THE CHALLENGE BLOOD BANKS FACE:
MEETING THE NEED FOR BLOOD WHILE PROTECTING THE DONORS

Blood transfusion saves lives and is an indispensable component of modern healthcare. For patients in emergency care, for patients with cancer or anemia, and for patients with chronic diseases who require life-long treatment with blood products, transfusions provide a lifeline. A well-functioning, efficient and quality controlled blood donation facility is crucial for meeting the needs of adequate, safe and high-quality blood and blood products.

To protect donors' as well as recipients' health, pre-donation testing is performed. Apart from excluding blood borne diseases, hemoglobin (Hb) screening is among the foremost tests done for blood donor selection. It ensures the donor is in good health and prevents blood collection from anemic donors.

It can be estimated that a donor's Hb will decrease approximately 0.7 to 1.5 g/dL after whole blood donation, depending on the donor's size and pre-donation Hb level. It then takes approximately three to four weeks for the body to reach normal level again.[1]

International and national guidelines commonly recommend a minimum acceptable Hb concentration for blood donation of 12.5 g/dL for both men and women[2], or 12.5 g/dL for women[3] and 13.0[4] or 13.5 g/dL[3] for men. The threshold is set to protect the donor from unwanted effects from the donation, including anemia or aggravating an already existing anemia. Approximately one third of deferrals are due to Hb values below threshold.[1]

Availability of high quality blood and blood products is a prerequisite of modern health care. Accurate Hb testing prior to blood collection is a necessary quality control that protects both donor and recipient.

NO CONSENSUS AS TO WHAT METHOD IS BEST FOR HB SCREENING

Even though Hb screening is well established and routinely performed before donation, there is no consensus as to which method is the best one to use. It is important that the method chosen is accurate enough to avoid blood collection from individuals with too low Hb concentrations, but no less important, a method that doesn't defer prospective donors inappropriately. Or put differently; a method that balances the need to ensure donor safety with the need to maintain an adequate blood supply. Other requirements are that donor discomfort should be minimal, the method should be quick, practical and easy to use by non-laboratory personnel and applicable in a mobile setting.

The historical standard method for Hb screening of blood donors has been the copper sulfate gravity method. In addition to this method, testing for spun microhematocrit and Hb determination with portable hemoglobinometers are also commonly used methods.

Thanks to being fast, inexpensive and easy to perform, the obsolescent copper sulfate method is still the method of choice in many countries. This method is performed by letting a drop of blood fall into a copper sulfate solution of known specific gravity. The drop will either sink or float depending on whether it is lighter or heavier than the copper sulfate solution. If the drop falls steadily to the bottom of the container, even if slowly, the specific gravity of the blood sample exceeds the solution. The blood droplet should be dropped into the copper sulfate solution from 1 centimeter above the surface, and the result should be read after 15 seconds. Assuming a normal specific gravity of plasma, the specific gravity of the blood sample is directly proportional to the Hb concentration.

There are a number of disadvantages with this method. It is not quantitative – it only gives a "yes" or a "no" to blood donation.[5] This means that individuals found to have a too low Hb value cannot be adequately counseled on the medical significance of the finding. In addition, among accepted donors, individuals with abnormally high Hb values will not be detected. Moreover, the method is susceptible to handling errors and the endpoint is subjective. The blood dropped into the solution gradually changes its specific gravity, as does evaporation of the solution, which can be a problem in areas with a hot climate. Waste disposal is an issue both because the solution used is a biohazard, and in some countries, also regarded an environmental toxin. Moreover, there is a lack of a generally accepted quality control for the method.[1]

There are concerns about sensitivity, specificity and accuracy of the copper sulfate method. Individuals with very low Hb values are occasionally falsely accepted for donation because of inadequate sensitivity, which may have serious consequences for the individual. One reason for a false "yes" for donation could be a high serum protein content, or high white blood cell counts, but there are also cases where no obvious reason for the failure of copper sulfate screening is found.[6]

A more common problem with the copper sulfate method is false deferrals of prospective donors. Lack of specificity of this test can result in unnecessary donor deferral.[7] There are reports describing recovery of around 50 % of deferred donors when tested with a different method.[1] A majority of blood centers using the copper sulfate method as their primary method, therefore retest donors who do not pass the first test.

