Review Article

Pathology Section

Preanalytical Errors: Some Common Errors in Blood Specimen Collection for Routine Investigations in Hospital Patients

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ABSTRACT

Preanalytical variables include specimen collection, handling, processing, physiological influences and/or interference factors. Since the blood collection is the first step, any error in this step will jeopardize the whole test results, no matter how accurately these are analysed in the laboratory. Here, some common errors in blood collection and handling in hospital patients have been highlighed by giving some instances. Preanalytics involve the patient, the physician, the resident doctor, the nurse, the technician, the laboratory personnel and the transport service. Therefore, all of them are required to know about preanalytical variables, their possible sources and their effect on the test results. Moreover, since the resident doctors have a direct interaction with the paramedical staff, it is very important for them to understand the preanalytical variables so that they could instruct the paramedical staff accordingly.

Key Words: Preanalytical errors, Blood collection

INTRODUCTION

There is an increasing trend in the awareness with respect to improving the laboratory results during the past several years. But in India, there is still a need for more awareness in this direction. The three main phases in laboratory testing are: preanalytical, analytical and postanalytical. Of these, the preanalytical phase is the major source of error, accounting for 81% of all the errors in lab tests [1],[2],[3],[4]. The preanalytical variables include specimen collection, handling, processing, physiological influences and/or interference factors. Since the blood collection is the first step, any error in this step will jeopardize the whole test results, no matter how accurately these are analysed in the laboratory. Here, I discuss the errors in blood collection and handling in hospital patients by giving some instances that I have come across during the last 25 years of my experience in a medical institution.

Case #1: A patient's haemoglobin was found to be 6.0 g/dl but when the blood smear of the same patient was examined, it showed normochromic, normocytic RBCs. The patient was not clinically anaemic. When another blood sample of the same patient was tested, the haemoglobin was found to be 12 g/dl. Upon enquiry, it was found that the previous blood was collected from the vein in which normal saline was being infused, thus resulting in the dilution of the blood. If this patient was infused glucose, then such a blood sample would also have given a high plasma glucose level. Therefore, blood should never be taken from the arm in which any fluid is being infused.

Case #2: Haemolysis is a very common error in the preanalytical phase and haemolysis can affect various tests due to the release of erythrocytic contents. Also, the reddish colour of the serum /plasma may interfere with various assays. Once, our laboratory received three blood specimens of a patient viz. with fluoride, oxalate and in a plain syringe without any anticoagulant. Out of these three, the blood in the fluoride and oxalate vials was haemolysed, while that in the syringe was nonhaemolysed. This was quite surprising because the blood was collected in one syringe and was then poured into the fluoride and the oxalate vials and the remaining was left as such in the syringe. Now, there could be three reasons for the haemolysis:

1. The vials were shaken too vigorously after pouring the blood into it (which is a very common practice), thus causing the breakdown of the RBCs,
2. The blood was poured into the vials through the needle and with great pressure and froth formation,
3. The presence of moisture or other contaminants in the vials. The third reason seemed to be least possible, as the vials were prepared in our laboratory with great care. Upon enquiry, it was found that the blood was poured through the needle into the vials.

There are certain other reasons for haemolysis in addition to those which are mentioned above:

1. Drawing the plunger of the syringe back forcefully while collecting blood [5].
2. Sometimes, when the vein is missed after venipunture and the same syringe and needle are used for another venipuncture in the same patient, even if there is no visible blood in the syringe from the previous venipunture,
3. Prolonged tourniquet time [6].
4. Blood drawn from the IV catheter [7].
5. Prolonged contact of the serum or plasma with the cells [8].

Recently, it has been shown that evacuated closed blood collection (vacutainer) resulted in a several fold reduction in the incidence of haemolysis as compared to the open collection by using a needle and syringe, by using either disposable tubes or rewashed glass vials [9].

