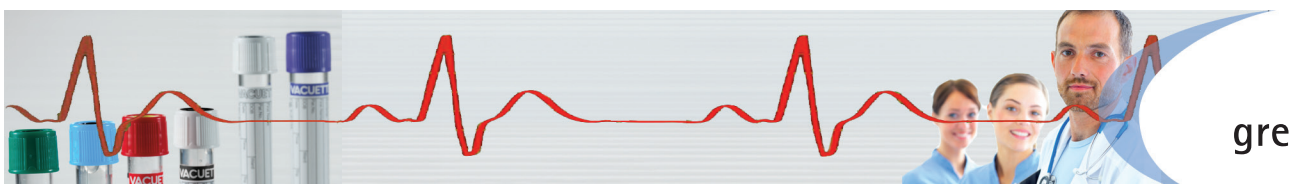

greiner bio-one

Serum or Plasma?

There is a continual debate on what type of sample a laboratory should use. While serum is still considered the gold standard and remains the required sample matrix for some assays, laboratories must consider turn-around time, which is a metric for lab performance and, more importantly, plays a critical role in patient care.

Serum is the liquid portion of the blood after it has been allowed to clot. It is free of clotting proteins but contains the clotting metabolites that result from the clotting process. It is a cleaner sample typically free of cells and platelets because they are trapped in the fibrin meshwork of the clot. Plasma, on the other hand, is the liquid portion of blood that has been prevented from clotting and is more reflective of the blood as it circulates in the body. Though it has an advantage over serum in that testing is not delayed by waiting 30 minutes for a clot to form, it is typically contaminated by platelets and cellular elements that have the potential to alter analytical results.

Both serum and plasma samples are commonly collected in evacuated tubes with a gel barrier, which separates the sample from the cellular elements that could impact analytical values. Centrifugation should occur within two hours of collection. Gels are thixotropic substances that liquefy upon centrifugation to move rapidly into place based on specific gravity. These inert gel polymers have a specific gravity that is between that of serum/plasma and the cellular portion of blood, typically around 1.04 g/cm3. With a serum sample, the gel moves up the side wall of the tube around the clot to settle into position. With plasma, this process involves free cellular elements moving down through the gel as it migrates up making it more challenging to achieve clean separation.

These sample characteristics result in definitive advantages and disadvantages with both sample types as summarized in Table 1. A serum sample must be allowed to fully clot, which may happen as quickly as 10 minutes in a healthy individual but may take up to 30 minutes in some patients. In the event that the time for the sample to reach the lab and be accessioned takes at least 30 minutes, it would seem that there is no wait prior to sample processing and analysis. However, this may be difficult to determine if samples are batched, i.e. the first samples collected in the batch may have set for 30 minutes but the last sample collected is likely to have had significantly less time to clot. Samples that have not been allowed to form a fully retracted clot that are then processed can result in latent fibrin trapped above the gel, which can interfere both analytically and mechanically when run on instrumentation. Rimming of the sample to remove fibrin is not recommended.

Ideally, serum samples should be allowed to clot in an upright position. This prevents the clot from adhering to the stopper and residual red cells from remaining in proximity to the sample and potentially impacting analysis. Exposure to red cells can alter test results such as potassium and glucose.

Plasma can be processed and tested immediately following collection. However, fibrin can also be found in plasma if the collection tubes are not mixed properly or in a timely fashion following collection. Fibrin may also form in plasma samples during refrigerated storage as a result of cold activation of clotting proteins. If there are add-on or repeat tests, the fibrin is an issue for instrumentation.

It is important that sample centrifugation is sufficient to achieve platelet-poor plasma as required for most routine assays. This is typically defined as a platelet count of less than 10,000. The manufacturer's Instructions for Use contain recommendations for centrifugation time and centrifugal force as required for FDA clearance. Other settings, i.e. higher g-force or less time, may also result in platelet-poor plasma but these setting should be validated to ensure that these changes do not result in increased platelets and cellular elements being trapped above the gel or have any impact on analysis.

There are also differences in stability of analytes with serum typically being the more stable of the two sample matrixes. Plasma tends to be less stable because of the cellular debris. Platelets , white cells and, though less common, red cells that are trapped above the gel are still metabolically active and are, therefore, capable of altering results. There is also potential for these cells to lyse and release their contents into the plasma, which will also cause changes in test results. Appropriate centrifugation will help negate this effect and minimize impact to testing.

Though there are definite differences between serum and plasma, these are minimal with proper sample handling. By adhering to good phlebotomy techniques and following both CLSI and manufacturer's recommendations for appropriate mixing, transport, processing and storage, the decision to use serum or plasma or some combination of both can be based solely on the characteristics of the sample and meeting the needs of the facility and the customers they serve.

Table 1: Comparison of Serum vs Plasma

Serum		Plasma	
Advantage	**Disadvantage**	**Advantage**	**Disadvantage**
Cleaner sample	Latent clotting can lead to fibrin formation	Faster turn-around time	Platelets and cells (typically white cells) often trapped above gel or found at plasma red cell interface in non-gel tubes
Considered the gold standard for some analyses	30 minute delay for clot formation	Representative of circulating blood	Metabolism and lysis of cells can alter test results
More stable once separated	Clot retraction elevates potassium levels relative to plasma values	Increased sample volume	Considered less stable especially when stored

Bibliography

Guder WG, et al. Use of anticoagulants in diagnostic laboratory investigations & stability of blood, plasma and serum samples. WHO/DIL/LAB/99.1 Rev.2. Geneva, Switzerland. *WHO -World Health Organization*, 2002.

Oddoze C, Lombard E, Portugal H. Stability study of 81 analytes in human whole blood, in serum and in plasma. *J Clin Biochem;* 2012, 45: 464–469.

Raffick A.R. Bowen RAR, Hortin GL, Csako G, Otañez OH, Remaley AT. Review: Impact of blood collection devices on clinical chemistry assays. *J Clin Biochem;* 2010, 43: 4-25.

VACUETTE® one step ahead ▶