
U. S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL
FORT SAM HOUSTON, TEXAS 78234

BLOOD DONOR OPERATIONS I



SUBCOURSE MD0867

EDITION 101

DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

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TABLE OF CONTENTS

<u>Lesson</u>	<u>Paragraphs</u>	<u>Page</u>
INTRODUCTION		iii
1 DONOR SUITABILITY AND BLOOD COLLECTION		
Section I. Donor Suitability.....	1-1--1-5	1-3
Section II. Blood Collection.....	1-6--1-11	1-27
Section III. Autologous Blood.....	1-12--1-16	1-42
Exercises		1-46
2 COMPONENT PROCESSING, TESTING, LABELING, STORAGE, AND DISTRIBUTION		
Section I. Component Processing	2-1--2-2	2-3
Section II. Blood Donor Testing	2-3--2-4	2-18
Section III. Review and Labeling	2-5--2-10	2-26
Section IV. Blood Storage/Distribution	2-11--2-17	2-37
Exercises		2-43
3 COMPATIBILITY TESTING AND BLOOD ADMINISTRATION		
Section I. The Immune Response and the Interaction of Antigens, Antibodies, and Complement in Immunohematology	3-1--3-11	3-2
Section II. The Antiglobulin Test.....	3-12--3-18	3-10
Section III. Red Cell Antibodies	3-19	3-16
Section IV. Compatibility Testing	3-20--3-29	3-17
Section V. Blood Administration.....	3-30--3-36	3-28
Section VI. Investigation of Adverse Effects.....	3-37--3-40	3-43
Exercises		3-51
Glossary		G-1
Annex A		A-1
Annex B		B-1
Annex C		C-1
Annex D		D-1

<u>Lesson</u>	<u>Paragraphs</u>	<u>Page</u>
Annex E		E-1
Annex F		F-1
Bibliography		BIB-1

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Page</u>
1-1 DD Form 572, Blood Donor Record (front side)	1-5
1-2 DA Form 572, Blood Donor Record (reverse)	1-6
1-3 Donor information.....	1-7
1-4 Donor screening utilizing DD Form 572 (continued).....	1-9
1-5 Bar Codes on reverse side of DD Form 572	1-20
1-6 Donor screening utilizing oral questions.....	1-22
1-7 Triple blood bag set.....	1-29
1-8 Trip balance set-up	1-30
1-9 Filling of sample tubes	1-34
2-1 Fullface label for RBCs	2-27
2-2 ISBT 128-Specified Label	2-35
3-1 The four-chain structure of an IgG molecule showing both interchain and intrachain disulfide bridges (Cbh = carbohydrate).....	3-5

LIST OF TABLES

2-1 Blood Anticoagulants/Preservatives Solution Licensed by the FDA.....	2-4
2-2 Amount of Glycerol Needed for Different Weights of RBC Units.....	2-9
2-3 Methods for Leukocyte Reduced Red Blood Cells	2-12
2-4 Summary of Quality Control Requirements for Components	2-17
2-5 Routine ABO Grouping	2-20
3-1 Antihuman Globulin Reactions	3-12
3-2 Blood Choice	3-21
3-3 Thrombocytopenia and Platelet Therapy	3-31
3-4 Blood Component and Fractions Containing Factor VIII	3-34
3-5 Plasma Substitutes	3-37
3-6 Management of Transfusion Reactions.....	3-44
3-7 Schedule of Investigation of Suspected Transfusion Reactions.....	3-47

**CORRESPONDENCE COURSE OF THE
U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL**

SUBCOURSE MD0867

BLOOD DONOR OPERATIONS I

Blood for transfusion is a biologically active therapeutic substance. It has specific effects on the human organism and dosage requirements just as any other therapeutic substance. Blood differs, however, from other biologicals in that it must be obtained from healthy individuals of the human race. The 1980's brought increasing complexity of blood banking operations and problems associated with assessment and management practices for donor suitability, deferral, and adherence to appropriate testing practices and prevention of inappropriate release of blood and blood components. The responsibilities of those who collect, process, and issue blood for transfusion are tremendous.

Blood transfusion attempts are recorded as far back as the 16th century. At first, animal blood was transfused to humans. Later, human blood was used. However, facts concerning the characteristics of even human blood were not known, and these early transfusions frequently caused severe reactions and often death.

The safety of blood transfusion is directly proportional to the knowledge, skill, and sense of responsibility of the laboratory technicians. It is not sufficient to establish appropriate procedures and techniques. Continuous instruction and training are required to assure the highest quality and safety in performance of blood bank procedures. That is why in this subcourse, instruction is concerned with blood donor center and transfusion service activities, including preparation of blood products for transfusion therapy.

Subcourse Components:

This subcourse consists of three lessons, a glossary of blood banking terms and definitions, six annexes, a bibliography, and an examination. The lessons are:

Lesson 1, Donor Suitability and Blood Collection.

Lesson 2, Component Processing, Testing, Labeling, Storage, and Distribution.

Lesson 3, Compatibility Testing and Blood Transfusion.

Credit Awarded:

Upon successful completion of this subcourse, you will be awarded 20 credit hours. You must receive a score of 70 percent or higher on the examination in order to successfully complete this subcourse.

Lesson Materials Furnished:

Materials provided include this booklet, an examination answer sheet, and an envelope. Answer sheets are not provided for individual lessons in this subcourse because you are to grade your own lessons. Exercises and solutions for all lessons are contained in this booklet.

You must furnish a #2 pencil to be used in marking the examination answer sheet. You may keep the subcourse booklet.

Procedures for Subcourse Completion:

Complete the subcourse lesson by lesson. When you have completed all of the lessons to your satisfaction, complete the examination answer sheet and mail it to the AMEDD Center and School along with the Student Comment Sheet (if appropriate) in the envelope provided. *Be sure that your social security number is on all correspondence sent to the AMEDDC&S.* You will be notified by return mail of the examination results. Your grade on the examination will be your rating for the subcourse.

Study Suggestions:

Here are some suggestions that may be helpful to you in completing this subcourse:

- Read and study each lesson carefully.
- Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson.
- After completing each set of lesson exercises, compare your answers with the solutions. If you have answered an exercise incorrectly, reread the text material cited after the solution to determine why your response was not the correct one.
- As you successfully complete each lesson, go on to the next. When you have completed all of the lessons, complete the examination, marking your answers in this booklet. When you are satisfied that you have answered all of the examination items to the best of your ability, transfer your responses to the examination answer sheet. Use a #2 pencil to mark the examination answer sheet.

Student Comment Sheet:

Be sure to provide us with your suggestions and criticisms by filling out the Student Comment Sheet found at the back of this booklet, and returning it to us with your examination answer sheet. In this way, you will help us to improve the quality of this subcourse.

If you wish a personal reply to a question, please call or write your question on a separate letter (not the Student Comment Sheet). The letter can be sent with the examination answer sheet. Be sure to include your name, rank, social security number, mailing address, and subcourse number on your letter.

LESSON ASSIGNMENT

LESSON 1

Donor Suitability and Blood Collection

TEXT ASSIGNMENT

Paragraphs 1-1 through 1-16.

LESSON OBJECTIVES

After completing this lesson, you should be able to:

- 1-1. Identify clinical signs and symptoms associated with HIV infection and AIDS.
- 1-2. Identify physical examination and medical history criteria which would be cause for donor rejection.
- 1-3. Identify "Confidential Unit Exclusion" (CUE) procedure.
- 1-4. Identify the requirements for the Donor Deferral Registry (DDR) and the associated codes.
- 1-5. Describe the donor deferral notification process.
- 1-6. Match deferral codes and infectious disease testing results using algorithms in Annex A.
- 1-7. Describe the donor collection procedure.
- 1-8. List symptoms of adverse donor reactions.
- 1-9. Describe treatment for adverse donor reactions.
- 1-10. Identify different types of donors and requirement variations.
- 1-11. Describe autologous donations.
- 1-12. List tests required for autologous blood donation testing.
- 1-13. Identify labeling requirements for autologous blood.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

DONOR SUITABILITY AND BLOOD COLLECTION

Section I. DONOR SUITABILITY

1-1. GENERAL

Blood donor centers and transfusion services depend on voluntary donors to provide the blood products needed to meet the organization mission requirements. The ultimate goal of donor centers and transfusion services is to obtain the safest blood product possible. Donor selection is based on a limited physical examination and a medical history done on the day of the donation. This process greatly decreases the chance of transmission of agents that can harm the recipient. It also ensures that there are not any negative effects on the donor. The most useful tool to accomplish the routine screening of blood donors is the use of the Blood Donation Record, DD Form 572 (see figures 1-1 and 1-2). To meet regulatory requirements, several critical points must be continuously managed and monitored when determining donor suitability: predonation event, donor registration, donor screening and acceptance, and donor deferral registry.

1-2. PREDONATION

a. To attract volunteer donors and to encourage the continued support of the blood program, it is important that the atmosphere surrounding the blood donation be as pleasant, safe, and convenient as possible. The donation area should be attractive, well-lighted, clean, comfortably ventilated, and open at convenient hours. Personnel should be friendly and understanding, professional and well trained. A Standing Operating Procedure Manual (SOP) that covers all phases of donor activities must be readily available.

b. Provide information to the prospective donor (figure 1-3). The information provided must include the following.

- (1) Clinical signs and symptoms associated with HIV infection and AIDS.
 - (a) Unexplained weight loss (10 pounds or more in less than 2 months).
 - (b) Night sweats.
 - (c) Blue or purple spots on or under the skin, eyes, or in the mouth.
 - (d) Swollen lymph nodes lasting more than one month.

- (e) Persistent white spots or unusual blemishes in the mouth.
 - (f) Temperature greater than 100.5°F for more than 10 days.
 - (g) Persistent cough and shortness of the breath.
 - (h) Persistent diarrhea lasting more than 1 month.
- (2) High risk activities pertaining to HIV transmission.
- (3) The importance of refraining from donating blood if he (she) has engaged in high risk activities or he (she) experiences the signs and symptoms of AIDS.
- (4) Information on the tests to be done on the donor's blood, the people that will be notified of abnormal results, and the possible inclusion on the donor deferral list.
- (5) The possibility that the testing may fail to identify individuals capable of transmitting infectious disease due to early stages of the infection. (Question 48 of DD Form 572 makes reference to this fact. Response must be "YES.")
- (6) Information on sites and/or mechanisms to obtain an HIV antibody test should be provided to all prospective donors.

NOTE: The same education material can be used to warn donors of possible reactions and give suggestions on what to do after the donation. All information provided to the prospective donor should be presented in a way that is easy to understand. Before the blood is collected, prospective donors must acknowledge in writing that they read and understood the information provided by the blood collecting facility, and that they have been given the opportunity to ask questions (question 49 of DD Form 572 must be answered "YES" in order for donor to be allowed to donate blood).

1-3. DONOR SCREENING UTILIZING DD FORM 572

a. Principles.

(1) Demographic information which may be used to identify blood donors must be recorded and verified during the time of each donation. Donor suitability must be determined on the day of collection by utilizing the donor medical history and limited physical examination. This information is required by the American Association of Blood Banks (AABB) and the Food and Drug Administration (FDA) and must be retained indefinitely.

BLOOD DONATION RECORD

DONATION IDENTIFICATION
NUMBER

SECTION I - (To be completed by Blood Donor Center personnel)												
1. DONATION FACILITY												
SECTION II (To be completed by Blood Donor)			2. TODAY'S DATE		3. DONOR SSN			4. DONOR FAMILY MEMBER PREFIX (FMP)/SPONSOR SSN				
5. NAME (Last, First, Middle Initial)				6. GRADE/RATE	7. DATE OF BIRTH	8. AGE	9. SEX F M	10. ETHNIC ORIGIN	11. ABO/Rh	12. DONOR CATEGORY Mil Dep Civ		
13. ADDRESS (Street, City, State, Zip Code)					14. COUNTRY		15. DUTY PHONE (Include Area Code)		16. HOME PHONE (Include Area Code)			
17. ORGANIZATION				18. STATION			19. (Local Use Only)		20. (Local Use Only)			
DONOR MEDICAL HISTORY (Circle "Y" for Yes, or "N" for No.)												
Y	21.	N	Have you ever given blood under another name or Social Security Number?	Y	38.	N	In the past 12 months, have you had a positive test for syphilis?					
Y	22.	N	In the past 8 weeks, have you given blood, plasma or platelets?	Y	39.	N	In the past 12 months, have you had or been treated for syphilis or gonorrhea?					
Y	23.	N	Have you ever been refused as a blood donor or told not to donate blood?	Y	40.	N	In the past 12 months, have you given money or drugs to anyone to have sex with you?					
Y	24.	N	Have you ever had chest pain, heart disease or lung disease?	Y	41.	N	Female Donors: In the past 6 weeks, have you been pregnant or are you pregnant now?					
Y	25.	N	Have you ever had cancer, a blood disease, or a bleeding problem?	Y	42.	N	In the past 4 weeks, have you had any shots or vaccinations?					
Y	26.	N	Have you ever had yellow jaundice, liver disease, hepatitis, or a positive test for hepatitis?	Y	43.	N	In the past 4 weeks, have you taken any pills, medications, Accutane or Proscar?					
Y	27.	N	Have you ever had Chagas' disease, babesiosis, or Leishmaniasis?	Y	44.	N	In the past 3 days, have you taken aspirin or anything that has aspirin in it?					
Y	28.	N	Have you ever been given human growth hormone?	Y	45.	N	Have you ever used a needle, even once, to take any drug (including steroids)?					
Y	29.	N	Have you ever taken Tegison for psoriasis?	Y	46.	N	Have you had sex, even once, with anyone who has ever used a needle, even once, to take any drug (including steroids)?					
Y	30.	N	Are you feeling well and healthy today?	Y	47.	N	Is your reason for donating blood to obtain an AIDS test?					
Y	31.	N	In the past 3 years, have you been outside the U.S.A. or Canada?	Y	48.	N	Do you understand that if you have the AIDS virus, you can give it to someone else even though you may feel well and have a negative AIDS test?					
Y	32.	N	In the past 3 years, have you had malaria or taken anti-malarial drugs?	Y	49.	N	Have you read and understood all the donor information presented to you, and have all your questions been answered?					
Y	33.	N	In the past 12 months, have you been under a doctor's care or had a major illness or surgery?	Y	50.	N	Have you or any of your family relations ever been told you have Creutzfeldt-Jakob disease?					
Y	34.	N	In the past 12 months, have you received blood or had an organ or tissue transplant?	Y	51.	N	Have you ever received a tissue transplant or tissue graft?					
Y	35.	N	In the past 12 months, have you had a tattoo, ear or skin piercing, acupuncture, or an accidental needle stick?	Y	52.	N	Were you born in, have you ever lived in or ever traveled to Central America, South America, or Mexico (other than a US / Mexico Border)?					
Y	36.	N	In the past 12 months, have you had close contact with a person with yellow jaundice or hepatitis, or have you been given Hepatitis B Immune Globulin (HBIG)?	Y	53.	N	In the past 12 months, have you been incarcerated for more than 72 consecutive hours?					
Y	37.	N	In the past 12 months, have you been given rabies shots?	Y	54.	N						
SECTION III - (To be completed by Blood Donor Center personnel)				55. DEFERRAL LIST CHECKED BY	56. DONOR ID VERIFIED BY	57. WEIGHT	58. TEMP.	59. PULSE	60. B.P.	61. HB/HCT	62. GENERAL APPEARANCE Sat Unsat	63. ARM CHECK Sat Unsat
64. DOES DONOR QUALIFY? Yes No	65. BAG TYPE 1 2 3 4 5		66. BAG LOT NO.	67. SEGMENT NO.		68. ANTI-COAGULANT CPDA-1 Other		69. ALERT CODE	70. TOTAL DONATIONS	71. DONATION TYPE Allo Therap Aphere Other Auto Direct		
72. DIRECTED DONATION RECIPIENT			73. FMP/SSN (Directed only)		74. HOSPITAL TRANSFUSION SITE		75. COMPUTER ENTRY BY	76. INTERVIEWER	77. MEDICAL REVIEWER			
SECTION IV				78. START TIME	79. STOP TIME	80. PHLEBOTOMIST	81. DONATION STATUS Complete Unsuccessful Incomplete Overfill		82. REACTION None Slight Moderate Severe			
SECTION V - DONOR MEDICAL HISTORY COMMENTS / DONOR REACTION COMMENTS												
(To be completed by Blood Donor Center personnel) (Continued on back)												
83. DONOR SIGNATURE. I have read the Privacy Act Statement and Statement of Consent on the back side, and have been given the opportunity to answer questions relating to the educational material and medical history questions. I have been asked and fully understand HIV high-risk behavior questions contained on the Oral Questions Sheet dated _____								84. DATE SIGNED		X CONFIDENTIAL UNIT EXCLUSION		

DD Form 572, FEB 93

PREVIOUS EDITION IS OBSOLETE

Figure 1-1. DD Form 572, Blood Donor Record (front side).