The microhematocrit method is a quantitative method that is used for blood donor screening in some blood centers, and in others it is used as a secondary procedure for donors who have failed the copper sulfate screening test. This method also has a number of disadvantages. An electrically powered centrifuge is required, which is of course not always available at mobile collection units. There is also a risk of erroneous determination of hematocrit level caused by trapped plasma in the column of packed red blood cells, or due to technical variations in the equipment used or the choice of anticoagulant.[1]

In 1995, WHO introduced a hemoglobin color scale (HCS) for detection of anemia. A drop of blood is placed on a test paper strip and the color of blood on the test strip is matched against 6 shades on the color scale. Initial results indicate a sensitivity of 95 % and specificity of 99.6 %. However, other studies have indicated much lower performance with conclusions that the HCS should not be used for Hb estimation, as the degree of accuracy is not considered clinically acceptable. Although it has been proposed to replace the copper sulfate method for screening of blood donors and the Sahli's method in primary health care centers, it is prone to inter-observer variability. It also has limited utility because it can only determine significant levels of anemia as it is not sensitive enough to detect incremental changes in Hb less than 1g/dl.[5]

Nowadays, blood centers commonly use digital hemoglobinometers that measure the Hb concentration spectrophotometrically.[1] The HemoCue system consists of disposable microcuvettes and a photometer. The cuvette is filled with capillary blood from a finger stick or anticoagulated venous blood. The battery-operated portable analyzer then reads the absorbance and compensates for any turbidity in the sample. Several studies report the HemoCue system to be reliable, accurate and to give reproducible results.[5]

The method chosen for pre-donation Hb testing needs to fulfill a number of criteria. It has to be accurate enough to avoid accepting anemic individuals for donation, and not unnecessarily reject eligible donors. It should be easy and straight forward to use by the health care staff, and last but not least important: be as convenient as possible for the prospective donor. Blood donors are volunteers and the donation process should be as quick, smooth and safe as possible.

PROSPECTIVE BLOOD DONORS ARE DEFERRED FOR A NUMBER OF REASONS. AVOIDING FALSE DEFERRAL IS IMPERATIVE.

Just as it is important to avoid collecting blood from individuals at risk of anemia, it is important also to ensure the supply of blood. It is crucial to maintain donors, recruit new ones and if possible increase their ability to donate by increasing donation frequency while not adversely affecting donor health. Therefore, it is necessary to minimize deferrals but also to reduce the risk of provoking iron deficiency or anemia to maximize the number of donors and donations.[8]

There are a number of factors why prospective blood donors may fail to meet the Hb threshold to be eligible for blood donation. Women generally have lower Hb levels than men and Hb tends to decrease with age. Higher ambient temperature, low body weight and shorter inter-donation intervals are factors associated with higher deferral rates due to low Hb. Ethnicity can also affect Hb levels.[8] Consequently, in situations where blood supply is always less than the demand, there is an urgent need to reduce the number of falsely deferred blood donors.

Several studies have found that a donor that has been deferred once is less likely to return later for a new attempt to donate blood. This applies even if the deferral is due to a temporary cause such as a cold, a high temperature or an Hb level under the threshold. The negative effect of temporary deferral is most pronounced for first time donors, but is also seen in individuals who donate blood regularly.

The American Red Cross Blood Services, Southeastern Michigan Region in the US, compared the return rates for deferred and non-deferred donors during a period of 4.25 years. Non-deferred donors were 29 % more likely to return during the study period than donors with a previous deferral. This resulted in 81 % more blood units collected from non-deferred donors at 4.25 years. This difference continues to increase with time.[9]

The Virginia Blood Services (VBS) in the US has calculated what the loss of donors means in practice for them. They also examined how changing screening methods affects the number of falsely deferred donors. VBS serves the Commonwealth's two largest teaching hospitals and is challenged to keep up with the demand for blood. In the study, the VBS compared the copper sulfate method with the HemoCue method with respect to number of falsely deferred prospective donors. They found that screening for Hb with the HemoCue method resulted in 1.9 % fewer rejected qualified donors. The VBS collects blood from approximately 100,500 donors annually. An inappropriate rejection rate of 1.9 % means that approximately 1,910 donors would have been needlessly rejected resulting in the need to import

an equivalent number of units. This equates to one week's utilization by the hospitals served by the center. The authors conclude that in combination with the finding by Halperin et al (1998) that donors are less likely to return for donation once deferred, the effect will be magnified. According to their findings, nearly 500 of the 1,910 will be less likely to donate in the future and these donors must be replaced through more costly marketing.[10]

There is a high risk that a deferred donor is a donor lost forever. It is easier to take good care of existing blood donors than to find new ones. Avoiding false deferrals is one way of minimizing donor loss.

