Advances in Blood Drawing Using Evacuated Tubes

Improving patient and clinician safety

by Ron Stoker

Dr. Charles Gabriel Pravaz (1791-1853), a French surgeon, and Alexander Wood (1817-1884), a Scottish physician, independently invented the hypodermic syringe. It was first used to inject morphine. It had a hollow pointed needle, made of steel, with a hard rubber hub. In 1897 Maxwell W. Becton and Farleigh S. Dickinson formed a company and started manufacturing an all-glass syringe imported from France.

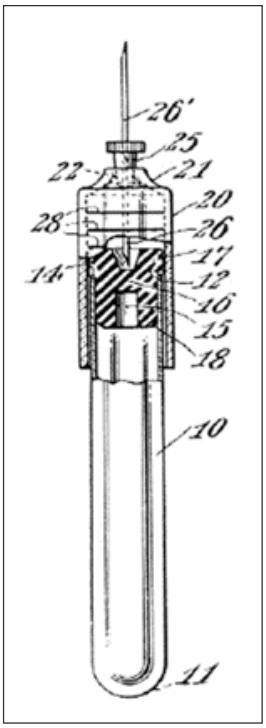
The world of drawing blood has changed radically from those days. In the early 1970s it was much more difficult to obtain a blood sample. There were no evacuated tube systems at the time. The laboratory staff would have to prepare a variety of solutions to be placed into glass test tubes. These solutions included EDTA, Citrate, and others. These solutions were dispensed into test tubes to prevent the coagulation of blood. In order to make sure that the proper amount of blood was placed into each test tube, the laboratory staff had to etch lines into the borosilicate glass tubes.

The phlebotomist would then collect blood specimens with needles and glass syringes. The phlebotomist would have to stick the patient many times providing samples for the chemistry lab, the hematology lab and for coagulation studies. The phlebotomist would then transfer the blood into a series of test tubes. Tubes were sealed with black rubber stoppers so that they could be transported to the laboratory.

This was before the day of disposable medical devices. After concluding all the tests laboratory personnel would have to wash the syringes and the test tubes for the next patient. Removing blood from the glass tubes was difficult but even more difficult was washing off the soap residue. Many rinses were needed to remove it. The needles were then re-sharpened using a grinding wheel, washed again and then re-sterilized. Can you imagine having to do all that?

Patients did not enjoy the multiple needle entries into the vein. There were many opportunities for errors to occur during the collection and transfer process.

Figure 1.
A drawing from Joseph Kleiner's "Evacutainer" patent.



The introduction of evacuated blood collection systems provided greater safety, while offering ease-of-use and speed. However, it also provided additional challenges. How was this procedure accomplished?

The evacuated blood collection system consisted of a needle assembly which had a distal needle that was inserted into the patient and a proximal needle that was in the backend of the holder. During a blood drop procedure, the distal end of the needle would enter into the patient's vein. The evacuated tube would be pushed down onto the proximal needle so that blood entry from the patient would fill up the evacuated tube. The vacuum enabled the tube to fill out with the appropriate volume of blood. When multiple specimens were required, additional evacuated tubes would then be inserted into the holders after the completion of the previous draw.

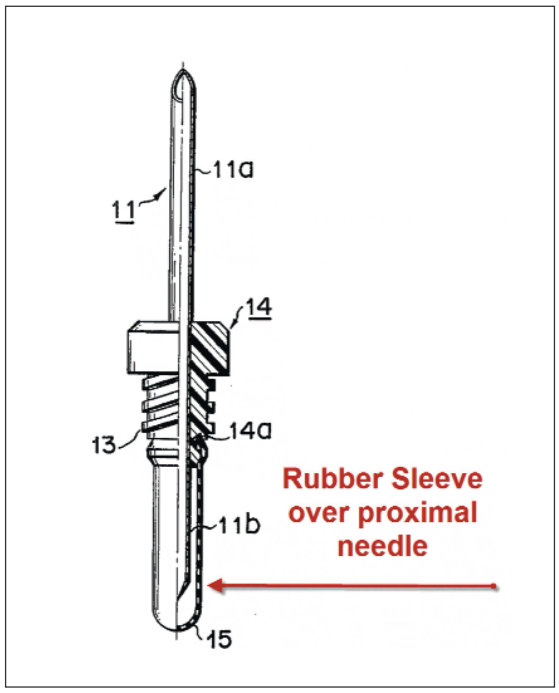
The first evacuated tube was invented by Joseph Kleiner and was called the "Evacutainer."[1] See Figure 1. He subsequently assigned the patent to BD in 1949 and was hired as a consultant to the company. Although this development made blood sampling easier it was not without its own set of problems.