SECTION VI - PRIVACY ACT STATEMENT / STATEMENT OF CONSENT		DONATION IDENTIFICATION NUMBER
PRIVACY ACT STATEMENT		
AUTHORITY:	10 U.S.C. 136 (Assistant Secretaries of Defense) and E.O. 9397.	
PRINCIPAL PURPOSE(S):	To record time of withdrawal and type of blood, and to determine suitability of voluntary blood donations. To administer the Armed Services Blood Program, and, in some cases, to recommend medical treatment.	
ROUTINE USE(S):	None	
DISCLOSURE:	Voluntary; however, failure to provide complete information will make you ineligible to donate blood at this time.	
STATEMENT OF CONSENT		
<p>I have reviewed and understand the information provided to me regarding the spread of the AIDS virus (HIV) by blood or plasma. If I am potentially at risk for spreading the virus known to cause AIDS, I agree not to donate blood or plasma for transfusion to another person or for further manufacture. I understand that my blood will be tested for antibodies to HIV and other disease markers. If this testing indicates that I should no longer donate blood or plasma because of a risk of transmitting the AIDS virus, my name will be entered on a list of permanently deferred donors. I understand that I will be notified of a positive result. If, instead, the result of the testing is not clearly negative or positive, my blood will not be used and my name may be placed on a deferral list without my being informed until the results are further clarified. I have been informed of the phlebotomy procedure and possible adverse reactions. I have also read the Privacy Act Statement above. I am voluntarily donating approximately 450 mL of blood to the Armed Forces for use in any way they deem advisable. I understand that I should not engage in strenuous exercise or hazardous activity on the day of donation. I attest that all the information provided is true to the best of my knowledge.</p>		
SECTION V - MEDICAL HISTORY COMMENTS / DONOR REACTION COMMENTS <i>(Continued)</i>		

DD Form 572, FEB 93 (Back)

Figure 1-2. DD Form 572, Blood Donation Record (reverse).

<p>HIV (Human Immunodeficiency Virus)</p> <p>HIV is the virus that causes Acquired Immunodeficiency Syndrome (AIDS). The test for AIDS that we use is very good, but no test is perfect. There is a period during early infection with HIV when tests for HIV may be negative yet infection may still be transmitted. An individual may be infected despite feeling well.</p> <p>HIV-Associated Signs and Symptoms include:</p> <ul style="list-style-type: none"> ● Unexplained weight loss (10 pounds or more in less than 2 months) ● Night sweats ● Blue or purple spots on or under the skin, eyes, or in the mouth ● Swollen lymph nodes lasting more than one month ● Persistent white spots or unusual blemishes in the mouth ● Temperature greater than 100.5°F for more than 10 days ● Persistent cough and shortness of breath ● Persistent diarrhea <p>You should not donate if...</p> <ul style="list-style-type: none"> ● you have AIDS or any one of the signs and symptoms listed above ● you have ever had a positive test for AIDS ● you are a male who has had sex with another male, even once, since 1977 ● you have ever used a needle, even once, to take any drug (including steroids) ● you have taken money or drugs for sex since 1977 ● you have ever taken clotting factor concentrates for a bleeding problem, such as hemophilia ● you are currently an inmate at a correctional facility (including prison and jail) <p>You should not donate if, during the last 12 months...</p> <ul style="list-style-type: none"> ● you had sex, even once, with anyone who has AIDS or has had any of the signs and symptoms of AIDS listed above ● you had sex, even once, with anyone who has tested positive for the AIDS virus ● you are a female who had sex with a man who had sex with another man, even one time, since 1977 ● you had sex, even once, with anyone who has ever taken clotting factor concentrates for a bleeding problem, such as hemophilia ● you had sex, even once, with anyone who has used a needle, even once, to take any drug (including steroids) ● you had sex, even once, with anyone who has taken money or drugs for sex since 1977 ● you have given money or drugs to anyone to have sex with you ● you had a positive test for syphilis ● you had syphilis or gonorrhea or were treated for syphilis or gonorrhea ● you have received a blood transfusion, organ transplant, or tissue transplant ● you have been a victim of rape or sexual assault ● you have been incarcerated at a correctional institution for 72 consecutive hours ● you have had contact with blood and/or body fluids through percutaneous inoculation (such as injury or accidental needle stick) or through contact with an open wound, not-intact skin, or mucous membrane 	<p>Blood Tests: The Donor Center is required to test all donated blood prior to transfusion to minimize the risk of transfusion reactions and transmission of infectious diseases. If you decide to donate, your blood will be tested for:</p> <ul style="list-style-type: none"> ● ABO & Rh type ● Antibody to Hepatitis C Antigen ● Other blood group antibodies ● Antibody to HIV (AIDS virus) ● Antibody to HTLV-1/II(Human T-Cell Leukemia Virus) ● Possible testing for Antibody CMV (cytomegalovirus) ● Antibody to Hepatitis B Core ● Hepatitis B Surface Antigen ● Syphilis ● HIV Antigen <p>Individuals who test positive for HIV or other diseases are notified and become part of a donor deferral registry. Public Health officials may also be notified. Never donate blood just to be tested. Confidential free AIDS testing is available by contacting Preventive Medicine Service at (PMS Phone #).</p> <p>Confidential Unit Exclusion:</p> <p>You will be asked to complete a "Confidential Unit Exclusion," a bar code to let us know your blood is not safe for transfusion. All confidentially excluded units will be destroyed, but donors are fully tested with the routine tests.</p> <p>After you donate:</p> <ul style="list-style-type: none"> ● You can remove the bandage after four hours ● Drink more fluids than usual in the next four hours ● No alcohol until you have eaten ● Do not smoke for half an hour ● If there is bleeding from the collection site, raise arm and apply pressure ● If you are feeling faint or dizzy, either lie down or sit down with your head between your knees ● If any symptoms persist, either call the Donor Center or see a doctor ● You may resume all normal activities after about half an hour if you feel well ● If you should become ill within 72 hours of donation, notify the Donor Center ● If you should develop hepatitis, a positive HIV test, or AIDS within 12 months of donation, notify the Donor Center <p style="text-align: center;">HOT LINE</p> <p>If you donated today, but are concerned for any reason that your blood may not be safe for transfusion, please call the donor center immediately. Your call will remain confidential. Just request that your blood not be given to a patient. You will not need to mention the reason for the request.</p>
--	--

Figure 1-3. Donor information.

(2) After Section II of the Blood Donation Record form is completed by the donor, a limited physical examination is performed and a confidential review and interview is conducted to determine donor eligibility. The confidential interview will include using HIV high risk behavior questions currently identified by the FDA. An explanation for each question marked "YES" (except for question 30, 48, and 49) or left unanswered will be written in Section V - Donor History Comments/ Donor Reaction Comments area of the DD Form 572.

b. **Questions.** The information given in figure 1-4 represents the questions on the DD Form 572.

c. **Procedure Notes.**

(1) Throughout the screening process, any answers requiring additional interpretation for acceptability beyond the scope of the screening staff, should be referred to the Blood Bank Medical Director or designee for timely response.

(2) Screening procedures will not ensure absolute safety to donors or subsequent patients, but by utilizing the screening procedures defined within this blood bank SOP, "Donor Screening Utilizing DD Form 572," military Blood Banks are able to provide the highest level of quality donor screening available at this time.

d. **Confidential Unit Exclusion.** All prospective blood donors will be asked to complete a "Confidential Unit Exclusion" portion on the DD Form 572. On the back of this form's top portion, there are two bar codes (figure 1-5): one for "Transfuse My Blood" and the other one is for "Do Not Transfuse My Blood." Give the appropriate instructions to the blood donor and let the donor complete it in private. The bar code selected must be affixed on the bottom right-hand side, at front of the DD Form 572. The Confidential Unit Exclusion (CUE) should be completed during the interview process or prior to the blood collection. All confidentially excluded units must be destroyed, but blood specimens are fully tested with the routine tests.

Section I: TO BE COMPLETED BY BLOOD DONOR CENTER

1. DONATION FACILITY: The blood collection facility's name and address.

Section II: TO BE COMPLETED BY THE DONOR EXCEPT BLOCK 19 AND 20

2. TODAY'S DATE: The medical history form must be completed on the date of donation. The donation date should be entered here.

3. DONOR SSN: Social Security Number of the donor. Verify the accuracy and legibility of the donor's social security number, preferably with a picture ID.

4. DONOR FAMILY MEMBER PREFIX (FMP)/SPONSOR SSN: A donor who is a family member of an active duty or retired military individual is registered in the military system under their family member prefix (FMP) and sponsor's SSN. Ensure that appropriate Family Member Prefix (FMP) and sponsor SSN are entered. Family member prefixes (FMP) commonly seen are:

Active Duty Member or Retired	
Military Member.....	20
Spouse of Sponsor.....	30
First Child of Sponsor.....	01
Second Child of Sponsor	02
Next Child	03, 04, 05, 06, etc.
Civilian, not related to a military sponsor.....	00

5. NAME: Ensure legible name is entered: LAST, FIRST, MI.

6. GRADE/RATE: Military or civilian grade. DEP for family member who is not employed by the Federal government.

7. DATE OF BIRTH: The date of birth should be entered here. Utilize DD/MM/YY format if numbers utilized exclusively, otherwise spelling of month will allow multiple acceptable formats.

8. AGE: Donors must be at least 17 years of age for routine donation. Donors under 17 may donate with written and signed consent of their parent or guardian. If the person is on active duty, no special consent from a parent or guardian is required.

9. SEX: M = Male; F = Female

10. ETHNIC ORIGIN: This is an optional field. Donors may write what they consider their ethnic origins to be. Persons of different ethnic origins may exhibit certain disease traits or genotypes which may assist in locating specific phenotypic blood units.

11. ABO/Rh: Donor's blood group and type, if known.

12. DONOR CATEGORY: Circle the appropriate code. MIL: Military, active or reserve; DEP: Military family member; CIV: Civilian.

13. ADDRESS: Installation mailing address for active duty personnel or home address for reservists, dependents, or civilians: Street, City, State, Zip Code.

14. COUNTRY: Enter the country of residence if other than United States; if resident is United States, no entry is required. No entry or a line through will be equivalent to United States of America.

15. DUTY PHONE (Include Area Code): Phone number at which the donor may be reached during the normal duty hours of the installation.

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

16. HOME PHONE (Include Area Code): Phone number at which the donor may be reached after normal duty hours. This phone number is particularly important for donors who are reservists on temporary duty or others who are not active duty military.

17. ORGANIZATION: Military or federal organization at which the donor is employed. Military family members and civilian (non federal employed) blood donors may leave this area blank.

18. STATION: The installation at which the person is employed.

19. (LOCAL USE ONLY):

20. (LOCAL USE ONLY):

**DONOR MEDICAL HISTORY:
TO BE COMPLETED BY THE DONOR**

21. HAVE YOU EVER GIVEN BLOOD UNDER ANOTHER NAME OR SOCIAL SECURITY NUMBER? This question is to cross-index previous records on donors who have had name changes or have donated under a different identification number. An example would be a donor who donated under the family prefix and sponsor's SSN instead of under his/her own SSN under his/her own SSN or a woman who donated under her maiden name.

22. IN THE PAST 8 WEEKS, HAVE YOU GIVEN BLOOD, PLASMA, OR PLATELETS? The interval between whole blood donations will be no less than 56 days (8 weeks) for routine donors. A donor who has had a pheresis procedure performed will normally be eligible to donate a whole blood unit 72 hours following the completion of that pheresis procedure providing that all other donor criteria are met.

23. HAVE YOU EVER BEEN REFUSED AS A BLOOD DONOR OR TOLD NOT TO DONATE BLOOD? Determine the reason for the prior rejection and if the reason still exists. Donors who have recurring donor reactions or from whom blood has not been drawn successfully (repeated entry failures or short draws due to the donor) may be considered for deferral.

24. HAVE YOU EVER HAD CHEST PAIN, HEART DISEASE OR LUNG DISEASE? Donors who experience unexplained chest pain are deferred. Chest pain due to strenuous exercise is **NOT** cause for deferral.

(a) Donors who experience unexplained chest pain are deferred. Chest pain due to strenuous exercise is NOT cause for deferral.

(b) Heart disease which affects physical activity is cause for deferral. Rheumatic heart disease or coronary disease which has resulted in permanent damage or chronic problems of the heart muscle is cause for permanent deferral. A single episode of rheumatic fever, pericarditis, or heart murmur does not automatically disqualify a donor. The donor must have a regular pulse to qualify.

(c) Active tuberculosis is cause for deferral. Prophylactic INH (Isonizid) therapy for a positive TINE test with a negative chest X-RAY is NOT cause for deferral.

(d) Donors with asymptomatic asthma may donate. Donors with other chronic lung conditions should be permanently deferred.

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

25. HAVE YOU EVER HAD CANCER, A BLOOD DISEASE OR A BLEEDING PROBLEM?

(a) Donors with diagnosed leukemia, lymphomas, or malignancies which may metastasize are to be permanently deferred. Donors with histologically proven melanomas should be permanently deferred because of the possibility of that tumor recurring later after removal and potentially be transmissible in rare instances.

(b) Donors with signs or symptoms of Kaposi Sarcoma are permanently deferred.

(c) Minor skin cancer (defined as basal cell carcinoma or squamous cell carcinoma, but NOT melanoma), adenomatous polyps of the colon with cancer in situ, or squamous carcinoma in situ of the uterine cervix which have been surgically treated without recurrence are NOT causes for deferral.

(d) History of utilizing Factor VIII (AFH) concentrates or Factor IX complexes is cause for permanent deferral.

26. HAVE YOU EVER HAD YELLOW JAUNDICE, LIVER DISEASE, HEPATITIS, OR A POSITIVE TEST FOR HEPATITIS?

(a) A donor will be deferred PERMANENTLY for a history of hepatitis or positive test for the following: Hepatitis B Surface Antigen, Hepatitis C Virus Antibody, or a positive hepatitis test of unknown origin. Donors with a Hepatitis B Core Antibody test positive on two separate donations must be PERMANENTLY deferred.

(b) Permanently defer a donor if their previous blood donation was the only unit of blood or component given to a patient who developed post transfusion associated hepatitis.

(c) Donors with a history of unexplained yellow jaundice after infancy

are permanently deferred unless the jaundice occurred before the age of eleven.

(d) Permanently defer any donor who has had clinical evidence of possible liver disease.

27. HAVE YOU EVER HAD CHAGAS DISEASE, BABESIOSIS, OR LEISHMANIASIS? The parasites of Chagas Disease, Babesiosis, and Leishmaniasis may be transmitted by blood transfusions. Donors who have been diagnosed as having been parasitized by Babesia microti, Trypanosoma cruzi, and visceral Leishmania spp. are to be permanently deferred. See Questions 31 and 52 regarding Chagas' risk criteria.

28. HAVE YOU EVER BEEN GIVEN HUMAN GROWTH HORMONE? Before 1986, pituitary growth hormone was of human origin and could transmit Creutzfeldt-Jakob disease (CJD). After 1985, the hormone was made from genetically altered bacteria. Permanently defer donors who have taken pituitary growth hormone of human origin. Tissue transplants (cornea or dura mater) may also transmit CJD. Donors should be permanently deferred.

29. HAVE YOU EVER TAKEN TEGISON FOR PSORIASIS? Permanently defer donors who have taken Etreinate (Tegison).

30. ARE YOU FEELING WELL AND HEALTHY TODAY?

(a) Donors who have any condition that elicits a "NO" answer should NOT donate blood or blood products and should wait until the disease or condition is resolved. Donors taking antibiotics are to wait until the course of treatment is complete and no symptoms persist.

(b) The answer to this question should be **YES**.

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

31. IN THE PAST 3 YEARS HAVE YOU BEEN OUTSIDE THE USA OR CANADA?

(a) Travelers who are permanent residents of nonendemic countries but have been in an area considered as a malaria endemic area, may be accepted as regular donors 12 months after return to the nonendemic area, providing they have been free of unexplained febrile illnesses.

(b) Donors who were born in, or have **ever** lived in or traveled to Central America, South America, or Mexico (other than a US/Mexico border town) are at an increased risk for contracting Chagas's disease. This question covers a period of travel for three years only. Donors traveling to the areas mentioned should have also answered "Y" to Question 52. Question 52 is specific for the evaluation of Chagas's Disease. This question evaluates travel or habitation in the risk areas for the entire life of the donor versus only a three year period covered in question 31. See question 52 for more details.

32. IN THE PAST 3 YEARS HAVE YOU HAD MALARIA OR TAKEN ANTIMALARIAL DRUGS?

(a) Prospective donors who have had malaria will be deferred for 3 years after becoming asymptomatic.

(b) Permanent residents of non-endemic countries who travel to an area considered to be endemic for malaria **WILL NOT BE** accepted as donors of whole blood and blood components prior to **one year** after their departure from the endemic area irrespective of antimalarial prophylaxis.

(c) Donors who have taken antimalarial prophylaxis and did not visit a malaria endemic area are eligible to donate.

33. IN THE PAST 12 MONTHS HAVE YOU BEEN UNDER A DOCTOR'S CARE OR HAD A MAJOR ILLNESS OR SURGERY?

(a) Chronic conditions must be evaluated individually. The conditions of high blood pressure controlled by medication, thyroid replacement therapy and diabetes controlled by diet or oral agents are acceptable as long as other donation criteria are met.

(b) Donors who have had minor surgery with no blood transfusion may donate once they have had any sutures removed and have resumed normal activity. Note the type of surgery, surgical date and acceptance/deferral remarks in section V of the DD 572.

(c) Donors who have had a tooth extraction or oral surgery are deferred for 72 hours after the procedure.

(d) For the safety of the donor, persons with a history of epilepsy or seizures after childhood are to be deferred. Donors who have a history of fainting while donating are to be deferred. A one time fainting episode is not usually cause for deferral.

34. IN THE PAST 12 MONTHS HAVE YOU RECEIVED BLOOD OR HAD AN ORGAN OR TISSUE TRANSPLANT?

(a) Defer 12 months if the donor received any blood or blood products.

