CLINICAL RESEARCH STUDY

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Reducing Blood Sample Hemolysis at a Tertiary Hospital Emergency Department

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ABSTRACT

PURPOSE: To determine the causes for sample hemolysis and measure the effect of an intervention to reduce sample hemolysis in the Emergency Department of a large hospital.

METHODS: We conducted a phased, prospective, interventional study. In phase 1, factors associated with urea and electrolyte sample lysis were studied. Based on these results and a literature review, an educational program consisting of a 15-minute presentation was implemented. In phase 2, questionnaires were distributed to the doctors and medical students conducting blood sampling, and outcome data were collected after the samples were processed.

RESULTS: In phase 1 (n = 227), the use of a vacutainer was associated with the highest rates of hemolysis. Lysis rate was 35.8% with use of the vacutainer, compared with 11% without (adjusted odds ratio 6.0, 95% confidence interval, 2.3-15.2). In phase 2 (n = 204), the following significant changes were found: increased use of a syringe rather than vacutainer (before 64.3%; after 98.5%, $P < .01$), increased use of venipuncture for blood sampling (26%-36.8%, $P = .02$), reduced arterial sampling (3.1%-0%, $P = .02$), increased sample volume (4.5-5.2 mL, $P < .01$) and reduced interval from sampling to analysis (60.8-48.4 minutes, $P < .01$). We were able to attain a reduction in sample hemolysis from 19.8% (before) to 4.9% (after) ($P < .001$). This would translate to a cost savings of SGD$834.40 (USD$556.30) per day at the emergency department and SGD$304,556 (USD$203,037) per year.

CONCLUSIONS: Introduction of an educational program at a hospital Emergency Department was able to significantly reduce rates of sample hemolysis.

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KEYWORDS: Chemistry testing; Emergency department; Sample hemolysis; Venipuncture; Venous cannulation

Hemolysis of blood samples is a common problem encountered in medical practice. It leads to inaccurate results and often necessitates a repeat sample.[1-3] High workloads and finite resources are a problem in many hospitals and Emergency Departments,[4] where conditions have time-dependent outcomes. Thus, accurate and quick blood results are important. Erroneous blood results lead to unnecessary delays and additional costs by obligatory repeat samples. Repeat blood sampling also can cause unnecessary pain to patients.

Hemolysis can occur in vivo and in vitro. In vitro hemolysis affects assay results by underestimating albumin, alkaline phosphatase, and sodium, and overestimating alanine aminotransferase, aspartate aminotransferase, creatine kinase, and especially, potassium levels.[2,5] In the Emergency Department, inaccurate potassium levels can lead to potential misdiagnosis and dangerous management, as treatment protocols for hyperkalemia and hypokalemia are drastically different.

Factors that have been suggested to cause increased sample hemolysis include pressure differences and needle

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size,[6,7] prolonged time between sample collection and analysis,[8,9] size of collection tubes,[10] difficulty of blood drawing,[11] and the use of a vacutainer system.[12,13]

The purpose of our study was to determine the causes for sample hemolysis in our local setting and to measure the effect of an intervention to reduce sample hemolysis in the Emergency Department.

CLINICAL SIGNIFICANCE

- Hemolysis of blood samples is a common problem encountered in medical practice. It leads to inaccurate blood results and has cost implications as blood samples have to be retaken.
- Introduction of an educational program in the Emergency Department was able to significantly reduce rates of hemolysis.
- Introduction of such a program can potentially reduce unnecessary repeat blood sampling and medical errors, leading to cost savings for patients.

METHODS

Study Design and Setting

We conducted a phased, prospective, interventional study at the Emergency Department of a large tertiary hospital from January 2006 to November 2006. The Singapore General Hospital (SGH) is Singapore's oldest and largest acute tertiary hospital and national referral center. SGH accounts for about one third of total acute hospital beds in the public sector and about a quarter of acute beds nationwide. Annually, about 60,000 patients are admitted to our wards, and another 600,000 attend our Specialist Outpatient Clinics. The Emergency Department sees 300 to 500 patients a day. The hospital institutional review board approved the study.

Selection of Participants

All patients who presented to the Emergency Department requiring blood urea and electrolyte analysis were eligible for our study regardless of demographics, co-morbidities, or presenting complaint. In our local setting, blood sampling in the Emergency Department is usually performed by doctors and medical students, not by nurses or medical technicians. Students receive theoretical teaching on drawing blood followed by practical experience in the wards as part of their medical education.

Data Collection

In phase 1, we collected an observational convenience sample of cases presenting to the Emergency Department requiring blood urea and electrolyte analysis. A questionnaire was designed and distributed among the potential blood sampling operators (doctors and medical students). This recorded their personal method of sampling a particular urea and electrolyte blood sample with reference to the following variables:

- Method [venipuncture or intravenous (IV) cannulation]
- System (arterial blood gas sampling or arterial puncture, syringe, vacutainer)
- Size of needle from either syringe (23 gauge or 21 gauge) or IV cannulation (24 gauge, 22 gauge, 18 gauge, or 16 gauge)
- Operator (Senior Attending, Junior Attending, Resident, or Student)
- Blood flow (fast, moderate, or slow)
- Difficulty of venipuncture/cannulation (easy, moderate or hard)
- Source (venous or arterial)
- Sample volume in milliliters (mL)
- Time sample taken
- Time sample processed by the laboratory. One questionnaire was completed for every blood sample obtained.

No limitations were placed on the operators in terms of number of blood samples taken and personal methods used. The patient's label was included in the questionnaire for ease of retrospective identification via the urea and electrolyte results from the biochemical laboratory to determine the main outcome, whether the blood urea and electrolyte sample was hemolyzed or not. The time the sample was drawn was prospectively recorded by the attending doctor or student. The time the sample was processed was automatically logged by the biochemistry laboratory's computer system (Beckman-Coulter DxC 800; Beckman Coulter Inc., Fullerton, Calif). Sample lysis was determined by the biochemistry laboratory with the use of a standardized validated quality control process integrated with the laboratory equipment. Actual urea and electrolyte results were not considered in our study. The analysis regarding whether the samples were hemolyzed was determined solely by the biochemistry laboratory according to their internal quality control methods. The Emergency Department or investigators were not involved in this determination in any way. A sample of the study questionnaire is included in the Figure.

Based on the phase 1 results and a literature review, an educational program consisting of a 15-minute presentation and discussion was implemented. This was conducted by the investigators for the operators. During the educational program, the factors thought to cause sample lysis were reviewed and the results of phase 1 of the study shared. The following were emphasized as take-home messages:

- Use of a syringe rather than a vacutainer when obtaining a blood sample. The method taught was to draw a sample via venipuncture or from an IV cannula using a syringe. The needle would then be discarded and the sample transferred directly from the syringe to the uncapped sample container. Plastic disposable syringes are used in our Emergency Department. These were attached directly to the needles without a plastic line.