THE MOST COMMON METHODS HAVE BEEN COMPARED IN SEVERAL STUDIES

With the purpose of developing a better system for blood donor screening for anemia, and to come to terms with the large number of inappropriate deferrals, a study was undertaken on 3,000 blood donors where 120 were deferred after being tested with the copper sulfate method. Of these, 92, or 76.6 %, were found to be falsely deferred when retested with the HemoCue system and an automated hematology analyzer.

The authors conclude that in an ideal situation, blood donors should be tested with an automated hematology analyzer that gives extremely accurate values in only 30 seconds. Such a hematology analyzer is however expensive and non-portable. The HemoCue system on the other hand, is small and lightweight, and displays an Hb value in within 60 seconds. Moreover, they state that a two-pronged approach for assessment of Hb would result in collection of a large number of additional units of whole blood per year, and that every effort to improve the accuracy for Hb screening for prospective blood donors should be made.[11]
In a regional blood transfusion center in Western India, the HemoCue system was introduced as an alternate method for Hb screening in August 2005. Between September 2005 and July 2006, a study was conducted to analyze the effect of using a digital hemoglobinometer for detection of Hb on donors that had been deferred by the copper sulfate method. 35,339 donors were included in the study and 4,391, or 12.4 %, were deferred with the copper sulfate method. When 3,163 of the deferred donors were rested with the HemoCue system, 1,196, or 37.8 %, were found to have a Hb value of >12.5 g/dL. The authors point out that in a country like India where 8 million donations are collected each year, even a small percentage of false accepts or deferrals at the Hb screening represents a large number of individuals. They conclude that using the HemoCue system, unnecessary deferrals of donors can be reduced to a great extent.[12]

In another study, a comparison of four Hb testing methods was combined with a cost analysis. The study was performed in a hospital based blood center in North India. The main objective was to compare the HCS, the copper sulfate method and the HemoCue system with a standard hematology analyzer. Over a six-month period, venous blood from 1,014 donors was tested with all four methods. The HemoCue technique was found to have the highest sensitivity and specificity (99.4 % and 84.4 %). The copper sulfate method also showed a high sensitivity (98.8%), but the specificity was lower (58.1 %). This method inappropriately passed 6.9 % prospective donors, and falsely deferred 1 %. The corresponding figures for HemoCue was 2.6 % and 0.5 % respectively. The authors speculate that by using the HemoCue system, 50 % of the inappropriately deferred donors could have potentially been recovered, although the number of false deferrals was low for both methods. The HCS did not show good agreement with the reference method. It gave 25.2 % false results (both false positives and negatives) against 7.9 % by the copper sulfate method and 3.1 % by HemoCue. The authors state that this method may be good to assess the prevalence of anemia in general population in peripheral areas but is definitely not suitable for Hb screening in prospective blood donors. In conclusion the authors think that even

if the HemoCue system would be the best method to use, it might be economically beyond reach as a primary method for many centers. They suggest that the copper sulfate method be retained as the primary testing method, but that subsequent testing is done with the HemoCue system to save inappropriate deferrals.[13]

In a Brazilian study on 969 female donors, Hb testing with the HemoCue system was found to decrease the risk of exposing anemic donors to blood donation without increasing the false deferral rate compared to another quantitative method, the microhematocrit method. The authors discuss the economic implications of changing screening methods to the HemoCue method, which was found to perform better than the microhematocrit method. According to the results of the study, and considering that 60,000 women annually give blood at Fundacao Pro-Sangue/Hemocentro de Sao Paolo, 1,114 truly anemic women would be saved from blood donation by the HemoCue method every year. In a cost benefit analysis, the authors come to the conclusion that the cost of saving these donors from the possible harm of blood donation is not too high, especially not if extra costs associated with anemia treatment is considered.[14]

A high proportion of false deferrals of prospective blood donors is a problem when using the copper sulfate method as the only anemia screening method in blood banks. A combined approach, where copper sulfate is used as the primary test, and a digital hemoglobinometer is used to re-test deferred donors, can be a successful compromise, economically sustainable also for countries where resources are limited.

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