(b) Donors who received allogeneic (homologous) blood must be deferred for 12 months after transfusion. Donors who received autologous blood only may donate once they have resumed normal activity.

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

(c) Donors who received cornea or dura matter transplants must be permanently deferred due to increase risk for Creutzfeldt-Jakob Disease. Also see question 50.

(d) Donors who had an organ or tissue transplant are permanently deferred. Also see question 51.

35. IN THE PAST 12 MONTHS HAVE YOU HAD A TATTOO, EAR OR SKIN PIERCING, ACUPUNCTURE, OR AN ACCIDENTAL NEEDLE STICK?

(a) All of the above may carry an increased risk of the transmission of the hepatitis virus or HIV. Clinical symptoms of hepatitis will normally be exhibited in an infected individual within 12 months. Defer any donor for 12 months after the procedure.

(b) Ear or other body site piercing is not cause for deferral if a sterile skin penetration occurs.

36. IN THE PAST 12 MONTHS, HAVE YOU HAD CLOSE CONTACT WITH A PERSON WITH YELLOW JAUNDICE, OR HEPATITIS, OR HAVE YOU BEEN GIVEN HEPATITIS B IMMUNE GLOBULIN (HBIG)? (HBIG is NOT the Hepatitis B vaccine series.)

(a) Exposure is usually defined as close physical contact, living with (cohabitation) or sharing the same eating and sanitary facilities with someone who has or has had hepatitis in the past twelve (12) months. These donors will be deferred for twelve (12) months from the last contact. The type of contact that most hospital personnel encounter in their routine work is not usually considered close contact and is not usually cause for deferral.

(b) A donor who has received immune globulin as a result of exposure to hepatitis must be deferred for 12 months after the administration of that immune globulin.

37. IN THE PAST 12 MONTHS, HAVE YOU BEEN GIVEN RABIES SHOTS?

Donors who have received rabies shots as a result of exposure to body fluids of an infected animal or an animal of unknown status must be deferred for 12 months following the exposure. Veterinarians and other staff who receive immunizations prophylactically are not deferred for their rabies shots.

38. IN THE PAST 12 MONTHS, HAVE YOU HAD A POSITIVE TEST FOR SYPHILIS?

(a) A confirmed positive test for syphilis indicates possible high risk behavior and donors are to be deferred for 12 months following treatment.

(b) Donors who have a positive RPR test but have a negative confirmation test may be acceptable for donation. Documentation of negative confirmatory testing must be maintained for these donors.

39. IN THE PAST 12 MONTHS, HAVE YOU HAD OR BEEN TREATED FOR SYPHILIS OR GONORRHEA?

(a) Donors who have had an episode of venereal disease must be considered as being exposed to the hepatitis virus and/or HIV and are to be deferred for one year (12 months) after treatment.

(b) Donors who are listed for sexually transmitted diseases on the donor deferral registry and who have had a positive confirmation test for that venereal disease are deferred for 12 months post treatment. Before reinstatement, the donor must present verification of completed treatment.

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

40. IN THE PAST 12 MONTHS, HAVE YOU GIVEN MONEY OR DRUGS TO ANYONE TO HAVE SEX WITH YOU? Defer donors for 12 months from the date that they last gave money and/or drugs to someone for sex. Persons who have given others drugs or money for sex are practicing high risk behavior and have an increased risk of developing AIDS and other sexually transmitted diseases.

41. FEMALE DONORS: IN THE PAST 6 WEEKS, HAVE YOU BEEN PREGNANT OR ARE YOU PREGNANT NOW? For males, answer NA (Not Applicable), line through the entry, or leave blank. This is an acceptable blank entry if area #9 is answered as male. Females are deferred until six (6) weeks after delivery/termination of pregnancy. Abortions or miscarriages up to the first trimester are not deferring. If the donor received blood or blood products, defer for 12 months after transfusion.

42. IN THE PAST 4 WEEKS, HAVE YOU HAD ANY SHOTS OR VACCINATIONS?

(a) ONE YEAR DEFERRAL: HBIG or Rabies following exposure.

(b) ONE MONTH DEFERRAL: German Measles (Rubella)

(c) TWO WEEK DEFERRAL: Smallpox, Sabin Polio (oral polio), Measles (Rubeola), Mumps, Yellow Fever. Two week deferral after the Chicken pox (Varicella) Vaccine series is completed.

(d) NO DEFERRAL IF SYMPTOM FREE: Heptavax, Influenza, Tetanus, Diphtheria, Pertussis, Typhoid, Paratyphoid, Rocky Mountain Spotted Fever, Salk Polio, Plague, Rabies (prophylactic), gamma globulin (without exposure, prophylactic) and any toxoid preparation.

43. IN THE PAST 4 WEEKS, HAVE YOU TAKEN ANY PILLS, MEDICATION, ACCUTANE, OR PROSCAR? Determine the reason why the donor is taking medication. Deferral for most drugs is based on the nature of the disease process, not for the properties of the drug itself. The following are acceptable drugs and normally are NOT cause for deferral:

(a) Topical Steroid Preparations for skin lesion/irritations not at the phlebotomy site.

(b) Blood Pressure Medications taken successfully so that pressure is at or below allowable limits. The donor should be free of side effects and cardiovascular symptoms.

(c) Isonizid (INH) given for a positive skin test but without any evidence of active tuberculosis.

(d) Decongestants, Antihistamines, Expectorants, Cough Suppressants, and Bronchodilators (over the counter) used for allergies.

(e) Oral Hypoglycemic Agents in well controlled diabetics without any vascular complications.

(f) Tranquilizers under most conditions. Donors using tranquilizers for the treatment of psychotic conditions are to be deferred until treatment is complete.

(g) Hypnotics used at bedtime.

(h) Other medications: oral contraceptives, mild analgesics, vitamins, minerals, replacement hormone, muscle relaxers, or weight reduction pills.

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

(i) Tetracyclines and other Antibiotics for Acne are acceptable with the following exceptions: Donors having taken Isotretinoin (Accutane) or Finasteride (Proscar) are deferred for one month after the receipt of the last dose. Donors having taken Etreinate (Tegison) are permanently deferred.

(j) Feldene (Piroxicam) like aspirin, inhibits platelet function. Random donor platelets collected from donors who have ingested compounds containing Feldene (Piroxicam) within 72 hours should not be the sole source of platelets for a patient. The random platelets should be labeled to reflect that the platelet concentrate should not be the sole source of platelets. Plateletpheresis will not be performed on donors who have ingested compounds containing Feldene (Piroxicam) within 72 hours.

44. IN THE PAST 3 DAYS, HAVE YOU TAKEN ASPIRIN OR ANYTHING THAT HAS ASPIRIN IN IT? Aspirin or aspirin-containing products depress platelet function and therefore these donors should not be the sole source of platelets for a patient. The random platelets should be labeled to reflect that the platelet concentrate should not be the sole source of platelets. Plateletpheresis will not be performed on donors who have ingested aspirin compounds or other platelet-affecting medications.

45. HAVE YOU EVER USED A NEEDLE, EVEN ONCE, TO TAKE ANY DRUG (INCLUDING STEROIDS)?

(a) Permanently defer all donors with a history of intravenous drug abuse. Donors with a history of drug abuse involving injected drugs have an increased risk of contacting and transmitting hepatitis, AIDS, and/or HTLV-I/II.

(b) Donors receiving injections prescribed by physicians and administered in a controlled environment may donate blood if all other donor criteria are met.

46. HAVE YOU HAD SEX, EVEN ONCE, WITH ANYONE WHO HAS EVER USED A NEEDLE, EVEN ONCE, TO TAKE ANY DRUG (INCLUDING STEROIDS)? Persons who have had sex with any person who is a past or present intravenous drug user or who has used IV muscle enhancers (steroids administered in a gym) are deferred for 12 months.

47. IS YOUR REASON FOR DONATING BLOOD TO OBTAIN AN AIDS TEST?

(a) Question the donor as to the reason for wishing an AIDS test. Defer the donor if high risk behavior is disclosed.

(b) Blood donation is not an appropriate method of obtaining an HIV test. Phone numbers and locations where the donor may obtain a test should be readily available and may be included in the AIDS information material. The HIV test for blood donation may not be substituted for the force testing requirements for the military at this time.

48. DO YOU UNDERSTAND THAT IF YOU HAVE THE AIDS VIRUS, YOU CAN GIVE IT TO SOMEONE ELSE, EVEN THOUGH YOU MAY FEEL WELL AND HAVE A NEGATIVE AIDS TEST? Donors are to understand the information provided concerning AIDS prior to donating blood. An oral interview will be conducted with each donor. The FDA questions regarding high risk behavior will be asked to each donor individually. You must orally review the AIDS information with any donor answering NO and the donor must decide, on the basis of the information, to change the answer to YES. If the answer remains NO, defer the donor. The answer to this question should be **YES**.

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

49. HAVE YOU READ AND UNDERSTOOD ALL THE DONOR INFORMATION PRESENTED TO YOU AND HAVE ALL YOUR QUESTIONS BEEN ANSWERED?

Donor information should be written in language that supports understanding by the donor to include the definition of high-risk behavior and the importance of self-exclusion. Donors will not be allowed to donate until they have had the opportunity to read and understand the donor information presented. The answer to this question should be **YES**.

50. HAVE YOU OR ANY OF YOUR FAMILY RELATIONS EVER BEEN TOLD YOU HAVE CREUTZFELDT-JAKOB DISEASE?

The FDA has concluded that persons with a family history, including all blood relatives, of Creutzfeldt-Jakob disease should be permanently deferred from donating blood due to increased risk for the disease. This includes all donors who have had cornea, dura mater, tissue transplant or tissue graft.

51. HAVE YOU EVER RECEIVED A TISSUE TRANSPLANT OR TISSUE GRAFT?

Donors who have had tissue transplants or tissue grafts, to include dura mater, are permanently deferred due to increase risk for Creutzfeldt-Jakob disease.

52. WERE YOU BORN IN, HAVE YOU EVER LIVED IN OR EVER TRAVELED TO CENTRAL AMERICA, SOUTH AMERICA, OR MEXICO (OTHER THAN A U.S./MEXICO BORDER)?

(a) If this question is answered "No," the donor is eligible to donate and no further evaluation for Chagas's disease is necessary.

(b) If this question is answered "Yes," the donor center technician will orally ask each of the following supplemental Chagas questions of the prospective donor.

The donor's responses will be documented in Section V of the DD Form 572 by entering either "Answered Yes to the Chagas risk questions" or "Answered No to the Chagas risk questions" whichever is applicable.

"Have you ever been told you have Chagas' disease or have you had a positive test for Chagas' disease?"

"Have you ever slept in a home or building with a palm thatched roof or walls made from mud?"

"Have you ever had a blood transfusion or shots of blood while living in this area?"

"Have you ever had facial swelling on one side while in, or shortly after, a visit to this area?"

(c) If any of the supplemental questions is answered "Yes," the donor should be indefinitely deferred pending evaluation by the Blood Bank Medical Director. If all four questions are answered "No," the donor is eligible to donate and no further evaluation for Chagas' disease is necessary.

(d) **Chagas' Risk Countries:**

ARGENTINA	GUATEMALA
BELIZE	GUYANA
BOLIVIA	HONDURAS
BRAZIL	MEXICO (see [e]
CHILE	below)
COLOMBIA	NICARAGUA
COSTA RICA	PANAMA
ECUADOR	PARAGUAY
EL SALVADOR	PERU
FALKLAND ISLANDS	SURINAME
URUGUAY	VENEZUELA
FRENCH GUIANA	

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

(e) MEXICO:

(1) Evaluate all **immigrants** for Chagas' disease, regardless of which part of the country they live in.

(2) **Travelers** to cities and towns directly across from the US border are not at risk and do not need to be evaluated for Chagas' disease.

(3) **Travelers** to the following cities are not at risk and do not need to be evaluated for Chagas' disease: Chihuahua, Ciudad Acuna, Ciudad Juarez, Ciudad Obregon, Ensenada, Gomez Palacio, Guayama, Hermosillo, La Paz (on Baja peninsula), Matamoros (the border town), Mexicali, Mexico City, Monterrey, Nogales (the border town), Nuevo Laredo, Piedras Negras (the border town), San Felipe (on Baja peninsula), Tijuana, Torreon, and Toluca.

53. IN THE PAST 12 MONTHS, HAVE YOU BEEN INCARCERATED FOR MORE THAN 72 CONSECUTIVE HOURS?

(a) Recent studies have indicated that a significant proportion of inmates in correctional institutions (jails and prisons) are at increased risk of infectious diseases such as hepatitis and AIDS. The increased risk was attributed to a high incidence of illicit intravenous drug use, high risk sexual behavior, and tattooing.

(b) As a result of information obtained through the studies, current inmates of correctional institutions and individuals who have been incarcerated (for more than 72 consecutive hours) during the previous 12 months must be deferred from donating blood for 12 months from the last date of incarceration.

54. LEAVE BLANK.

SECTION III: TO BE COMPLETED BY BLOOD DONOR CENTER PERSONNEL

55. DEFERRAL LIST CHECKED BY:

Personnel checking the manual deferral printout or the computer deferral database will initial this area.

56. DONOR ID VERIFIED: Donors should have some type of picture identification to verify their identity. If documents are not available to make SSN verification, the donor may be asked verbally their SSN and the individual doing the verification will check the donor's response against the recorded SSN.

57. WEIGHT: Donor's weight in pounds (lbs.) Donors must weigh at least 110 lbs for a routine donation of 405-495 ml of whole blood. See the appropriate SOP for possible variations which may apply to autologous or therapeutic blood donors.

58. TEMPERATURE: Donor's temperature must NOT exceed 99.5°F on the oral or earlobe thermometer. Defer donors with a temperature of 99.6°F or higher for ten days or until the temperature has returned to normal limits.

59. PULSE: Donors should have a pulse between 50-100 beats per minute and have a pulse that reveals no possible pathologic cardiac irregularity. Donors with a pulse rate less than 50 beats per minute are to be questioned as to their exercise habits. People who exercise often may have a decreased pulse rate. Donors with an elevated rate or irregular pulse should be encouraged to seek medical evaluation and are to be deferred for ten days or until the pulse has returned to normal limits.

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

60. BLOOD PRESSURE (BP): The donor's blood pressure is to be within normal limits. The systolic must not exceed 180 mm Hg and the diastolic must not exceed 100 mm Hg. Donors with elevated blood pressure should be encouraged to seek medical evaluation. Defer donors until the blood pressure is within normal limits.

61. HB/HCT: (HEMOGLOBIN, HEMATOCRIT) A sample of blood obtained by finger stick, earlobe puncture or venipuncture will be obtained for hemoglobin or hematocrit determination prior to the blood donation. The donor's HB (hemoglobin) must be equal to or greater than 12.5 g/dL. The HCT (hematocrit) must be equal to or greater than 38% for routine donors. Defer donors with a low HB/HCT for ten days or until hemoglobin/hematocrit returns to normal screening limits.

62. GENERAL APPEARANCE: Circle the appropriate answer. (SAT = Satisfactory; UNSAT = Unsatisfactory). Donors should appear to be in good health. Donors who are excessively nervous, appear ill or under the influence of a mind altering substance (alcohol or drugs) should be deferred from donating.

63. ARM CHECK: Circle the appropriate response. (SAT = Satisfactory; UNSAT = Unsatisfactory). Both arms are to be inspected for evidence of skin punctures or scars indicative of possible drug abuse. The skin must be free of sores or rashes that may interfere with phlebotomy or contaminate the blood upon phlebotomy.

64. DOES DONOR QUALIFY?

(a) The interviewer must review Section II and Section III (areas #55-63), area #83 and area #84 to determine the donor's eligibility.

(b) An explanation for each "YES" or blank question (except area #'s 30,48,49, and 41 for male donor) or any out of range value must be entered in Section V - DONOR MEDICAL HISTORY COMMENTS/ DONOR REACTION COMMENTS area. The interviewer/reviewer must initial each comment entered.

(c) Current FDA required questions on high risk behavior will be asked and documented as asked on the DD Form 572.

65. BAG TYPE: Circle the number which reflects the type of bag used.

- 1 = bag + 0 satellite bags
- 2 = bag + 1 satellite bags
- 3 = bag + 2 satellite bags
- 4 = bag + 3 satellite bags
- 5 = bag + 4 satellite bags

66. BAG LOT NUMBER: Record the blood bag lot number. If blood bank has previous records reflecting bag lot numbers against corresponding donation identification (unit) numbers, then this area may be lined through or left blank.

67. SEGMENT NUMBER:

(a) Enter the integral segment number.

(b) When the blood collection bag is issued, the corresponding donation identification (unit) number must be placed on the area of the DD Form 572 for donation identification (unit) number. Verify that the donation identification (unit) number on the blood collection bag and satellites match the donation identification (unit) number on the DD Form 572.

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

68. ANTICOAGULANT: Circle the type of anticoagulant used. When using anticoagulant "OTHER" than CPDA-1 enter the anticoagulant.

69. ALERT CODE: If available at time of screening, enter the alert code for donor's with previous positive test reports who are still eligible to donate blood. If unavailable at time of screening, this area may be lined through or left blank.

70. TOTAL DONATIONS: Total units donated by donor. If available at time of screening, enter the total number of donations to include today's donation. If unavailable at time of screening, this area may be lined through or left blank. If DD Form 572 is printed on DBSS, the system will print the number of donations in the system.

71. DONATION TYPE: Circle the appropriate answer.

- (a) Allo = Allogeneic
- (b) Therap = Therapeutic
- (c) Aphere = Apheresis
- (d) Auto = Autologous; #73 and #74 must be completed
- (e) Direct = Designated/Directed; #72, #73, and #74 must be completed according to dictated policies.