Case #3: One patient's serum potassium level was found to be 18 mmol/L and his sodium level was 210 mmol/L. On suspecting some contamination, another blood sample of the same patient was collected which showed the potassium and sodium levels to be within normal limits. When the nurse who had collected the

first sample was asked as to how exactly she had collected the blood, she said that she had poured the blood into the fluoride vial (containing sodium fluoride and potassium oxalate) by mistake but that upon realizing her mistake she had withdrawn the blood immediately into the syringe and had sent it to the laboratory. She did not realize that the anticoagulants would have had dissolved so quickly. This resulted in high sodium and potassium values. The other possible causes of pseudohyperkalaemia are:

1. Repeated fist clenching during the tourniquet application [10],[11],[12].
2. The lysis of leucocytes and thrombocytes in the specimens with leucocytosis and thrombocytosis [13]. This is why sometimes the potassium values are higher in the serum than in the plasma due to the lysis of the cellular elements during the process of clotting.
3. Storing the clotted blood in a refrigerator leads to the inhibition of the Na-K ATPase pump, thus leading to the efflux of potassium from the cells into the serum and the influx of sodium into the cells from the serum, thus resulting in hyperkalaemia and hyponatraemia respectively [13].
4. Potassium may falsely be elevated in the serum/plasma if the blood is collected into nonadditive/heparinised vacutainers after collecting the blood in EDTA-K3 or K-oxalate-fluoride vacutainers [14], [15].

Case #4: For the collection of heparinized blood, it is very important to use the correct salt of heparin and its quantity [16]. Example: A healthy subject's serum electrolyte level assessment was advised and since the report was needed urgently, I asked the resident doctor to collect heparinized blood. When I tested his plasma sodium and potassium levels, I found both to be below the normal limits. This was not expected as he was quite healthy and had come for a routine cardiac check up. Moreover, he was not taking any medication which might affecte the electrolyte levels. The test was repeated by using the same sample, but I got the same results. Unfortunately, another blood sample could not be collected. Then I asked the resident doctor as to how he actually collected the blood. He told me than he had taken about 0.5 ml of heparin in the syringe, but could collect even less than 1ml of blood. So, the dilution of the blood with heparin had resulted in the low values of electrolytes.

The correct amount of heparin is 20-50 U/ml of blood [17], but 12-30 U/ml is also satisfactory [18]. However, if the amount of heparin is more than the required amount, then the ionized calcium levels may be underestimated due to the binding effects of heparin on ionized calcium [17].

The sample to additive ratio: This is also very important e.g. for Prothrombin Time (PT) and for activated Partial Thromboplastin Time (aPTT). For these tests, blood is collected in citrated vial/tube in the ratio of 1:9 (1 part of citrate and 9 parts of blood). If less blood is collected (e.g.1:7), then there is a significant increase in the aPTT results as compared to those which are obtained with the 1:9 ratio [19]. However, this effect of less blood to citrate is lesser on PT. The effect of the anticoagulant/blood ratio on PT becomes meaningful only when the ratio reaches 1:4.5 i.e. just less than half of its nominal volume [20]. For polycythaemia patients, PT and aPTT can be prolonged when the nominal 1:9 ratio is used [21]. This can be rectified by adjusting the citrate concentration in accordance with the hematocrit value by using an empirical formula or by using a 1:19 ratio [20], [21].

Preanalytics involve the patient, the physician, the resident doctor, the nurse, the technician, the laboratory personnel and the transport service. Therefore, all of them are required to know about the preanalytical variables, their possible sources and their effects on the test results. Moreover, since the resident doctors have a direct interaction with the paramedical staff, it is very important for them to understand the preanalytical variables so that they could instruct the paramedical staff accordingly. For more details about the preanalytical variables one can go through the review article by Narayanan [12].

SOME DO'S AND DON'TS

1. The vein to be punctured should be localized and the area should be cleaned with 70% alcohol or chlorhexidine. It should be allowed to air dry before venipuncture.
2. The torniquet should not be applied for more than 1-2 minutes and the patient's fist should not be clenched repeatedly to visualize the vein.
3. Do not collect the blood from the vein or even from the arm which is receiving an infusion.
4. Avoid collecting blood from an IV catheter.
5. If the needle slips after venipucture, then it should be taken out and it should not be manipulated. A fresh prick should be made by using a fresh needle and syringe, even if there is no visible blood in the previous syringe.
6. Blood should not be poured into the vial/tube through the needle and with great pressure.
7. The amount of blood to be taken into an additive tube/vial should be exactly as is actually required for that tube/vial.
8. Do not shake the vial/tube vigorously after pouring the blood into it.
9. When collecting blood into vacutainers, follow the following sequence: plain tube (no additive) – citrated tube – heparin tube – EDTA tube – fluoride tube.
10. Do not keep the blood sample in a freezer or a refrigerator. Keep it at room temperature and send it to the laboratory as soon as possible.

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