and have recorded a decrease in hemolysis rates. They claim that adopting tube holder systems would alleviate errors during sampling and therefore improve patient comfort and reduce costs. Lastly, Aykal et al. [17] have underlined the importance of periodic personnel training for eliminating high hemolysis rates in the pre-analytical phase.

## Conclusion

In order to reduce hemolysis rates at busy emergency departments, periodically training the personnel drawing blood and utilizing the Luer-Lok (BD Vacutainer®) are among viable strategies. By improving the quality of patient care, diagnosis and treatment delays are minimized and patient turn-over is maintained steadily.

## Limitations

The presence of hemolysis was determined by a visual scale in this study.

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