72. DIRECTED DONATION RECIPIENT: Local policy within the blood bank facility, as determined by the Medical Director, will dictate procedures to be followed for directed/designated blood request. If local policy dictates directed donor collection, the name of the recipient should be placed in this block.

73. FMP/SSN (Directed Only): Medical record number of the intended recipient as dictated by the policy of the Medical Director on directed/designated blood request.

74. HOSPITAL TRANSFUSION SITE: Complete this area for autologous and directed donations for location and intended use date.

75. COMPUTER ENTRY BY: Person performing computer registrations. If computer system not in use, this area is lined through or left blank.

76. INTERVIEWER:

(a) Initials of the person performing the oral interview and determines final donor eligibility. Initial's in this block also indicates that the donor was asked the oral questions.

(b) A "yes" answer to any of the oral questions requires the type of deferral and the eligibility date for temporary deferrals annotated in Section V.

77. MEDICAL REVIEWER: Initials of the person reviewing the DD Form 572. Initials does not need to be a physician.

SECTION IV: TO BE COMPLETED BY PHLEBOTOMIST

78. START TIME: Enter the time phlebotomy begins. Use the 24-hour clock.

79. STOP TIME: Enter the time phlebotomy ends. Use the 24-hour clock. If the draw time is more than 10 minutes, write ">10" in the area above the area designated for the donation identification (unit) number. This is to assist in preventing platelets, fresh frozen plasma, or cryoprecipitate from being prepared from this unit.

Figure 1-4. Donor screening utilizing DD Form 572 (continued).

80. PHLEBOTOMIST: Initials of the person performing phlebotomy.

81. DONATION STATUS: Circle the appropriate status as defined by the SOP covering the blood collection process:

- (a) Complete (completed donation).
- (b) Unsuccessful (not a successful phlebotomy).
- (c) Incomplete (only partial unit collected).
- (d) Overfill.

82. REACTION: Circle the appropriate donor condition/reaction during phlebotomy. Comment on all reactions other than "none" in section V of the DD Form 572.

83. DONOR SIGNATURE: Record the SOP date printed on the Oral Questions Sheet (figure 1-6). Donor's signature recorded here indicates that he/she has been orally questioned, interviewed, and understands the HIV related questions and has read the privacy act statement (figure 1-2).

84. DATE SIGNED: Donor records date of signature. This date should be the same date as the donation date.

SECTION V: DONOR MEDICAL HISTORY COMMENTS/DONOR REACTION COMMENTS

This area is used to record information pertinent to the donor's medical history and for any donor reactions, the steps taken to treat the reaction, and final disposition of the donor. Entries may be continued on back of DD Form 572 in Section V - Medical History Comments/ Donor Reaction Comments (Continued).

Figure 1-4. Donor screening utilizing DD Form 572 (concluded).

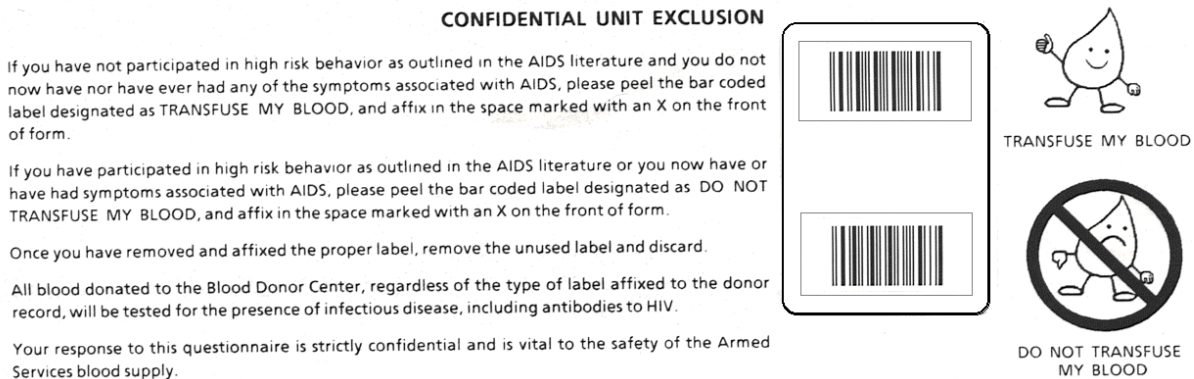


Figure 1-5. Bar Codes on reverse side of DD Form 572.

1-4. DONOR DEFERRAL REGISTRY

When blood from donors is deemed unsuitable for transfusion due to abnormal results for infectious agents or due to pre-donation medical screening, the donor name must be entered on a donor deferral registry (DDR). This deferral registry enables blood donor centers and transfusion services personnel to identify and defer these donors from blood donations until the time period of their ineligibility has ended. This registry must identify donors that are permanently excluded for blood donation. The Food and Drug Administration (FDA) mandates the maintenance of records that include permanent and temporary deferrals for health reasons including the reason for deferral. This section will cover the standard requirement for the establishment and maintenance of a donor deferral registry for all U.S. Army blood donor centers and transfusion services.

a. General.

(1) The DDR is the most useful tool that blood donor centers (BDC) and transfusion service facilities have to prevent the collection, distribution, and transfusion of blood products from already identified ineligible individuals. Each BDC and transfusion service must maintain a DDR to keep records of all ineligible blood donors.

(2) The eligibility of each donor is determined by the use of oral questions (figure 1-6), answers to questions on the DD Form 572, the confidential unit exclusion process, and through serological testing. If it is determined that the donor's blood is unsuitable for transfusion, all products collected from the donor must be destroyed and donor's name entered on the DDR.

(3) The following information must be included on all computers as well as on manually generated lists:

- (a) Names: last, first, middle initial.
- (b) Social Security Number (and FMP/Sponsor's SSN if applicable).
- (c) Birth dates.
- (d) Date deferred.
- (e) Explanatory deferral code.
- (f) A re-eligible donation date (if applicable).

NOTE: Manually generated lists must include the name of the facility, date that the list is effective, and the signature of approving authority.

DIRECT ORAL QUESTIONS

16 January 1997

Questions 1-7 (Permanent Deferral):

1. Do you have AIDS or have you ever had a positive test for the AIDS virus (HIV)?
2. Have you ever taken illegal drugs with a needle, even one time (including steroids)?
3. Have you ever taken clotting factor concentrates for a bleeding disorder such as hemophilia?
4. **MALE DONORS:** Have you had sex with another male, even one time, since 1977?
5. At any time since 1977, have you taken money or drugs for sex?
6. Have you ever received a tissue transplant or tissue graft to include dura mater?
7. Were you born in, or have you lived in, or traveled to any of the following countries since 1977: Cameroon, Central African Republic, Chad, Congo, Equatorial Guinea, Gabon, Niger, or Nigeria? Have you received blood products or had sexual contact while in these countries or with anyone who has lived in these countries since 1977?

Questions 8-16 (12 month Deferral):

8. Have you had sex in the last 12 months, even once, with anyone who has AIDS or has had a positive test for the AIDS virus?
9. Have you had sex in the last 12 months, even once, with anyone who has ever taken illegal drugs with a needle (including steroids)?
10. Have you had sex in the last 12 months, even once, with anyone who has taken clotting factor concentrates for a bleeding disorder such as hemophilia?
11. **FEMALE DONORS:** In the last 12 months, have you had sex with a man who had sex with another man, even one time since 1977?
12. At any time in the last 12 months, have you given money or drugs to anyone to have sex with you?
13. At any time in the last 12 months, have you had sex with anyone who has taken money or drugs for sex?
14. In the past 12 months, have you had a positive test for syphilis?
15. In the last 12 months have you had syphilis or gonorrhea or have you been treated for syphilis or gonorrhea? (Add locally appropriate synonyms.)
16. In the last 12 months, have you received blood or blood products?
17. In the last 12 months have you been incarcerated in a correctional institution (including jail or prison) for more than 72 consecutive hours?

AN AFFIRMATIVE RESPONSE TO ANY QUESTION MAY BE GROUNDS FOR TEMPORARY OR PERMANENT DEFERRAL

Figure 1-6. Donor screening utilizing oral questions.

b. Deferral Codes and Definitions.

(1) *Permanent deferral.* The donor is no longer eligible to donate. Reentry protocol is not available to this donor.

(2) *Indefinite deferral.* The donor is no longer eligible for donation. A reentry protocol may be developed in the future for these individuals if they meet all criteria for reentry.

(3) *Surveillance list.* This list is used for donors that are still eligible to donate blood but may become ineligible in the future. The donors can be accepted for donation until any changes to their eligibility status changes.

(4) *Temporary deferral.* This is for donors that cannot donate for a specific period of time. At the end of the period they are taken out of the DDR.

(5) *Deferral codes.* These are the symbols used to identify different categories of donor deferral.

c. Defense Blood Standard System (DBSS). DBSS is an information system developed to automate and standardize the Armed Services Blood Program (ASBP) information management capabilities for the military blood community (CONUS AND OCONUS). DBSS supports the ASBP functions by providing inventory control, management reporting, donor, mobile collection drives, and transfusion services data automation. This includes tracking blood donor and transfusion recipients. It also allows blood donor centers and transfusion services to maintain a list of deferred donors who are not eligible to donate blood. Another feature of DBSS is that it provides a look-back capability that satisfies the infectious disease reporting requirements.

d. Updates of the DDR.

(1) The DDR must be updated 72 hours after completion of processing of each batch of donor blood products.

(2) The names of temporarily deferred donors must be removed from the DDR once the deferral period has ended.

(3) Key personnel for performing updates on the DDR must be identified. They are the only ones that should have access to the deferral codes.

(4) Personnel identified to enter data to the DDR must assign the proper deferral codes based on the deferral criteria used.

(5) If a donor status has changed from surveillance to a permanent status, the DDR must be updated to reflect this change.

(6) Each time a new donor is entered in the DDR, the blood bank medical director or designee must be notified. The medical director or designee must ensure that the donor is properly notified of the finding.

(7) If using the DBSS generated DDR, key personnel must manually enter information into the list under the following circumstances:

(a) Deferral occurs during the donor registration and screening.

(b) Deferral occurs after DD Form 572 review.

(c) Donors or patients are identified positive for one or more infectious disease markers during a look-back research process.

(d) Prior to the implementation of the DBSS, the donor is on a permanent deferral list.

(8) DBSS will automatically enter information into the list for verified, repeatedly reactive (RR), or confirmed reactive donors.

(9) Manual entries on the DDR must be reviewed by key personnel for record of effective date and donor reentry dates. When the reentry date cannot be established, calculate the reentry date using the date of the last donation. Record the date on the DD Form 572.

e. DDR's Hard Copies.

(1) When unable to use DBSS, Blood Donor Centers and Transfusion Services may create a "hard copy" of their DDR. Designated personnel can update this list by manually adding or deleting information. If DBSS is in use, a hard copy must be maintained to be used if DBSS should go down.

(2) The hard copy must be updated every three days and must be visually checked for completeness and accuracy. There are two ways that this can be accomplished: generate a new hard copy or add a list containing the names of the new deferred donors.

(3) When a new DDR hard copy is created, it must be thoroughly reviewed for duplications, errors, or deletions. The list must be verified and approved by designated personnel. When validating the DDR in DBSS, the list must be validated against the original record (DD 572), not just the list against entries in DBSS.

(4) Destroy DDR hard copies when they are no longer needed.

f. **General Procedure for Use of the DDR.**

(1) *Before collection.*

(a) Prospective donors must be checked against the DDR prior to blood donation, either during the screening process or during the DBSS registration process.

(b) Check the donor's full name and SSN when verifying information on the DDR.

(c) Personnel checking donors against the DDR must initial box 55 on DD Form 572. The DD Form 572 must be reviewed by key personnel prior to blood products being released for distribution.

(d) When the prospective donor is shown to be a temporary or permanent deferral, the individual must be informed of his or her ineligibility. Once an individual's name is found on the deferral list for temporary or permanent deferral, the donation process ends for that individual. When the donor eligibility is identified as an indefinite deferral, he or she can donate blood if a reentry protocol has been established and criteria to donate blood is satisfied.

(e) When a donor is on a surveillance status, he or she is allowed to continue with the donation process. Do not inform the prospective donor of their surveillance status. The status of these donors will be evaluated after the completion of the donor's blood testing.

(2) *After collection.*

(a) If the donor name is not checked against the DDR prior to the blood collection, the list must be checked prior to the labeling of any blood product collected from the donor.

(b) After the testing of the blood is completed, all donors will be evaluated for possible inclusion on the DDR.

(c) DD Form 572 and serological blood results must be reviewed for possible deferral information

(d) Blood products that are found not suitable for transfusion during the testing and review process must be retrieved and quarantined immediately. These blood products will remain on quarantine until their suitability for use has been determined by appropriate personnel. The products either will be released to inventory or destroyed as instructed by appropriate authority.

(e) When adding new ineligible donors (temporary, indefinite, or permanent) or surveillance status donors on the DDR, enter the donor's name, SSN, birth date, date of deferral, an explanatory deferral code, and reentry donation date (if applicable).

g. Reentry/Removal from the DDR.

(1) After the name of a donor is placed on the DDR, the blood donor center or transfusion service medical director is responsible for any change in the donor's status.

(2) The medical director in a case-by-case base will evaluate any potential donor reentry. The reason for the donor's status change must be documented, and if applicable the removal of the donor's name from the DDR must be verified.

(3) Blood products cannot be released for distribution until their suitability is confirmed by key personnel.

h. Standard Algorithms for Blood Donor Deferral. The Department of the Army has developed a set of algorithms for blood donor deferral based on the results of infectious disease marker testing. These sets of algorithms are contained in Annex A.

1-5. DONOR DEFERRAL NOTIFICATION PROCESS

a. The blood donor center medical director should establish a procedure for the timely notification of donors with any medically significant abnormality detected during the predonation evaluation or as a result of laboratory test results.

b. The medical director of the blood collecting facility is responsible for the proper notification and medical/clinical follow-up for deferred donors. A reconciliation mechanism must be established to ensure that notification was sent for all deferred donors.

c. The blood collecting facility must develop a mechanism to notify preventive medicine personnel of reportable positive serologic test results. Through a locally approved mechanism, deferred donors will be interviewed and counseled and if necessary, repeat testing on the donor. Examples of donor notification letters are found in Annexes B through F.

Section II. BLOOD COLLECTION

1-6. GENERAL

a. The collection of blood from a donor is perhaps the most critical step on the blood donor center operation. In order to ensure a successful collection, individuals performing the phlebotomy procedure must be well trained. To protect the donor and the recipient, blood must be collected by aseptic methods, using a sterile, closed system. If more than one puncture is needed, a new blood collecting set must be used.

b. During collection, blood must be mixed with the anticoagulant/preservative solution frequently. The use of devices such as scales, trip balances, counterweight balances, etc., are necessary to ensure adequate volumes of blood are withdrawn from each donor (450 mL \pm 45 mL for whole blood). On the average, the actual blood collection time is between five and ten minutes.

c. For healthy individuals, the total blood volume is between 4000 to 5500 mL (8 to 11 pints). With proper liquid intake, a person who just donated blood will have their blood volume restored within 72 hours; however, the donor is not eligible to donate blood again until eight weeks after the last donation.

1-7. IDENTIFICATION OF DONOR AND LABELING OF MATERIALS

a. A numeric or alphanumeric system must be used to identify and match the donor record (DD Form 572), the processing tubes, the blood collection bag, and the satellite bags to the donor.

b. All cards and labels should be checked for printing errors.

c. Before starting the phlebotomy procedure, identify the donor record by name with the donor.

d. Attach the same identification label (unit number) to the donor card, test tubes for donor blood samples, and the blood collection bag including the attached satellite bags prior to blood collection.

e. The phlebotomist must check the unit numbers on the DD Form 572, bag, and sample tubes when the tubes are filled. This is a very critical step, especially when more than one donor is drawn at the same time by one phlebotomist.

f. Each blood drawing bag and its satellite bags have a unique number on the attached tubing referred as the "segment number." This number must be entered on the DD Form 572, block 67. This number will help identify the blood or any of its products with the donor.

NOTE: It is a common practice of many blood centers to prelabel the blood collection bags and the sample tubes prior to a blood drive. To avoid identification errors, it is imperative that phlebotomists verify that blood collection tubes, blood donor cards (DD Form 572), the blood collection bags, and satellite bags have the same identification number.

g. Prior to blood collection start, DD Form 572 must be reviewed for completeness. The phlebotomist must ensure that the Confidential Unit Exclusion sticker is attached to the blood donor card.

1-8. COLLECTION

a. General.

(1) Personnel involved in the collection of blood should be well trained in the phlebotomy procedure. Phlebotomists must take meticulous care to prevent infection of the donor or the blood unit by having clean hands and work surfaces, by following thorough skin preparation procedures including "no touch" venipuncture technique, and by knowing what constitutes air contamination of blood and how to prevent it.

(2) The blood collection room should be well lighted, clean, at a comfortable temperature, and pleasant. If more than one venipuncture is needed, another container and donor set must be used. The donor must never be left unattended during the phlebotomy procedure.

b. Equipment and Materials Used.

(1) Blood collecting set. The standard blood collecting set consists of a plastic bag with an integral plastic tubing attached. The set routinely used is for the collection of 450 mL (± 45 mL) of blood. The collecting blood set is available with one or more integrally connected bags referred as satellite bags. These bags are used in the manufacture of blood products. The bag into which the blood is collected is called the primary bag. It contains enough anticoagulant/preservative solution for the collection of 405 to 495 mL of whole blood. The satellite bags also can be used to separate the unit into smaller amounts when required for blood transfusion of small children or babies. (See figure 1-7).