When the distal needle is inserted into a vein the blood flows from the distal needle to the proximal needle. This proximal needle, capable of penetrating the plug on the evacuated tube, was always left open. Blood flowing under its own pressure from the vein would flow past the proximal needle and into the holder leading to blood loss, discomfort for patients and bloodborne pathogens exposure. When the evacuated tube was removed, blood would continue to drip into the holder.

In 1973, Sinae Miyake came up with a clever innovation that would eliminate some of these problems. His idea was to put

a thin rubbery multiple sample sleeve onto the proximal needle which would envelope the proximal needle (see Figure 2).

Figure 2. Miyake placed a multiple sample sleeve over the proximal needle.[2]



When the needle was inserted into a vein, blood was unable to pass from the distal needle into the proximal needle because of this multiple sample sleeve. However, when the evacuated tube stopper is pushed against this sleeve it would allow the needle to poke through this sleeve and into the evacuated tube. When the evacuated tube was removed the multiple sample sleeve would again cover up the needle and prevent blood flow, thus protecting both healthcare worker and patient. This system has been in use for almost 30 years now. This sleeve has been very successful in preventing the errant flow of blood into the holder.

Unfortunately there are some drawbacks with this sleeve. While the multiple sample sleeve prevents blood from flowing until it is perforated by the collection tube insertion, it also prevents flashback, a sign that the vein has been entered into properly. Some patients have small veins or have veins that are not very close to the skin surface. In patients like these, it is sometimes difficult to obtain a blood sample because the needle may miss the vein entirely or may pass completely through a thin vein. In instances like this, blood flowing through the needle and into the evacuated blood collection tube may be inadequate to fill, which may require the clinician to start the procedure all over again. This wastes time for the clinician, adds the expense of additional needles and evacuated tubes, and patients are not too happy about having multiple needlesticks. Therefore, there is a great need to be able to be able to know when the needle has entered into the vein.

Ideally, the clinician inserts the point of the needle into the patient until one sidewall of the vein has been punctured. It is at this point that it is important for the clinician making the vein entry to ensure the vein entry has actually been made so that the rest of the procedure can be completed. Phlebotomists are busy assessing the patient's physical and psychological condition as they select the venipuncture site. Phlebotomists must also select the proper corresponding equipment and then perform the procedure with a technique that controls bleeding and must properly collect and identify fluid specimens for testing. All this while making sure that the hidden needle tip is in the correct position.

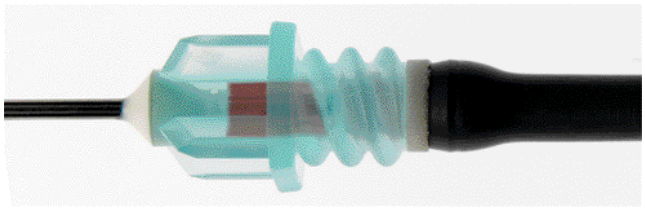
In the mid-'80s, Greiner Bio-One made one of the first innovations to provide more safety in blood collection, with the invention of the first virtually unbreakable evacuated blood collection tube made out of plastic.

A new product has been recently introduced which helps clinicians with an additional safety feature that improves on previous generations of blood drawing equipment. The product, the VACUETTE® QUICKSHIELD Complete Plus is manufactured and distributed by Greiner Bio-One. The QUICKSHIELD Complete Plus is a pre-assembled VISIO PLUS Needle (providing flashback control) pre-assembled into a QUICKSHIELD safety tube holder. The combination provides users and patients with safety and comfort. See Figure 3.

