

Reduction of burden of hemolyzed specimens in a large urban emergency department: A real-world, five years' experience

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Abstract

In vitro hemolysis may jeopardize patient care because tests results generated using unsuitable specimens may lead to inappropriate patient management. The prevalence of hemolyzed specimens is high in the emergency department (ED). We previously showed that collecting blood by means of a closed system entailing manual aspiration of blood instead of using conventional evacuated systems was effective to cut-down by nearly half the rate of hemolysis. Aim of this *real world* study was to verify whether long-term replacement of standard evacuated blood collection systems may be really effective to reduce the burden of spurious hemolysis. Starting from May 2014 in the ED of our Hospital vacuum tubes were replaced with S-Monovette serum tubes. We compared data about hemolyzed specimens entered in the two years before the implementation of the new device (*i.e.*, 2012 and 2013) and the two years after introducing S-Monovette in manual aspiration mode (*i.e.* 2015 and 2016). The year 2014 was not considered due to mixed data. The rate of hemolyzed specimens decreased from 4.36% to 3.07% with the use of S-Monovette in manual aspiration mode (Chi squared, 183.8; $P < 0.001$). The likelihood of obtaining hemolyzed specimens was hence reduced by approximately 30% (relative risk, 0.707), with an expected economic saving of approximately 510€/year. The results of this real-world study demonstrate that the use of an alternative closed device encompassing manual aspiration for drawing blood from intravenous catheters may reduce hemolyzed samples by approximately 30%, so representing a valuable perspective for safeguarding patient safety and improving ED efficiency.

Introduction

The term hemolysis (or haemolysis) originates from the Greek *hemo* (*i.e.*, blood), and *lysis* (*i.e.*, breakdown). Hemolysis is a pathological process encompassing the breakdown of red blood cells (RBCs), so resulting in massive release of hemoglobin and other intracellular compounds in plasma.¹ In clinical medicine, distinguishing *in vivo* and *in vitro* hemolysis is of utmost importance, since the former may be due to a number of conditions and disorders, whereas the latter is substantially attributable to problems occurred during collection, handling or transportation of blood specimens. *In vitro* hemolysis may seriously jeopardize patient care because tests results generated on unsuitable specimens may derange the diagnostic reasoning and lead to inappropriate patient management.¹ The prevalence of hemolyzed specimens has been found especially high in healthcare settings entailing blood collection from intravenous lines.² These conventionally include the emergency department (ED), intensive care unit (ICU), as well as neonatal and pediatric wards. In the ED, in particular, the risk of collecting hemolyzed specimens is magnified, with a rate of unsuitable specimens that can even approximate 12% of all collected samples.²

Such a high prevalence of hemolyzed specimens collected in the ED has led to propose many potential strategies, but none of these was proven to be really effective to solve all the potential issues.^{3,4}

In an observational study conducted in a large urban ED we previously showed that collecting blood by means of a closed system entailing manual aspiration of blood instead of using conventional evacuated systems was effective to cut-down by nearly half the rate of hemolysis (*i.e.*, from 4.41% to 2.57%).⁵ Therefore, the aim of this observational, real world, study was to verify whether long-term replacement of standard evacuated blood collection systems with closed system entailing manual aspiration of blood (S-Monovette, Sarstedt AG & Co., Nümbrecht, Germany) may be really effective to reduce the burden of spurious hemolysis.

Materials and Methods

This study entailed the systemic identification of hemolysis in all serum samples received in the clinical laboratory of the University Hospital of Parma from the local ED, a large urban facility with approximately 94.000 visits per years. In the local ED, blood samples are drawn through intravenous catheters (1.0x3.2 mm, 20-gauge catheter;

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Key words: hemolysis; hemolyzed specimens; preanalytical variability; blood collection tube; blood drawing.

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Neo DELTA VEN, Viadana, MN, Italy). Starting from May 15th, 2014, the Direction of the University Hospital authorized the replacement of standard 13x100 mm x 5.0 mL BD Vacutainer® SST II Plus plastic serum tubes (Becton Dickinson Italia S.p.A, Milan, Italy) with 4.0 mL S-Monovette serum tubes. After an appropriate period of training, starting from June 1st 2014 blood started to be collected only using S-Monovette blood tubes in aspiration mode. The detailed description of this device has been provided elsewhere.⁵ In the local laboratory, all serum samples are systematically screened for hemolysis after centrifugation by photometrical assessment on Beckman Coulter AU5800 (Beckman Coulter Inc., Brea, CA, USA). The analyzer provides a semi-quantitative measure of hemolysis from (0 to 5 g/L) as hemolysis index (HI) by means of bichromatic readings at 410/480 and 600/800 nm. As for local practice, established in accordance with current indication,⁶ hemolysis is considered significant (*i.e.*, generating a bias in the measurement of hemolysis-sensitive analytes such as potassium and lactate dehydrogenase) when the HI is ≥ 0.5 g/L.