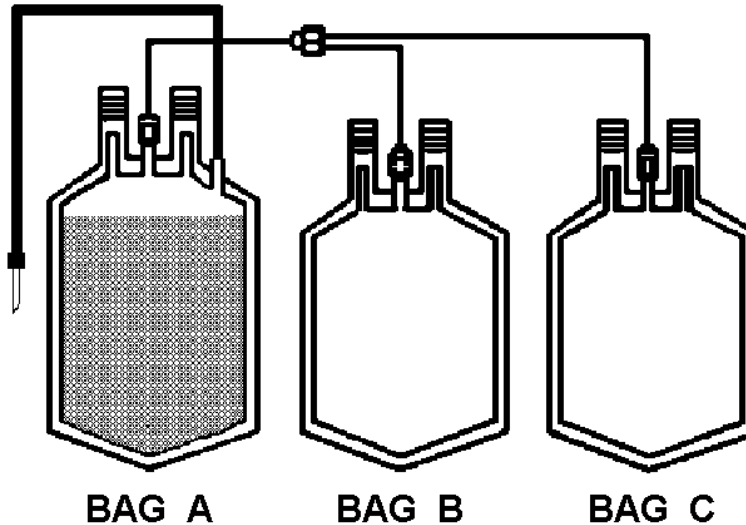


Diagram of a blood collection set. Bag A is the primary bag used for the collection of 450 mL (± 45 mL) of whole blood. It contains 63 mL of anticoagulant. Attached to the primary bag is a 16-gauge needle. Bags B and C are satellite bags used for the preparation of blood products.

Figure 1-7. Triple blood bag set.

(2) Scales. In order to monitor the volume of blood taken from the donor, the use of scales is necessary. The scales or any other equipment used to monitor the volume of blood to be drawn must be checked each day of use. The performance of the scales used can be checked by using prefilled bags of known weight. The scales should be calibrated to near the mean acceptable blood drawing volume. All the methods available to monitor blood volume draw use weight to indicate the volume collected. This value is the final weight of the blood drawn plus the weight of the bag, tubing, and the weight of the solution inside the bag. One milliliter (mL) of blood weighs 1.053 g. The weight of the bag and the anticoagulant varies from each manufacturer and sometimes with different lot numbers. Weigh at least 10 bags from each lot in use and from each manufacturer. Post these weight conversion values. When determining the weight of the bag, which contributes to the total weight that tripped the scale, remembers that not the entire blood collection bag contributes to the total weight.

(a) Example.

Tare weight of bag = 130 g (empty)

Bag final weight = 600 g

$VOL = (600 \text{ g} - 130 \text{ g}) / 1.053 \text{ g/mL}$

$VOL = 446.3 \text{ mL}$ (This is an acceptable volume as it falls in the 405-495 mL range.)

(b) The three types of scales that are commonly used are discussed below.

1 A trip balance (see figure 1-8) that constricts the tubing to slow down the flow of blood when the blood bag reaches the desired weight. It is important to remember that these scales won't always stop the flow of blood to the bag.

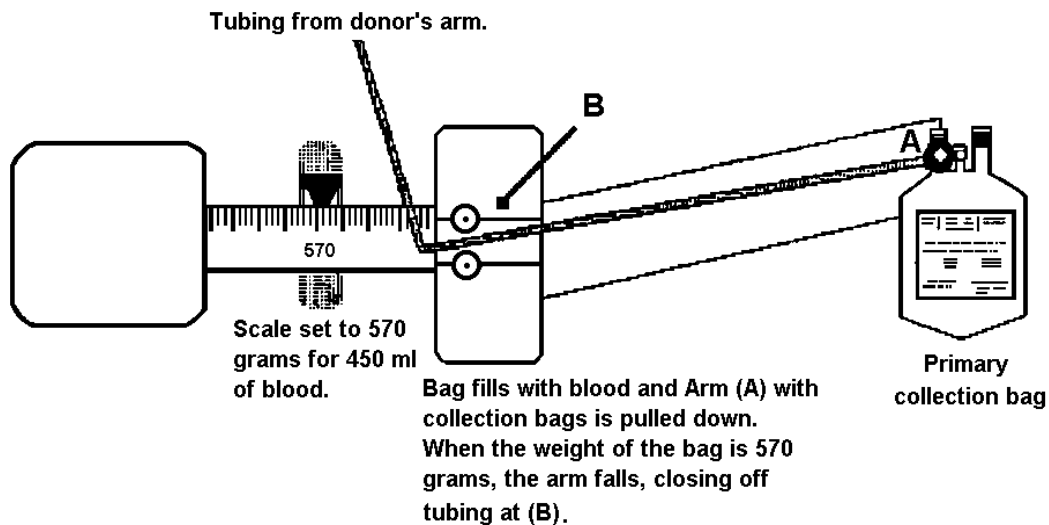


Figure 1-8. Trip balance set-up.

2 A mechanical agitator calibrated to shut off when the desired weight is achieved.

3 A platform scale that must be kept under observation so that the phlebotomist can stop the blood flow manually when sufficient blood has been collected.

- (3) Metal clips and hand sealer.
- (4) Scissors, hemostats.
- (5) Devices for stripping blood in blood bag tubing.

NOTE: Items used during phlebotomy procedure can be acquired through regular supply channels. These items are available in sterile, single-use, disposable form. If the material is damaged in any way that affects the sterility, then it must be discarded. Items such as gauze, forceps, and forceps holders may be properly sterilized by steam under pressure for at least 30 minutes at 121.5° C or for two hours if using dry heat or gas sterilization. Containers of bulk-sterilized items should be labeled and dated as to when they were sterilized and when opened. Unopened sterilized containers may be stored for two to three weeks if the container closure ensures sterility of the contents.

Open containers may be used for one week if the lids are replaced after removal of contents and contents are removed using aseptic technique.

c. **Preparation of Venipuncture Site.** Prior to skin puncture, the site where the puncture is to be performed must be prepared. Iodophor or other sterilizing compounds are used at this stage of the phlebotomy procedure. Some of the sterilizing solutions are available in prepackage single use form. Two solutions are used to sterilize the site of venipuncture: scrub solution (0.7% aqueous solution of iodophor compound) and the "prep" solution (10% PVP-iodine). No method used is going to sterilize completely the venipuncture area, but surgical cleanliness can be achieved to provide maximal assurance of a sterile unit. Once the site for the skin puncture is prepared, it must not be touched again. An alternate method of skin preparation must be available to draw donors that are sensitive to the iodine commonly used in venipuncture site preparation.

(1) *Routine procedure.*

(a) Identify the venipuncture site. Use a tourniquet or a blood pressure cuff inflated to 40-60 mm Hg to locate a firm large vein. Ensure that the site is free from skin lesions. It is often helpful to have the donor open and close the fist several times. It is a good practice to examine both arms to find the best vein. Once the site for the venipuncture is selected, the tourniquet or the blood pressure cuff must be released.

(b) Scrub an area of three inches in diameter on the selected venipuncture site for 30 seconds with 0.7% aqueous scrub solution of iodophor compound.

(c) Starting at the intended skin puncture site, apply "prep" solution. Apply the solution by moving outward in a concentric spiral form and without going twice to the same spot. Let it stand for at least 30 seconds before the skin puncture.

(d) The sterilized site should be covered with a dry and sterile gauze until venipuncture is performed. It is important to remember that the site must not be touched again. If this happens, the skin preparation procedure must be repeated.

(2) *Method for donors who are allergic to iodine.*

(a) Scrub entire antecubital area with green soap swab, using a random scrub for 30 seconds. Remove soap solution with 70% alcohol/acetone swab.

(b) With a second alcohol/acetone swab, start at the intended point of entry and apply alcohol in an enlarging concentric pattern until an area 3 inches in diameter is covered.

d. **The Phlebotomy and the Collection of Blood Samples.** Blood must be collected in FDA approved containers. During the collection, blood must be mixed with the anticoagulant regularly. The system used to monitor the amount of blood collected must ensure the collection volume does not exceed 525 mL including samples. Once the blood bag is filled with the appropriate blood volume, pilot tubes must be filled. Any blood-contaminated material must be disposed of properly. For safety purposes, do not recap the needle after collection is completed. Dispose of the needle in a puncture-proof container.

NOTE: Policies on the wearing of gloves vary from location to location. You must follow local policies.

(1) Have the donor seat comfortably on the donor chair. Make the donor feel at ease by talking to him or her. This is very important, especially with first time donors and donors who are nervous. It is a good practice to keep a conversation with the donor through the entire procedure.

(2) Confirm the donor's identification. Review donor card (DD Form 572) for completeness. Ensure that the unit identification number on the blood bag, the pilot tubes, and the donor card match.

(3) Locate and select the venipuncture site. Prepare the venipuncture site using one of the procedures above.

(4) Set up and inspect the bag for any type of defect. Check to make sure the bag does not leak and that the anticoagulant solution is clear. Position the bag so it is below the level of the donor's arm. Any scale used to monitor the blood volume drawn has to be checked on the date of intended use. It is a good practice to perform the check on scales prior to the beginning of the blood drive or at the beginning of the duty day as part of the regular QC program.

(5) Place a hemostat between the needle and primary bag. This must be done prior to uncapping the needle. If this is not done, air will enter the bag (air contamination) and you will need to get a new blood collection set. Any unit collected in an air contaminated bag must be destroyed (open system).

(6) Give the donor something to squeeze. Reapply the tourniquet or inflate the blood pressure cuff. Instruct the donor to squeeze or clench the fist and hold.

(7) Uncover the needle, being careful not to contaminate it, and perform the venipuncture immediately. Place the thumb of your free hand below the intended venipuncture site and pull the skin taut. Enter the skin at a 45° angle. Once in the skin, reduce the angle of the needle to about 10-20 degrees, orient the line of the vein, and push the needle in the vein. Thread the needle up the vein about one-half inch to avoid the needle slipping out of the vein during the collection of blood.

(8) Release the hemostat on the line between the needle and the primary bag to let the blood flow freely. Make sure there is a steady flow of blood.

(9) Tape the needle and tubing to hold the needle in place on the donor's arm. This also will prevent accidentally pulling the needle out.

(10) Using a clean 4X4 sterile gauze, cover the venipuncture site.

(11) Tell the donor to open and close the fist, squeezing lightly on the object given, once every 10-12 seconds during the collection.

CAUTION: DO NOT LEAVE THE DONOR UNATTENDED AT ANY TIME DURING THE BLOOD COLLECTION PROCEDURE.

(12) Mix the blood with the anticoagulant periodically, approximately once every 45 seconds, during collection.

(13) Record the time that the venipuncture was initiated in block 78 of DD Form 572. Initials of the phlebotomist must be entered in block 80. Once the procedure is completed, enter the stop time in block 79. There is no time limit on when to stop the blood collection process, as long as a continuous blood flow and frequent agitation of the unit are maintained (some local policies state to discontinue at 15-20 minutes). Time limits apply to the manufacture of some of the blood products. Technicians manufacturing blood products should review blocks 78 and 79 to find out the time it took to collect the blood unit.

(14) Monitor the volume of blood being drawn. If using a trip balance, the balance will be tripped once the proper amount of blood is collected. This type of balance does not always completely stop the flow of blood to the blood bag, so you need to act fast in order to avoid an overfilled unit. This may happen during blood drives with a large number of donors, where the phlebotomist is forced to draw more than one donor at a time. If while drawing more than one donor (should not be more than three donors per phlebotomist), the balances trip at the same time clamp the line between the primary bag and the needle to stop the flow of blood to the bag until you have taken care of the other donors.

(15) Once a good flow is established, at some point during the blood collection procedure or as indicated on the organization's SOP, enter the blood bag integral segment number on block 67 of DD Form 572.

(16) When the correct volume of blood has been obtained, instruct the donor to stop squeezing. Using a metal clip on the "x," permanently close the tubing at a point approximately 6-10 inches from the needle. Put a hemostat on the tubing in between the needle and approximately one inch from the metal clip. With a pair of scissors cut the tubing between the hemostat and the metal clip.

(17) Fill sample tubes with blood (figure 1-9). Uncap the sample tubes. Take the sample tubes one at a time and, using the portion of the tubing still attached to the donor's arm, put the tip of the line in the tube and release the hemostat. Let the blood flow in the tube. When a sample tube is filled, close the hemostat to stop the flow of blood and take the next sample tube. Repeat this procedure until all of the sample tubes are filled with blood. Some bags have integral sampling devices, making the cut and drip method unnecessary. Compare the sample tubes identification number with the blood bag number and the number on the DD Form 572.

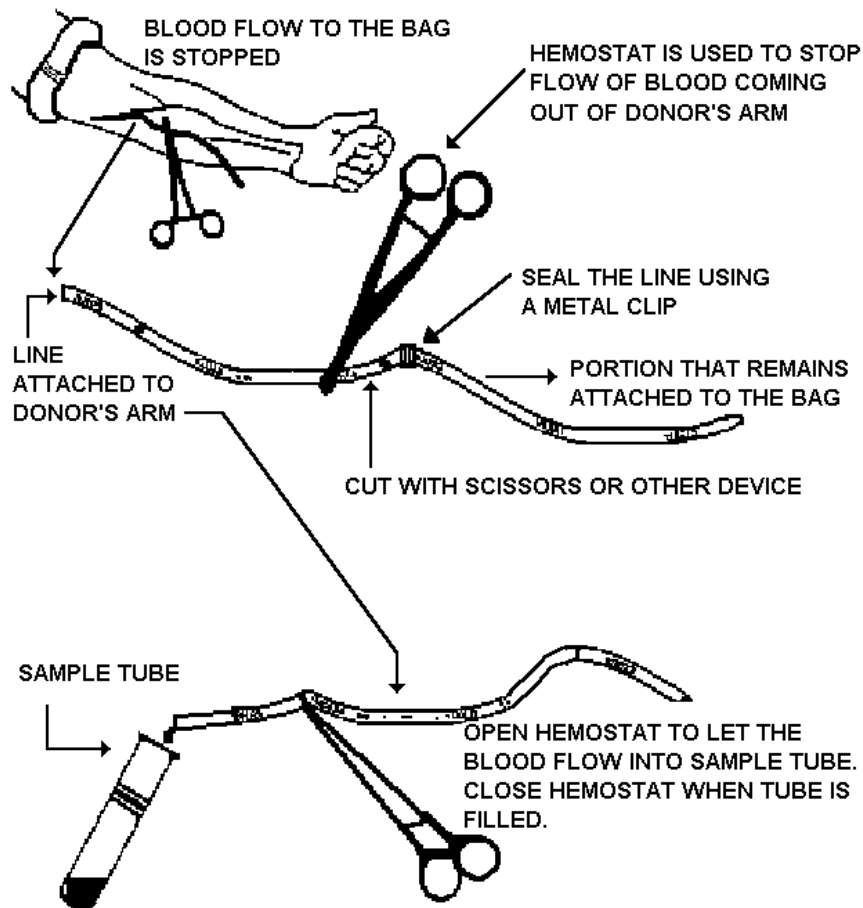


Figure 1-9. Filling of sample tubes.

(18) Release the tourniquet and remove the needle from the donor's arm. Discard the needle in a sharps container. Instruct the donor to keep pressure on the venipuncture site (over the gauze) and to raise his or her arm with the elbow straight for several minutes or until bleeding stops (approximately two minutes).

(19) Record the stop time, donation status (block 81 on DD Form 572), and any reaction (block 82). Comments on all reactions other than "none" is mandatory. Any pertinent comment on donor reactions must be entered on section V of the donor card.

(20) Strip blood bag tubing as completely as possible into the bag, starting just after the metal clip end all the way to the bag. Hold the line shut with the stripper and mix the blood bag several times to ensure proper mixing of the blood. Release the stripper to allow the tubing to fill with blood and repeat the procedure at least one more time. It is very important to strip the line immediately to avoid clotting of the blood on the tubing.

(21) Place a bandage on the donor's arm and give donor instructions about post phlebotomy care. On the top portion of DD Form 572 you will find all the necessary instructions that must be given to the donor. This portion must be detached from the DD Form 572 and given to the donor. You must ensure that the donor reads and understands the instructions. It is a good practice to reemphasize some of the points contained on these instructions. Specific instructions on post donation care should be included in the facility SOP.

(22) Instruct donors to go to the designated refreshment/recovery area and remain there for a period of time. The period of time and recovery in the refreshment area should be included in the SOP. Ensure that the donor is in satisfactory condition before letting him or her walk to the refreshment area.

(23) Before the donor departs, thank him or her for an important contribution and encourage repeat donation after proper intervals.

(24) Take the blood, sample tubes, and donor record card (DD Form 572) to the blood processing area.

1-9. ADVERSE DONOR REACTIONS

The majority of donors tolerate the donation of blood with no problems. Occasionally you might have to deal with adverse donor reactions during the donation process. All personnel working in a blood collecting facility must be trained to identify, prevent, and treat adverse donation reactions. Personnel working in the donor room must be trained in CPR procedures. The blood bank medical director must provide written instructions for handling donor reactions. The procedure must include the steps to be taken in order to obtain emergency medical assistance. **An important precaution is to have a second trained technician available in the donor room before drawing a donor.**

a. The causes of adverse donor reactions vary, ranging from slight reactions to severe ones. In order to properly react to them, the blood bank technician must be familiar with the signs and symptoms and the treatment of adverse reactions. Some of the signs and symptoms that you can expect to see are listed below.