Figure 3. Quickshield Complete Plus

The new VACUETTE QUICKSHIELD Complete Plus contains the new VACUETTE® VISIO PLUS Needle with optical venipuncture control already pre-assembled into a VACUETTE® QUICKSHIELD Safety tube holder and is ideally suited for daily blood collection routine. Immediately on correct vein penetration, blood flow enters the transparent hub of the needle, thus indicating to the user that the tip of the needle is in the correct position in the vein lumen (see Figure 4).

Figure 4. When needle penetrates vein correctly blood flows into the transparent hub of needle.



For the phlebotomist, this means much more safety. There is no change to venipuncture technique; the only difference is the ability to know that the needle is in the vein. The VACUETTE QUICKSHIELD Complete Plus also has advantages for the patient. Movement in the vein during penetration while searching for the vein lumen is sometimes painful for the patient. Due to the visible blood flow in the view window, this movement is avoided. The special cut of the needle tip makes penetration of the tissue easier as well.

It is easy to use. Simply follow these guidelines:

- Make sure that the patient is identified correctly.
- The evacuated tubes that will be needed for the test should be identified and readily available. In addition all other equipment that may be needed should be located nearby.
- The evacuated tubes should be properly labeled and placed in order of use.
- A tourniquet is applied on the arm where blood collection will occur. The tourniquet should be just tight enough that blood will collect in the veins.
- Using gloved hands, the vein should be palpated to determine its depth size and direction and to give the clinician opportunity to determine the best angle to puncture the skin.
- Select the puncture site.
- Wipe this area with an alcohol swab or iodine preparation as per hospital protocol. Allow to air dry.
- Insert the needle into the vein with the bevel facing upward. The needle should be inserted quickly and smoothly to minimize pain and to prevent blood from splashing out through the bevel. **When venipuncture has been carried out successfully, blood flow is visible in the view window in the transparent plastic hub of the needle.**
- Push the tube into the VACUETTE QUICKSHIELD holder and onto the needle valve puncturing the rubber diaphragm. Hold tubes in place with thumb until filled to the required level.
- The tourniquet should be promptly removed once blood starts to enter the evacuated tube. The tourniquet should not be left on the arm longer than one minute or it could skew the results.
- Remove the last tube from the holder prior to pulling the Visio Plus needle out from the vein following hospital guidelines.
- Activate the safety shield on the VACUETTE QUICKSHIELD holder by gently drawing the needle toward the shield on a stable surface. An audible click can be heard, ensuring the user that the safety shield has been properly activated.
- Dispose of the VACUETTE QUICKSHIELD Complete Plus device in a sharps box.

The VACUETTE QUICKSHIELD Complete Plus with the pre-assembled VISIO PLUS Needle provides the added "vision" to show the clinician that the blood drawing needle is indeed in the vein providing the clinician with venipuncture control. The ease-of-use of the flashback window located in the translucent cannula hub makes it easy to know whether or not the needle is appropriately in the vein. This flashback window has an integrated filter preventing any possible leakage. The new needles are available in two different needle sizes (21G and 22G) and two lengths (1 inch and 1.5 inches). For more information, visit www.gbo.com/preanalytics or call 704.261.7800. ✛

References

1. Kleiner J. "Blood collecting apparatus," U.S. Patent No. 2,460,641, August 1945.
2. Rubber Sleeve over Proximal needle, © copyright 2008 ISIPS.

Ron Stoker is the founder and executive director of the International Sharps Injury Prevention Society (ISIPS). Mr. Stoker has a graduate degree in Bioengineering from the University of Utah with an undergraduate degree from Brigham Young University. He has been involved in the medical device industry for more than 28 years in a variety of settings, including research and development, business development, marketing and public relations, and has six patents issued in his name. He writes frequently about sharps safety and infection control issues and speaks internationally. Mr. Stoker is co-author of the Compendium of Infection Control Technology and has compiled a comprehensive list of safety products. The list is available at www.isips.org/safetyproductlist.php.