The information of all hemolyzed specimens received in the local laboratory are systematically entered into a specific software, designed for recording a vast array of preanalytical problems.⁷ The analysis was based on data about hemolyzed specimens entered in the two years before the implementation of the new blood drawing device (*i.e.*, 2012 and 2013) and the two years after introducing S-Monovette in manual aspiration mode (*i.e.* 2015 and 2016). The year 2014 was not considered in our analysis due to mixed data between one system and the other and the period of training necessary to the nurses to

get used to the new system. The statistical analysis was based on Chi squared statistics with Yates's correction and relative risk estimation (with 95% confidence interval; 95% CI), using Analyse-it (Analyse-it Software Ltd, Leeds, UK) and MedCalc Version 12.3.0 (MedCalc Software, Mariakerke, Belgium). The study was carried out in accordance with the Declaration of Helsinki, under the terms of all relevant local legislations and was cleared by the Institutional Review Board.

Results

The main results of this study are shown in Figure 1. Despite a constant increase in the number of specimens collected in the ED was observed, mostly due to the parallel increase in the number of ED visits from 2012 to 2016, the rate of hemolyzed specimens significantly decreased, from 4.36% before the introduction of the new system to 3.07% with the use of S-Monovette in manual aspiration mode (Chi squared, 183.8; $P < 0.001$). The likelihood of obtaining hemolyzed specimens was hence reduced by approximately 30% (relative risk, 0.707; 95% CI, 0.672-0.743; $P < 0.001$) after the introduction of the new system. As regards the potential economic savings, we have estimated that the much lower burden of hemolyzed samples occurring after the introduction of S-Monovette would have allowed saving approximately 1073 blood tubes (including double recollections) over the total amount of those collected in the years 2012-2013. As for national regulation, replacement of a medical device within an

ongoing tender is only possible if the new device is offered at the same price as, or at a lower cost than, the former. Therefore, considering the actual cost of a single blood tube (*i.e.*, 0.46 €), the cost of a new blood tube label (*i.e.*, 0.05 €), the estimated cost attributable to nurses drawing an additional blood tube (*i.e.*, ~0.22 €/min), the introduction of the new blood tubes would translate into an expected economic saving of approximately 510€/year. Since repeated sampling is always associated with diagnostic delay and prolonged stay in the ED (usually between, 2 to 3 hours per patient, according to the type of testing), we can also suppose that between 990-1485 patient-hours have been gained in the local ED.

Discussion

The collection of hemolyzed specimens remains an important problem in modern medicine. This is mostly attributable to the potential impact on patient safety, of diagnostic delays caused by recollection of additional specimens, or to the derangement of managed care when medical decisions are taken on unreliable data generated from the analysis of unsuitable specimens. In vitro hemolysis is also associated with organizational and economic issues. Sample recollection necessitates the use of another blood tube, another tube label and, frequently, another needle when blood is drawn with standard venipuncture, but also entails a potentially avoidable activity (*e.g.*, sample recollection may consume 1 to 3 min of phlebotomist's time). The need of recollecting unsuitable samples also contributes to

increase overcrowding in short stay units such as the ED, since the patients cannot be discharged or hospitalized until complete laboratory data are available to the emergency physician.

Conclusions

The results of this real-world study, based in a large urban ED, convincingly demonstrate that replacing standard evacuated blood tubes with an alternative closed device encompassing manual aspiration when drawing blood from intravenous catheters may reduce the need to recollect hemolyzed samples by approximately 30%, so representing a valuable perspective for safeguarding patient safety and improving efficiency both in the ED and in the laboratory. Unfortunately, no systematic survey has been carried out to assess the level of compliance of the procedure and/or the satisfaction of the nursing staff. This may be indeed a reasonable topic for a further study.

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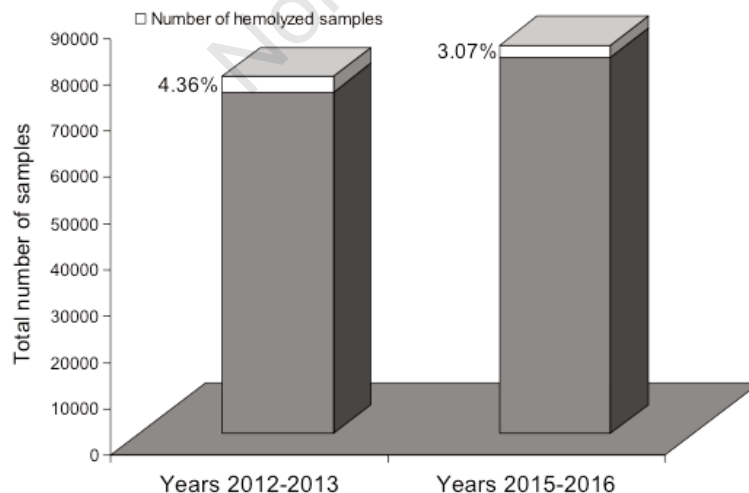


Figure 1. Hemolysis rate in serum samples collected from intravenous lines in a large emergency department using a conventional evacuated system (years 2012-2013) and with the S-Monovette system in aspiration mode (years 2015-2016).