- (1) Weakness.
- (2) Sweating.
- (3) Dizziness.

- (4) Pallor.
- (5) Loss of consciousness.
- (6) Convulsions and involuntary passage of feces.

(7) The skin feels cold and blood pressure falls. Sometimes the systolic levels fall as low as 50 mm Hg or cannot be heard with the stethoscope.

(8) Pulse rates often slow significantly, providing a useful sign to make a distinction between a vasovagal attack and severe cardiogenic or hypovolemic shock, in which pulse rates rise.

b. The following are procedures performed during the treatment of different types of donor reactions.

(1) *General.*

(a) Remove the tourniquet and withdraw the needle from the arm at the first sign of reaction during the phlebotomy.

(b) If possible, remove any donor who experiences an adverse reaction to an area where he or she can be attended in privacy.

(c) Call the blood bank physician or the physician designated for such purposes if the first aid measure taken does not help the donor to recover.

(2) *Fainting.*

(a) Place the donor on his/her back and raise the feet above the level of the donor's head.

(b) Loosen tight clothing.

(c) Ensure the donor has a clear airway.

(d) Apply cold compresses to the donor's forehead or the back of the neck.

(e) In some situations the use of aromatic spirits of ammonia may be useful. You must test the ammonia spirits on yourself before passing it under the donor's nose. Strong ammonia spirits may injure the nasal membranes. The donor should respond by coughing, which in turn elevates the blood pressure.

(f) Check and record the blood pressure, pulse, and respiration periodically. Enter this information on section V of DD Form 572.

(3) *Nausea and vomiting.*

- (a) Make the donor as comfortable as possible.
- (b) Tell the donor to breathe slowly and deeply.
- (c) Put an ice pack to the donor's forehead or on the back of the neck.
- (d) The donor's head must be turned to the side.
- (e) Have available a suitable container for the donor in case he or she vomits. If needed, provide tissue or a damp towel to the donor. Give the donor a cup of water to rinse out his or her mouth.

(4) *Twitching or muscular spasms.* Muscular twitching and spasms usually happen in conjunction with loss of consciousness. Approximately half of the donors that experience loss of consciousness have some type of short, weak, convulsion-like movements of one or more extremities. Extremely nervous donors may hyperventilate, causing a faint muscular twitching or tetanic spasm of their hands or face. It is very important that blood donor center personnel be alert at all times in order to promptly identify these symptoms. A good practice for preventing some reactions, especially with extremely nervous donors, is to engage in a conversation with the donor. If you suspect that hyperventilation is the cause of the donor reaction, having the donor breathe into a paper bag will usually alleviate the problem.

(5) *Convulsions.* True convulsions are rare; but when it happens, prompt assistance is indispensable in order to prevent a very undesirable situation.

(a) Call someone to help you immediately. Prevent the donor from injuring him/herself. If possible hold the donor on the chair or bed, this sometimes is very difficult since some donors show or exhibit great muscular power and are difficult to hold in place. If the donor cannot be held in the chair or bed, lay the donor down on the floor. Blood donor facilities should have a system in which someone is always available to provide assistance when a severe or less severe reaction occurs.

- (b) Ensure that the donor has an open airway.
- (c) Notify the blood bank physician.

(6) *Hematoma.*

(a) A hematoma is identified by a swelling at or near the venipuncture site. It is caused by blood leakage into the tissue around the phlebotomy area. It may form due to one of the following:

- 1 The size of the vein is too small for the needle.
- 2 The needle was inserted all the way through the vein.
- 3 Not pushing the needle deep enough into the vein.
- 4 Leaving the tourniquet on after the needle was removed from the vein.
- 5 After the phlebotomy procedure was completed, pressure to the site was not adequately applied.

(b) If a hematoma starts to form while collecting the blood, follow these steps immediately:

- 1 Remove the tourniquet and the needle from the donor's arm.
- 2 Place three or four sterile gauzes over the hematoma and apply firm digital pressure for 7-10 minutes with the donor's arm held above the heart level.
- 3 If desired, apply ice to the area for few minutes.

(7) *Arterial puncture.*

(a) When an arterial puncture is suspected, stop the blood collection immediately. Withdraw the needle and release the tourniquet. Apply firm pressure to the site for at least 10 minutes until bleeding stops.

NOTE: Artery punctures can be recognized by the blood's bright red color.

- (b) Apply a pressure dressing afterwards.
- (c) Check for the presence of a radial pulse.

(8) *Cardiac problems.*

(a) Even though cardiac problems are very rare during the donation process, the blood bank technician must be prepared to deal with such problems. Call the emergency medical unit immediately.

(b) If the donor is in cardiac arrest, start CPR without delay and continue until the emergency medical unit arrives.

1-10. COLLECTION PROBLEMS

a. **The Nature and Treatment of All Donor Reactions.** All donor reactions, as well as the action taken during the reaction, must be documented on the DD Form 572. Possible causes of the reaction should be investigated if possible. Blood bank technicians must be aware of conditions that can cause adverse reactions during the donation process. Part of the prevention of donor reactions is to ensure that those conditions are minimized. Conditions such as room too hot or too cold can affect the outcome of the collection process. If the donor has not eaten for a long period, he or she could become ill during the donation process. Phlebotomists must be aware of how nervous the donor is.

b. **Double Venipuncture.** During collection of blood, the needle cover is removed just prior to the venipuncture. The needle should enter the skin only once. If the first venipuncture is unsuccessful, a new blood collection set must be used. A sterile connecting device may be used to attach a new needle only if blood has not entered the tubing. The donor consent should be requested before attempting a second venipuncture. If the second venipuncture is successful, the integral tubing number of the new bag must be entered on the respective block of DD Form 572. Write on Section V of the donor card any pertinent information as outlined on the organization's SOP.

c. **Incomplete Collections.** The volume of blood collected from a donor must be at least 300 mL. If less than 300 mL of blood is obtained, the unit must be discarded. Write on the DD Form 572, Section V, incomplete collection and the volume or the weight of the unit. Under special circumstances, such as autologous donation, a volume of less than 300 mL can be drawn, but the amount of anticoagulant/preservative solution in the container must be adjusted. When the volume of the unit drawn is from 300 to 404 mL, the unit must be labeled as a low volume unit. Write the volume on the label. The reason for incomplete and low volume units must be investigated.

d. **Overfilled Units.** The usual blood collection set allows for the draw of 450 mL (± 45 mL) of blood. The total volume of blood that can be drawn from a donor is 525 mL, including the sample tubes. There are no valid reasons to justify the collection of units that exceed 495 mL (overfilled units). Collection of overfilled units should be investigated and corrected. Some of the most common causes for overfilled units are given below.

(1) *Inattentive phlebotomist.* When using trip balance, the phlebotomist must closely monitor the unit of blood being collected to manually stop the flow of blood to the bag once the balance is tripped. The trip balance does not always stop the blood flow.

(2) *Inexperienced phlebotomist.* An experienced phlebotomist can handle three bed stations without problems. For new or inexperienced phlebotomists, one or two bed stations should be provided until they can handle more donors. Proper pacing during the handling of donors will decrease the chance of having two donors finishing at about the same time. If drawing more than one donor at a time, and more than one balance is tripped at the same time, use a hemostat to stop the blood flow to the bag while you take care of the other donor. This may happen during blood drives with a large number of blood donors.

(3) *Wrong setting or defective blood scales.* Scales must be set up to allow a volume of 450 mL (± 45 mL) of blood to be drawn. A good quality control program will decrease this type of problem. When setting the weight where the scale's mechanism is tripped, it is recommended to set the weight value at the mean for a normal weight volume unit. Setting the weight too low may cause drawing units of low volumes and setting the scales close to the upper limit may cause units to be drawn above the range. One mL of blood weighs not less than 1.053 grams for a regular donor (the weight of the blood for a donor with a hemoglobin of 12.5 g/dl). To find the lower limit of the weight of the blood and container, including the anticoagulant/preservative solution, multiply 1.053×405 mL and add the weight of the container with the solution. The upper limit, multiply 1.053×495 mL and add the weight of the container with the solution.

Example: The weight of the primary bag with the anticoagulant/preservative solution is 90 grams. Find the upper and lower limits for a normal unit and select the best setting for the scales.

(a) Determine the minimum and the maximum weight value of the blood to be drawn. The volume of blood to be drawn from a normal donor that weights 110 lbs. or more is 405 mL up to 495 mL. Change the volumes given by multiplying them by 1.053.

$$\begin{aligned} 405 \text{ mL} \times 1.053 \text{ g/mL} &= 426 \text{ g} \\ 495 \text{ mL} \times 1.053 \text{ g/mL} &= 521 \text{ g} \end{aligned}$$

(b) Determine the weight of the bag. If using a trip balance, only the weight of the primary bag with the anticoagulant/preservative solution has any effect on the total weight of the unit at the time of collection. The weight of the bags differs with manufactures and sometimes with each lot number. To get an accurate number, weigh at least ten bags and determine the average weight. Remember that the weight of the needle and its line cannot be included on the weight of the bag because it does not have any effect on the scale.

For this example, 90 g is the weight of the primary bag and the solution inside.

(c) Add the weight of the bag to the weight of the blood to be collected.

$$426 \text{ g} + 90 \text{ g} = 516 \text{ g}$$

$$495 \text{ g} + 90 \text{ g} = 585 \text{ g}$$

(d) Set up the scales. It is recommended to use a value that is half way in between the lower and upper limits. For this example 550 is the value to be used to set up the scales.

NOTE: Scales must be checked for proper operation at least one time each day of use. The performance of platform scales and trip balances can be checked with prefilled bags of known weight. It is a good practice to use two bags, one that is below the normal range weight, and a second with a weight just above the set weight on the scales.

e. **Contaminated Bleed.** The most common type of contamination is air contamination. To avoid air contamination, a hemostat must be placed on the tubing, between the needle and the primary bag, prior to uncapping the needle. If air enters the bag prior to the venipuncture, a new collection bag must be used. If for some reason air enters the bag any time during collection or during processing of the unit, it must be destroyed. Not threading the needle correctly into the vein can cause the needle to slip out of the vein causing air to enter the bag. If needle is not completely inserted into the vein, blood may fill the bag at a very slow rate. Partial needle insertion can also cause blood to leak into the tissues and form a hematoma.

f. **Extended Collection.** Ideally, the time to collect a complete unit of blood should be from 4-7 minutes. Blood collection lasting longer than 10 minutes usually results from a poor venipuncture and slow blood flow. If it takes longer than 10 minutes to collect the unit of blood, the phlebotomist must write "> 10 minutes" on DD Form 572.

g. **Arterial Puncture.** Should an arterial puncture be suspected, immediately withdraw needle and apply firm pressure for ten minutes. Apply a pressure dressing afterwards and check for the presence of a radial pulse. If a pulse is not palpable or if weak, call the blood bank physician. Document any pertinent information on Section V of DD Form 572.

1-11. DONOR EXCEPTIONS

a. **Autologous Donors.** Donor suitability requirements and other procedures may vary for these donors. The next section discusses these variations.

b. **Therapeutic Donors.** Blood drawn for therapeutic phlebotomies is not to be crossed over into the regular inventory in DOD. Units are drawn from these donors to treat various blood disorders and the units are discarded. These donors do not need

to meet regular suitability requirements, but must have a physician order for the procedure and the blood bank's medical director's approval.

c. **Directed Donors.** The public's AIDS-related concern about the safety of transfusion has generated demands from potential recipients to choose the donors to be used for their transfusions. These donors **MUST** meet the same criteria as other allogeneic donors. There are numerous problems associated with directed donors and DOD discourages this practice unless medically indicated (e.g., HLA match or other compatibility match).

SECTION III. AUTOLOGOUS BLOOD

1-12. GENERAL

a. An autologous donation is donation by the intended recipient of his or her own blood or blood component for possible subsequent transfusion. The patient who receives his or her own blood receives the safest possible blood because no foreign antigens are introduced, and it possesses no infectious diseases other than what the patient may already have acquired. Although transfusion practice has existed for over 100 years, the last decade has seen explosive growth in the use of autologous blood. This growth has occurred in large part as a result of public concern over the risk of transfusion-transmitted diseases. Autologous blood services are best used as part of a comprehensive strategy of blood conservation that includes careful attention to the proper indications for transfusion acceptance of nonvolemia, and avoidance of excessive blood sampling for diagnostic testing.

b. Four categories of autologous blood services exist:

- (1) Preoperative donation.
- (2) Intraoperative hemodilution.
- (3) Intraoperative blood collections.
- (4) Post-operative collection.

1-13. PREOPERATIVE AUTOLOGOUS BLOOD DONATION

a. The initiation of predeposit autologous donation begins with the patient and his or her physician. Not every patient is a candidate for autologous donation. The patient's physician and the blood bank medical director must work together in reviewing the patient's prospective transfusion needs versus the medical risks of donation.

b. Examples of patients who generally would not be candidates for autologous donation:

(1) Having suffered a myocardial infarction in the past 3 months.

(2) Having congestive heart failure, aortic stenosis, significant ventricular arrhythmias, or marked hypertension.

c. For patients who, because of their clinical condition, may be at some risk for predeposit autologous donation, the actual phlebotomy procedure may be performed with greater safety in the hospital setting than at a blood center. The hospital, with its ready access to emergency room equipment and personnel, may be better equipped to handle severe donor reactions.

d. The patient's physician determines how many units are needed for the pending surgery (number should coincide with the MSBOS). It is possible that by carefully monitoring a patient and utilizing an iron supplement, five to six units of autologous blood can be drawn from that patient in the weeks prior to surgery, the last one being drawn no later than 72 hours before scheduled surgery.

e. Some adverse effects of autologous donation include:

(1) Phlebotomy induced anemia.

(2) Increased cost over allogenic blood.

(3) Risk of donor reactions.

(4) Risk of transfusion of wrong unit.

1-14. CRITERIA FOR AUTOLOGOUS DONATION

a. Donor criteria for autologous donation may be somewhat modified from those of the allogeneic donor.

b. Criteria for autologous donation:

(1) Hemoglobin - acceptable at 11 g/dL or 33% hematocrit.

(2) Age - no upper or lower age limit.

(3) Weight - no minimum weight. If the patient weighs less than 110 lbs, adjustments of the amount of blood drawn and anticoagulant must be made.

(4) Frequency of donation - no more than every 3 days; not less than 72 hours before scheduled surgery.

(5) Self-exclusion opportunity - if the unit is not to be used for an allogeneic product [we do NOT "crossover" in the Department of Defense (DOD)], no self exclusion is necessary.

(6) Acceptable blood pressure and pulse values are at the discretion of the blood bank medical director. Use homologous values as guidelines.

(7) Temperature - not to exceed 37.5°C or 99.5°F (the same as homologous).

b. Autologous donation requires the consent of:

- (1) Patient.
- (2) Patient's physician.
- (3) Blood bank medical director.

c. Patients are required to sign an informed consent acknowledging they understand the risks of donation and that their physician will be informed of any positive test results detected. This informed consent, along with the donor's record, becomes part of the permanent file for the facility performing the phlebotomy.

1-15. LABORATORY TESTING

a. Minimum laboratory testing requirements for the autologous units that are to remain autologous are:

- (1) ABO group.
- (2) Rh type.
- (3) Antibody screen.

b. If the blood is to leave the collecting facility for transfusion, tests for the following are recommended or required by the FDA (required for ALL autologous units in DOD):

- (1) HBsAg.
- (2) Anti-HIV-1/2.
- (3) Anti-HTLV-I/II.
- (4) Anti-HBc.

- (5) Anti-HCV.
- (6) Syphilis.
- (7) HIV-1 antigen.

c. If any of these infectious disease tests are positive, a biohazard label must be applied to the unit(s) and the patient's physician informed. DOD prohibits the use of units that are HBsAg or HIV positive.

d. Units that are confirmed positive for any infectious disease markers are not shipped without a written statement from the physician that such units are acceptable.

e. A final decision on the use and/or transportation of products with a positive infectious disease test is made by the receiving facility's medical director, the blood bank medical director, the facility's risk assessment team, and the patient's physician. The patient's physician is always informed of reactive or unexpected laboratory results.

f. The advantages of autologous donation to both the patient and the community blood supply can be significant. Despite additional patient and product handling requirements for this type of donation, the overall benefit to all concerned should be kept in mind when evaluating this option for the patient.

1-16. LABELING

a. Each unit drawn is assigned a unique number that is placed on the phlebotomy bag, sample test tubes, segments, and donor record, as it is with allogeneic donations. This allows the unit to be tracked through its final disposition.

b. The patient's name with some type of identifying number (Social Security Number, birth date, hospital number) must be on the phlebotomy bag for easy matching of the patient and unit.

c. As the unit drawn is to be used only for that patient, a label stating "FOR AUTOLOGOUS USE ONLY" must be placed on the bag. This helps to distinguish the unit from allogeneic units. FDA regulations for labeling autologous units require that "FOR AUTOLOGOUS USE ONLY" label be affixed to the front of the product in the place of the ABO/Rh label. This way there is no risk of transfusing the product to any other patient.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson, and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1-22. Fill in the appropriate answer in the table below:

Type Donor:	Autologous	Homologous
Min Weight	1. _____	12. _____
Min Age	2. _____	13. _____
Max Systolic BP	3. _____	14. _____
Max Diastolic BP	4. _____	15. _____
Max Oral Temp (F)	5. _____	16. _____
Max Oral Temp (C)	6. _____	17. _____
Min Pulse	7. _____	18. _____
Max Pulse	8. _____	19. _____
Min Hematocrit	9. _____	20. _____
Min Hemoglobin	10. _____	21. _____
Min Donation Interval	11. _____	22. _____

BP = Blood Pressure

Min = Minimum

Max = Maximum

23. Which of the following are HIV-associated signs and symptoms?

- I. Unexplained weight loss.
- II. Blue or purple spots on or under the skin or eyes, or in the mouth.
- III. Persistent congestion.
- IV. Persistent white spots or unusual blemishes in the mouth.
- V. Persistent diarrhea.

a. I, II, III, V.

b. II, III, IV, V.

c. I, II, IV, V.

d. I, II, III, IV, V.

