The Center for Phlebotomy Education Presents

Needle Know-How

How Underfilling Tubes Cheats Patients

You're drawing blood into a syringe. Everything is going fine when suddenly the blood stops flowing. You stop pulling on the plunger for a moment, thinking that maybe you were pulling too hard and the vein collapsed, but that doesn't help. You relocate the needle ever so slightly and pull again. Nothing. You need a CBC, chemistry panel and coags and you only have half the blood you need. **What do you do?**

If you were wise enough to stock your tray with a wide variety of collection tubes, you don't have a problem. That's because you have smaller volume tubes that you can fill completely with what little blood you have. Without them, you have what we call a dilemma.

You know that the EDTA and the citrate tube have a calculated amount of anticoagulant placed in them by the manufacturer to provide accurate results when the tube is filled to capacity. If they're underfilled, it's anyone's guess on whether the results will be accurate or not. Your dilemma is to either restick the patient—which you don't really want to do since his veins and his good nature are both in short supply—or you underfill the specimens and hope the testing personnel don't reject the specimen. Suddenly, two pieces of advice enter your mind simultaneously. One is from your mother who always said that the right decision is usually the harder one; the other is from your phlebotomy instructor who told you a hundred times: "Every patient is someone's loved one." You redraw the specimen.

Properly filling collection tubes is not just a good thing when you can do it, it's a bad thing when you can't. That's because underfilling tubes with additives alters the balance between blood and additive and tinkers with the chemistry. Such tinkering can wreak havoc with results even when it's a dry additive. For example, underfilling an EDTA tube can result in excessive anticoagulation and erroneous results. When the ratio of EDTA to blood is too high, as in an underfilled tube, the red cells tend to shrink. As a result, hematocrit, mean cell volume (MCV), and the mean corpuscular hemoglobin concentration (MCHC) will be affected.

It's in the best interst of the patient to submit for testing only tubes tha have been filled to capacity.

The following chart shows how underfilling an EDTA tube to 20 percent of capacity affects test results.

	Proper fill volume	Underfilled (1ml/5ml tube)	% Change
WBC	3.2	2.4	25%
RBC	2.8	2.4	14%
HGB	10.1	8.6	15%

The tube most sensitive to underfilling is the sodium citrate tube (blue top) used for coagulation studies. Any citrate tube filled less than 90 percent of its stated volume will yield falsely lengthened coagulation results and can result in the physician adjusting the patient's anticoagulant dosage downward to a degree that risks serious complications including blood clots and stroke. Collectors who submit a tube that does not reach the manufacturer's minimum fill volume puts the patient at risk of being diagnosed, medicated and/or treated according to erroneous results with the potential for serious complications.

(cont.)

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When heparin tubes are underfilled, the accurate results of many critical analytes are at risk. According to a study published in the May/June 2006 issue of Clinical Laboratory, when the concentration of lithium heparin is three times what it is when the tube is properly filled, the following analytes exhibit changes when compared with results obtained from serum: ALT, AST, amylase, lipase, and potassium.[1] If a half-filled tube doubles the heparin concentration, it stands to reason that filling it less than 50 percent will approach a concentration three times the optimal strength. Excess heparin is also reported to cause falsely lower sodium, CK and GGT levels. The authors conclude that all anticoagulant tubes should be filled to prevent erroneous results.

Underfilling blood culture bottles also cheats the patient out of an accurate result. The optimum volume for adult patients is 20cc of blood evenly distributed between two bottles, not to exceed 10ml each. Collecting 1cc of blood for every year of life is the recommended blood culture volume for pediatrics.[2]

Organisms that cause septicemia can be in concentrations as low as one organism per milliliter of blood. Therefore, when blood culture specimens are short-sampled, the bacteria causing complications in the patient may take longer to detect, delaying antibiotic therapy and leading to complications including death. There is also the chance that the causative organism will not be detected at all in underfilled blood culture bottles.

Therefore, the more blood that is collected for a blood culture, the better the chances are of harvesting the causative organism of bacteremia. If a collection yields less than 20cc of blood on an adult patient, evacuate up to the maximum recommended volume into the aerobic vial instead of dividing lesser amounts between two vials. (98% of all septicemias are a result of aerobic organisms or facultative anaerobes, i.e., anaerobic organisms that can tolerate aerobic environments.)

Not all draws go as planned. It has been reported that 16% of all unacceptable specimens are underfilled.[1] When posed with draws that yield less than the optimum volume of blood, healthcare personnel with specimen collection responsibilities can maintain the integrity of the specimen and the subsequent results by always having a supply of lesser volume tubes available. Preparing for lesser volumes helps to assure your patients that they will not be cheated by underfilled tubes, but diagnosed, treated and medicated according to accurate results. It also prevents you from having to redraw patients whose veins have already proven to be difficult. When posed with the options of either submitting underfilled tubes for testing or having to redraw your patient, a well stocked tray with smaller volume tubes may save you from the dilemma. Your mother and your phlebotomy instructor will be proud.

References:

1) Lippi G, Salvagno G, Montagnana M, Franchini M, Guidi G. Phlebotomy issues and quality improvement in results of laboratory testing. *Clin Lab* 2006;52(5–6):217–30.

2) Garza D, Becan-McBride K. *Phlebotomy Handbook*. Pearson Prentice Hall. Upper Saddle River, NJ. 2005.