24. List six (6) of the nine (9) blood tests performed on donor blood:

25. If it is determined that the donor's blood is unsuitable for transfusion, all products collected from the donor must be _____ and the donor's name entered on the _____.

26-30. Match the appropriate deferral code in Column I with its definition in Column II.

	Column I	Column II
26.	___ Permanent Deferral	a. These are symbols used to identify different categories of donor deferral.
27.	___ Indefinite Deferral	b. Used for donors that are still eligible to donate, but may become ineligible in the future.
28.	___ Surveillance List	c. Donor is no longer eligible to donate. No reentry protocol is available.
29.	___ Temporary Deferral	d. Donor is no longer eligible to donate. A reentry protocol may be developed in the future or exists for these individuals if they meet all reentry criteria.
30.	___ Deferral Codes	e. Donors deferred for specified period of time.

31. Exceptions to usual eligibility requirements may be made for which of the following donors?

- a. Autologous.
- b. Therapeutic.
- c. Directed.
- d. Responses a and b above.
- e. Responses a, b, and c above.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. *None (para 1-14)
2. *None (para 1-14)
3. *None (para 1-14)
4. *None (para 1-14)
5. 99.5 (para 1-14)
6. 37.5 (para 1-14)
7. *None (para 1-14)
8. *None (para 1-14)
9. 33% (para 1-14)
10. 11 mg/dL (para 1-14)
11. 3 days (para 1-14)
12. 110 lbs (figure 1-4 para 57)
13. 17 (figure 1-4 para 8)
14. 180 (figure 1-4 para 60)
15. 100 (figure 1-4 para 60)
16. 99.5 (figure 1-4 para 58)
17. 37.5 (figure 1-4 para 58)
18. 50 (figure 1-4 para 59)
19. 100 (figure 1-4 para 59)
20. 38% (figure 1-4 para 61)
21. 12.5 mg/dL (figure 1-4 para 61)
22. 8 weeks (figure 1-4 para 22)

*Medical Director's discretion

23. c (para 1-2b)
24. ABO & Rh type Anti-HCV
Antibody Screen Anti-HIV-1/2
Anti-HTLV-I/II HBsAg
Anti-HBc HIV-1 Ag
Syphilis (RPR) Possibly CMV
(figure 1-2, para 1-15)
25. destroyed, Donor Deferral Registry (DDR)
(para 1-4a(2))
26. c (para 1-4b)
27. d (para 1-4b)
28. b (para 1-4b)
29. e (para 1-4b)

30. a (para 1-4b)

31. d (para 1-11)

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2

Component Processing, Testing, Labeling, Storage, and Distribution

LESSON ASSIGNMENT

Paragraph 2-1 through 2-17

LESSON OBJECTIVE

After completing this lesson, you should be able to:

- 2-1. List the components of whole blood.
- 2-2. Identify the methods for preparing components.
- 2-3. List anticoagulants and associated expiration dates.
- 2-4. Given a list of donor blood tests and methods, match the testing method and the donor blood test.
- 2-5. State QC requirements for blood components.
- 2-6. Given a list of infectious disease descriptions and causative agents, match the causative agent to the disease description.
- 2-7. Identify requirements for the labeling of blood components.
- 2-8. List two types of barcode systems used to label blood.
- 2-9. List storage and shipping temperatures for each blood component.
- 2-10. List separate areas required for storage in the blood refrigerator.
- 2-11. Select the statements that best describe the monitoring and alarm requirements for blood component refrigerators and freezers.
- 2-12. Describe characteristics of contaminated/ abnormal units of blood.

2-13. Select the statements that best describe the shipment of blood components.

2-14. Identify blood disposal requirements.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 2

COMPONENT PROCESSING, TESTING, LABELING, STORAGE, AND DISTRIBUTION

Section I. COMPONENT PROCESSING

2-1. GENERAL

Blood component therapy refers to the transfusion of the specific part of blood that the patient needs, as opposed to the transfusion of whole blood. Preparation of blood components and their appropriate therapeutic use expands the number of patients who benefit from a limited resource - human blood. A unit of whole blood can be separated into several components. The cellular components include red blood cells (RBC), white blood cells (WBC), and platelets. The cellular components can be further processed into rejuvenated red cells, frozen/deglycerolized red cells, leukocyte-reduced red cells, and platelet concentrates. The plasma can be processed into fresh frozen plasma and cryoprecipitate.

2-2. PROCEDURE

Centrifugation is the primary method of separating cellular and liquid components. Centrifuged products settle out in the following layers starting from bottom of the bag: red cells represent the heaviest cellular component of whole blood followed by white blood cells then platelet rich plasma (PRP) containing some coagulation factors.

a. **Whole Blood.** A unit of whole blood contains 450 ±45 mL of donor blood plus an anticoagulant / preservative solution. Anticoagulant/preservative is a solution designed to preserve the viability and function of the collected blood and prevents clotting. Such solutions provide buffering capability and nutrients for cellular metabolism. All anticoagulant/preservatives must be licensed by the Food and Drug Administration (FDA). See Table 2-1 for approved anticoagulant/preservative solutions and expiration dates for whole blood.

(1) *Materials.* See Lesson 1.

(2) *Storage.* Storage temperature must be between 1 and 6° C for the shelf life of whole blood. The determination of the shelf life or expiration date is based on the type of anticoagulant/ preservative.

Table 2-1: Blood Anticoagulant/Preservative Solutions Licensed By the FDA		
Anticoagulant/Preservative	Abbreviation	Expiration
Heparin	None	48 hours
Acid-citrate-dextrose	ACD	21 days
Citrate-phosphate-dextrose	CPD	21 days
Citrate-phosphate-double dextrose	CP2D	21 days
Citrate-phosphate-dextrose-adenine	CPDA-1	35 days
CPD plus additive solution (Fenwal)	AS-1	42 days
CPD plus additive solution (Cutter)	AS-3	42 days
CPD plus additive solution (Terumo)	AS-5	42 days

b. **Red Blood Cells.** Red blood cells are prepared by removing approximately 80% of the plasma from a unit of whole blood. Because red cells have higher specific gravity than plasma, the red cells move to the lower portion of the collection bag by either gravitational settling or centrifugation. The plasma portion is then removed from the top of the bag into a satellite bag. The plasma portion may be used for further component separation. Red cells should have a final hematocrit between 70% and 80%.

(1) *Materials.*

- (a) Freshly collected whole blood with integrally attached transfer containers.
- (b) Plasma extractor.
- (c) Metal clips and hand sealer.
- (d) Clean scissors and hemostats.
- (e) Dielectric sealer.
- (f) Refrigerated centrifuge.

(2) *Procedure.*

(a) Centrifuge whole blood using a heavy spin, with a temperature setting of 5° C. If RBCs have sedimented, centrifugation is not necessary.

(b) Place the primary bag containing centrifuged or sedimented blood on a plasma expresser and release the spring, allowing the plate of the expresser to contact the bag.

(c) Clamp the tubing between the primary and satellite bags with a hemostat or, if a mechanical sealer will not be used, make a loose overhand knot in the tubing.

(d) If two or more satellite bags are attached, apply the hemostat to allow plasma to flow into only one of the satellite bags. Penetrate the closure of the primary bag. A scale, such as a dietary scale, may be used. The removal of 230-256 g (225-250 mL) of plasma will generally result in residual red cells with a hematocrit between 70% and 80%.

(e) Reapply the hemostat when the desired amount of supernatant plasma has entered the satellite bag. Seal the tubing between the primary bag and the satellite bag in two places.

(f) Check that the satellite bag has the same donor number as that on the primary bag and cut the tubing between the two seals.

(g) Label red cells with appropriate FDA approved label, i.e., Red Cells CPDA-1.

(3) *Storage.* Red cells storage temperature must be between 1 and 6° C. The determination of the shelf life or expiration date depends on the type of anticoagulant as described in Table 2-1.

c. **Rejuvenated Red Blood Cells.** Rejuvenation is a process that is used to restore depleted metabolites and to improve the function and post transfusion survival of RBCs that have been stored at 4° C for 14 days or longer (the normal outdate plus 3 days). After addition of the rejuvenation solution and incubation with the cell concentrate, the component can be prepared for transfusion or for glycerolization and freezing.

(1) *Reagents/materials.*

(a) RBCs obtained from a unit of whole blood collected in CPD or CPDA-1.

(b) 50 mL Red Blood Cell Rejuvenation Solution. It contains pyruvate, inosine phosphate and adenine (PIPA).

- (c) Waterproof plastic bag.
- (d) Metal clips and hand sealer.
- (e) Sterile airway.

(2) *Procedure.*

(a) Using aseptic technique, connect the container of rejuvenating solution to the RBCs with a transfer bag.

(b) By gravity, add 50 mL of rejuvenating solution to the RBCs. A sterile airway is required if the solution is in a bottle. Gently agitate the cell/solution mixture during this addition.

(c) Seal the tubing near the blood bag, and incubate the mixture for 1 hour at 37° C. Incubate in either a dry incubator or circulating waterbath (it is essential to protect the RBCs against contamination by using a waterproof overwrap that allows complete submersion of the mixture).

(d) If the rejuvenated cells are to be used within 24 hours, wash with saline (2 L unbuffered NaCl) by an approved protocol. Storage of the washed cells should be at 4° C. (**Note: The rejuvenating solution is toxic and is not intended for IV administration**).

(e) If the rejuvenated cells are to be cryopreserved, glycerol can be added to the red cell/rejuvenation solution mixture following the same protocol used for preparing other units for frozen storage.

(f) After completion of processing, be sure that units are appropriately labeled ("Red Blood Cells, Rejuvenated," ABO/Rh, a facility label, and original unit number) and that all applicable records are complete.

(3) *Storage.* Washed rejuvenated red cells intended for transfusion are stored between 1 and 6° C and expire in 24 hours of thaw time.

d. **Frozen Red Cells (RBCs Cryopreserved using High-Concentrate Glycerol -Valeri Method).** Frozen red cells are prepared for various reasons, which may include the storage of blood from a rare donor, autologous units stored for a future scheduled surgery, or as a means to conserve and stockpile inventory that may be needed for military activity or natural disaster. Red cells collected in CPD, CPDA-1, AS-1, or AS-2 (additive solutions) may be frozen within 6 days of collection. After 14 days of storage following drawing, the red cells may be frozen if they are first rejuvenated. Rejuvenated red cells can be frozen up to 3 days after expiration date. Freezing of red cells requires the addition of a cryoprotective agent such as glycerol prior to freezing to prevent cellular damage or hemolysis.

(1) *Materials.*

- (a) Quadruple plastic bag collection system with 800-mL primary bag.
- (b) Hand sealer clips.
- (c) Empty 2 mL polyethylene cryogenic vials with screw caps.
- (d) Plasma transfer set with 2 couplers.
- (e) Freezing tape.
- (f) Haemonetics 115 Cell Washer.
- (g) 50-mL Red Blood Cell Processing Solution (Rejuvesol, Cytosol Laboratories, Braintree, MA).
- (h) Heat-sealable 8 x 12 inches plastic bags.
- (i) Fenwal rejuvenated harness.
- (j) Sterile filtered airway needle.
- (k) Cutter rejuvenation harness.
- (l) 500-mL glycerolyte 57 solution (Fenwal 4A7833) or 500-mL solution of 6.2 M glycerolization solution (Cytosol PN-5500).
- (m) Labels--Red Blood Cells, Frozen, Rejuvenated.
- (n) Corrugated cardboard storage box (7" x 5.5" x 2" outside dimensions).

(2) *Procedure.*

- (a) Preparing RBCs for glycerolization.

1 Collect 450 mL of whole blood in the primary bag. Invert the bag, fold it about 2 inches from the base, secure the fold with tape, and place the bag upright in a centrifuge. Centrifuge and remove the supernatant plasma. The hematocrit of the RBC unit must be 75% \pm 5%.

2 Store RBCs in the 800-mL primary bag, along with the adaptor port on the tubing connecting the primary bag and transfer pack, at 1-6° C for 3-35 days (indated) or for 36-38 days (outdated).

3 Prior to rejuvenation, centrifuge stored RBCs to remove all visible plasma. The gross (* see note in Table 2-2) and net weights of the RBCs should not exceed 402 and 330 grams, respectively.

4 Transfer plasma to integrally connected transfer pack, fold the integral tubing and replace the hand sealer clip (not crimped).

5 Transfer 1 mL of plasma to all three cryogenic vials for future testing.

(b) RBC biochemical modifications.

1 Using Fenwal rejuvenation harness, aseptically insert the needle of the Y-type Fenwal harness into the rubber stopper of a 50-mL red blood cell processing solution (Rejuvesol) bottle and the coupler of the set into the adaptor port of the primary collection bag. Insert the filtered airway needle into the rubber stopper of the Red Blood Cell Processing Solution bottle.

2 Using Cutter rejuvenation harness, aseptically insert the vented white spike with the drip chamber into the rubber stopper of the Red Blood Cell Processing Solution bottle and the nonvented spike into the special adaptor port on the primary collection bag.

3 With gentle manual agitation, allow 50 mL of Red Blood Cell Processing Solution to flow directly into the RBCs.

4 Heat-seal the tubing of the harness set that connects the bottle of Red Blood Cell Processing Solution to the adaptor port. The second tubing of the harness Y-set is used to add glycerol (see below).

5 Completely overwrap the 800-mL primary bag, the integrally connected empty transfer pack and the coupler of the Y-type harness and incubate the RBCs in a 37° C waterbath for 1 hour.

(c) Glycerolization.

1 Remove the numbered crossmatch segments, leaving the initial segment and number attached to the collection bag. Weigh the unit.

2 Determine the amount of glycerol to be added based on the gross (* see note in Table 2-2) or net weight of the unit from the values shown in Table 2-2. Mark the column of glycerol to be added in the glycerol bottle for each of the three steps, using the factor graduations on the bottle.

3 Aseptically insert the coupler of the rejuvenation harness into the outlet port of the rubber stopper on the glycerol solution bottle. For Fenwal harness only, insert a filtered airway needle into the vent portion of the glycerol bottle stopper.

4 Place the RBC bag on a shaker. Add the amount of glycerol shown in Table 2-2 for the first volume while the bag is shaking at low speed (180 oscillations/minute).

5 Equilibrate the mixture for 5 minutes without shaking and add the second volume. Equilibrate for 2 minutes. Add the third volume of glycerol, using vigorous manual shaking.

6 Heat-seal the tubing between the empty bottle of glycerol and the tubing proximal to the adaptor port. Ensure that the transfer pack remains integrally attached to the primary collection bag.

7 Centrifuge the RBC-glycerol mixture and transfer all visible supernatant glycerol to the transfer pack. Resuspend unit and mix.

8 Seal the tubing 4 inches from the primary collection bag and detach the transfer pack containing the supernatant fluid and discard.

9 Affix an overlay blood component label, the facility label, and an ABO/Rh label. Record the expiration date (currently 10 years.)

10 Weigh the unit just prior to freezing and record the weight.

Table 2-2. Amount of Glycerol Needed for Different Weights of RBC Units					
Gross Weight of Unit (grams)	Net Weight of Units (grams)	Initial Addition of Glycerol (mL)	Second Addition of Glycerol (mL)	Third Addition of Glycerol (mL)	Total Glycerol Added (mL)
222-272	150-200	50	50	250	350
273-312	201-240	50	50	350	450
313-402	241-330	50	50	400	500
* Gross weight includes the primary bag, remaining satellite bag, and unused portion of rejuvenation harness.					

11 Fold over the top portion of the primary bag (approximately 2 inches). Place the primary bag into a plastic bag. Overwrap and heat seal the outer bag across the top so that there is as little air as possible.

12 Place one polyethylene cryogenic vial of plasma and the plastic bag containing the glycerolized RBCs in the cardboard box.

13 Affix a “Red Blood Cells, Frozen, Rejuvenated” label, an ABO/Rh label, a facility label, and original unit number on the outside of the box.

14 Freeze the unit in an ultra-low freezer. No more than 4 hours should be allowed to elapse between the time the RBCs are removed from the 4° C refrigerator and the time they are placed in the ultra-low (must store at $\leq -65^{\circ}$ C).

(d) Storage. Store frozen RBC units in a -80° C freezer for up to 10 years from date of freezing (21 years for war stock).

(e) Thawing and deglycerolizing.

1 Place the frozen RBCs in either a 37° C waterbath or a 37° C dry warmer.

2 Agitate gently to speed thawing. The thawing process takes at least 10 minutes. Thawed cells should be at 37° C.

3 After RBCs are thawed, use the Haemonetics 115 (or cell washer) to deglycerolize cells frozen in high glycerol concentration. Follow local or standard DOD deglycerolization SOP for solutions, heights, and flow rates.

4 Record the lot number and manufacturer of all solutions and software used. Label the unit with the “Red Blood Cells, Deglycerolized” (D-RBCs) label. Also, identify the collecting facility as well as the facility preparing the D-RBCs, ABO/Rh, whole blood number, expiration date and time to the transfer pack.

5 Dilute the unit with 50 mL hypotonic (12%) NaCl solution. Allow to equilibrate for at least 2 minutes.

6 Using the Haemonetics 115, wash with 0.9% NaCl - 0.2% dextrose until deglycerolization is complete. Approximately 2 liters of wash solution are required.

(f) Check for residual glycerol:

1 Materials.

a D-RBCs, 0.5 mL.

b Normal Saline.

c Color comparator.

2 Procedure.

a Add 0.5 mL of deglycerolized RBCs to 10 mL of normal saline.

b Mix well and centrifuge for 1 minute at 1000 x g.

c Estimate level of hemolysis by comparing the specimen with a known control or by comparison with a commercially available color comparator. There should be no more than 3% hemolysis.

d On appropriate form, document the date of testing , the blood unit number, the results, and the initials of the person performing the test. Document corrective action when the desired result is not achieved. **Deglycerolized red cells expire 24 hours after thawing.**

e. Leukocyte-reduced Red Cells. The primary reason for leukocyte reduced red blood cells is to minimize the risk of non-hemolytic febrile (increase in temperature: 1° C or 2° F) transfusion reaction. Leukocytes infused in patients can cause these patients to develop antibodies (sensitization) to foreign human leukocyte antigens (HLA). This may result in the patient becoming refractory (a state of general unresponsiveness to therapy) to platelet transfusions or graft rejection. Leukocyte reduction can also reduce the risk of transmission of certain viral infections that are found primarily in the leukocytes. Cytomegalovirus (CMV), Epstein-Barr virus (EBV), and human T-lymphotrophic virus type I (HTLV-I) are transmitted exclusively by the cellular components of the blood, primarily the leukocytes. Patients who are most at risk of suffering a febrile transfusion reaction or of becoming refractory are those who have been multiply transfused, or are immunosuppressed or immunodeficient (leukemia, aplastic anemia, etc.) Methods for preparation of leukocyte-reduced products include the following: centrifugation, saline washing, spin-cool filtration, freezing and deglycerolization, bedside filtration and prestorage filtration. Leukocyte-reduced red cells should retain 80% of the original red cells and have a final white blood count below $5 \times 10^6/L$ to be considered leukocyte reduced. Table 2-3 summarizes the methods.

(1) *Centrifugation.* Centrifugation for Leukocyte Reduction Centrifugation of packed RBCs results in a buffy coat between red cells and the plasma. The buffy coat and some red cells are drawn off into a satellite bag. A variation of this method is to invert the blood bag, centrifuge and remove most of the red cells into a satellite bag, leaving the buffy coat and plasma in the original bag. Although this is a simple, cost effective method, only 70%-80% of the leukocytes are removed and results in a 20% loss of red cells. If the leukocyte reduced product is made using satellite bag or sterile docking device, the original expiration date stands. If, however, the unit is opened and a transfer bag is attached, the product expires in 24 hours.

(2) *Washed cells for leukocyte reduction.* The advantage of washing red cells for leukocyte reduction is it also removes plasma, and platelets along with the white cells. The technique is performed by taking any unit of indate red cells, adding saline, mixing, centrifuging, removing the saline and plasma and repeating the process several times until the leukocytes, platelets, and plasma are removed. The washing process can also be accomplished by using an automated instrument specifically designed for

this process. The disadvantages include: it is labor intensive if done manually, requires special equipment for automated washing, resulting in only a 70%-90% reduction in leukocytes and the product expires in 24 hours because the sterility of the original unit has to be broken to perform the procedure.

(3) *Spin-cool filter method.* The spin-cool filter method utilizes centrifugation of the unit, cooling the unit at 4° C for 3 hours followed by filtration at bedside. Although this method removes only 82%-90% of the leukocytes, the advantages are it is simple, cost effective, and the unit maintains its original expiration date with only 10% loss of red cells.

Table 2-3. Methods for Leukocyte-Reduced Red Blood Cells					
Methods	% WBC Removed	% RBC Recovery	Outdated	Advantages	Disadvantages
Centrifugation	70-80	80	Original	Simple	Poor WBC removal; loss of RBCs
Washed red cells	70-95	86	24 hours	Removes platelets, plasma	Short Outdate; labor intensive
Spin-cool filtration	82-92	92	Original	Cost effective, good outdating	Requires centrifuge
Bedside filtration	99-99.9	90	Original	No special handling	Filters more expensive
Prestorage filtration	99.7-99.9	90	Original	Remove WBC and microaggregates	Labor intensive; must be done at center within 8 hours of drawing
Frozen/Thawed units	95-99	90	24 hours	Patents with antibodies who require rare blood	Expensive; short shelf life.

(4) *Frozen/deglycerized red cells.* Freezing and deglycerizing red cells removes 95%-99% of leukocytes with a 20% loss of red cells. This process is labor intensive and expensive and would only be used in cases of patients who have antibodies to high incidence or rare antigens or, in DOD's case, remote location storage to tide us over until liquid blood arrives in theater. The product has an expiration date of 24 hours from the time it is thawed.

(5) *Bedside filtration.* Bedside filtration is one of the most effective methods of leukocyte reduction since it removes 99%-99.9% of the leukocytes and allows 90% infusion of red cells. The method utilizes a filter attached as part of the infusion system. The advantages are there is no time lost in preparation and no waste of the product if not transfused to patient.

(6) *Prestorage filtration.* Prestorage filtration method for leukocyte reduction utilizes the principle that leukocytes begin to deteriorate within 8 hours of phlebotomy. By removing leukocytes before they disintegrate and fragment, the incidence of sensitization of patients to HLA antigens and viral infections transmitted by leukocytes is reduced. This can be done in two ways: by connecting a bedside filter to the primary storage bag and filtering the blood into a sterile satellite bag utilizing sterile technique or utilizing a collection bag with a filter already incorporated in the system. The blood is filtered within 8 hours, thereby accomplishing the leukocyte reduction. This method removes 96.2%-97% of leukocytes and retains 90% of the red cells. The expiration date is also not affected with this procedure.

NOTE: These products must be labeled with the Leukocyte-Reduced label, anticoagulant used, facility label, and correct expiration date.

f. **Platelet Concentrate (PC).** Platelet transfusions are used to prevent spontaneous bleeding or stop established bleeding in patients with hypoplastic anemia, marrow failure, malignancies or chemotherapy and other thrombocytopenic causing conditions. They also maintain vascular integrity and stabilize the hemostatic plug. Platelets are harvested from whole blood following "light spin" centrifugation. The platelets are concentrated by "heavy spin" centrifugation with subsequent removal of supernatant plasma. Guidelines have been established by the FDA/AABB that must be followed if whole blood donations are intended for platelet preparation which include:

(1) Donor abstain from taking any aspirin-containing drugs or Feldene 72 hours prior to donating (aspirin containing drugs effectively inhibit platelet function).

(2) To prevent activation of the coagulation system blood, collection should not exceed 10 minutes.

(3) Whole blood intended for platelet preparation must be separated within 8 hours of collection and be cooled to within 20-24° C.

(4) Materials.

(a) Freshly collected whole blood in a unit with integrally attached transfer containers. The final plastic container must be approved by the FDA for platelet storage.

(b) Metal clips and hand sealer.

(c) Clean scissors and hemostats.

(d) Plasma extractor.

(e) Dielectric sealer (optional).

(f) Calibrated refrigerated centrifuge.

(5) Procedure.

(a) Centrifuge the blood using light spin at 20° C.

(b) Express the supernatant platelet rich plasma into the transfer bag intended for platelet storage. Seal the tubing twice between the toe seals. Refrigerate the RBCs at 1-6° C.

(c) Centrifuge the platelet rich plasma using the heavy spin at 20° C.

(d) Express the supernatant platelet poor plasma into the second storage bag and seal the tubing. The platelet poor plasma may be frozen and utilized as fresh frozen plasma. Some plasma should remain on the platelet button.

NOTE: AABB Standards requires that sufficient plasma remains with the platelet concentrate to maintain the pH at 6.0 or higher for the entire storage period. The standard dose label requires a 45-65 mL volume.

(6) With conventional storage bags, platelet concentrates (PC) are to be stored at 20-24° C with continuous agitation. The FDA (CFR 640.25a) allows PC storage at 1-6° C for 72 hours with agitation optional.

g. **Platelets, Apheresis.** Platelets can be collected by cytopheresis methods, which allow for the return of red cells and all but 180-250 mL of plasma to the donor. The process of collecting only platelets during a cytopheresis process is called plateletpheresis. Indications for use of apheresis platelets includes patients who require platelet transfusions, patients who have become refractory to random donor platelets, and patients who require HLA matched platelet products. A major advantage for use of platelets derived from apheresis is the decreased exposure to random donor antigens. Another advantage of apheresis platelets is that apheresis products contain an equivalent of 5-8 random donor units and eliminates the need for pooling (the process of combining several random donor platelet units). The storage and expiration of apheresis products are the same as platelet concentrates.

h. **Fresh Frozen Plasma.** Indications for use of fresh frozen plasma (FFP) include treatment of congenital or multiple coagulation factor deficiencies, thrombocytopenic purpura, antithrombin III deficiency, dilutional coagulopathy of massive transfusions, and reversal of the effects of Coumadin. FFP is plasma that is separated from whole blood and frozen at -18° C within 8 hours of collection. Again, there are time constraints in the blood collection procedure.

(1) *Materials.*

- (a) Freshly collected whole blood.
- (b) Metal clips and hand sealer.
- (c) Clean scissors and hemostats.
- (d) Plasma extractor.
- (e) Dielectric sealer (optional).
- (f) Dietary scale.
- (g) Refrigerated centrifuge.

(2) *Procedure.*

- (a) Centrifuge blood at 4° C using a “heavy” spin within 8 hours of collection, unless also preparing platelets.
- (b) Place primary bag containing centrifuged blood on a plasma extractor and place the attached satellite bag on a dietary scale adjusted to zero. Express the plasma into the satellite bag and weigh the plasma.
- (c) Seal the transfer tubing with a dielectric sealer or metal clips, but do not obliterate the segment numbers of the tubing. Place another seal nearer the transfer bag.
- (d) Label the transfer bag with the unit number prior to separation from the original container and record volume of plasma on the label.
- (e) Cut the tubing between the two seals. The tubing may be coiled and taped against the plasma container; the segments are then available for reverse grouping or other tests.
- (f) Place the plasma at -18° C or lower within 8 hours of collection of the donor unit.

i. **Cryoprecipitated Antihemophilic Factor (AHF).** The primary indications for use of cryoprecipitate include bleeding associated with Factor VIII deficiency, von Willebrand’s disease, and fibrinogen or Factor XIII replacement in patients whose laboratory studies support these specific needs. The cold insoluble precipitate recovered from a controlled thaw of FFP is known as cryoprecipitate or antihemolytic factor (AHF). Cryoprecipitate is rich in coagulation Factor VIII, both Factor VIII:C (procoagulant activity factor) and Factor VIII:vWF (von Willebrand factor), Factor XIII,

and fibrinogen (Factor I). The product also contains variable amounts of fibronectin, a protein that participates in phagocytosis. Cryoprecipitation is accomplished by rapid freezing of plasma followed by slow thawing at 1-6° C.

(1) *Materials.*

- (a) Freshly collected whole blood.
- (b) Metal clips and hand sealer.
- (c) Clean scissors and hemostats.
- (d) Plasma extractor.
- (e) Dielectric sealer (optional).
- (f) Refrigerated centrifuge.

(g) Freezing apparatus: suitable freezing devices include blast freezers or mechanical freezers capable of maintaining temperatures of -18° C or below, dry ice, or an ethanol-dry ice bath. In a bath of 95% ethanol and chipped dry ice, freezing will be complete in about 15 minutes.

(2) *Procedure.*

(a) Collect blood in a collection unit with two integrally attached transfer containers.

(b) Centrifuge blood at 1-6° C using a “heavy” spin. Separate plasma from the RBCs within 8 hours of phlebotomy. Collect at least 200 mL (205 g) of cell free plasma for processing into cryoprecipitate.

(c) Freeze plasma rapidly within 8 hours of phlebotomy. The plasma should become solidly frozen within 1 hour of the time freezing was initiated. Plasma containers immersed in liquid must be protected with a plastic overwrap.

(d) Allow the plasma to thaw at 1-6° C by placing the bag in a 4° C shaking waterbath or in a refrigerator. If thawed in a waterbath, use a plastic overwrap (or other means) to keep container ports dry.

(e) When the plasma has a slushy consistency, follow either step below:

1 Centrifuge the plasma of the 1-6° C using a “heavy” spin. Hang the bag in an inverted position and allow the supernatant plasma to flow rapidly into the transfer bag, leaving the cryoprecipitate adhering to the sides of the primary bag. 10-15 mL of supernatant plasma may be left in the bag to resuspend the cryoprecipitate

after thawing. Separate promptly to prevent the cryoprecipitate from redissolving and flowing out of the bath, and then refreeze immediately.

2 Place the thawing plasma in a plasma expessor when approximately one tenth of the contents is still frozen. With the bag in an upright position, allow the supernatant plasma to flow slowly into the transfer bag, using the ice crystals at the top as a filter. The cryoprecipitate paste will adhere the sides of the bag or to the ice. Seal the bag when about 90% of the cryoprecipitate-poor plasma has been removed and refreeze the cryoprecipitate immediately.

(3) *Storage*: Store at -18° C or lower preferably -30° C or lower, for up to 12 months from the date of blood collection. **NOTE: Cryoprecipitate may be made from FFP anytime within the 12 months of collection. The expiration date of the cryoprecipitate is 12 months from the date that the original donor blood was collected.**

j. **Quality Control.** Quality control values as expected as minimums as mandated by the FDA and AABB for all products are summarized in Table 2-4.

Table 2-4. Summary of Quality Control Requirements for Components
<p>RED BLOOD CELLS</p> <p>Hematocrit: 70-80% Survival: Minimum of 70% of transfused red cells surviving in patient 24 hours after transfusion</p>
<p>FROZEN/DEGLYCERIZED RED CELLS</p> <p>Recovery of a minimum of 80% original red cells Survival: Minimum of 70% of transfused red cells surviving in patient 24 hours after transfusion</p>
<p>LEUKOCYTE-REDUCED RED CELLS</p> <p>Minimum of 80% of red cell remaining in leukocyte reduced product To prevent febrile reactions: white count less than 5×10^8 For other reasons: white count less than 5×10^6</p>
<p>PLATELET, CONCENTRATE</p> <p>Platelet count: 5.5×10^{10} or greater in 75% of units tested pH: 6.0 or greater Platelets must be tested at the maximum storage time</p>
<p>PLATELET, APHERESIS</p> <p>Platelet count: 3.0×10^{11} or greater in 75% of units tested pH: 6.0 or greater Product must be tested at maximum storage time</p>
<p>CRYOPRECIPITATE</p> <p>Factor VIII content: 80% IU/L product or greater in 75% of units tested</p>

Section II. DONOR BLOOD TESTING

2-3. INTRODUCTION

This section will not present detailed procedures for all of these tests because each test must be performed strictly in compliance with current instructions provided by the manufacturer of the test materials and equipment in use. The following general principles apply to all tests and records on donor blood.

a. General Requirements.

(1) For tests required by the FDA/ AABB, all reagents used must meet or exceed the requirements of the FDA. The most recent instructions from the manufacturer must be followed in their use.

(a) Acceptable specimen.

(b) Required controls and manner of use.

(2) Tests must be performed on a properly identified specimen from the current donation. Every donation intended for allogeneic use must undergo complete testing.

(3) Results of each test must be recorded immediately after observation; interpretation is recorded only when testing is complete.

b. Required Tests.

(1) ABO and Rh.

(2) Antibody screen.

(3) Infectious disease testing to include: hepatitis B surface antigen (HBsAg); HIV antigen (HIV-1 Ag); antibodies to HIV-1/2, HBc, HCV, and HTLV- I/II and a serologic test for syphilis (STS).

c. Equipment Requirements.

(1) All equipment used for testing must be properly calibrated and validated upon installation and after repairs. There must be a schedule for planned maintenance, and all maintenance and repair activities must be documented for each instrument.

(2) Software used to control the instrument and/or to interface with the institution's computer system must be properly validated.

d. Record Requirements.

(1) It must be possible to trace from its source to its disposition, any unit of blood and every component from each unit. Records on donor units and recipients must make it possible to investigate adverse reactions manifested by a recipient.

(2) Each unit must be tested; previous records cannot be used.

(3) Current donation ABO and Rh must match previous group and type. If a discrepancy is found, the unit must not be used until there is resolution to the discrepancy.

e. ABO and Rh Testing.

(1) *Principle.*

(a) ABO forward grouping: Tests that use anti-A or anti-B to determine the presence or absence of the antigens on donor cells.

(b) ABO reverse group: The use of reagent A₁ and B red cells to detect anti-A and anti-B in donor serum. Two different technicians must perform the forward and reverse grouping and any discrepancies resolved before labeling the unit.

(c) All donor cells must be Rh typed (to determine if the D antigen is present or absent).

(2) *Procedure.*

(a) ABO testing must be performed by testing donor red cells with reagent anti-A and anti-B, and donor serum or plasma with A₁ and B cells.

(b) Rh type must be determined by testing donor red cells with anti-D serum. This must include a method designed to detect weak D (Du). All donor cells that do not agglutinate at immediate spin must be taken through the Anti-Human Globulin (AHG) phase (also known as Coomb's phase). Red cells reactive with anti-D either by direct agglutination or by the test for weak D must be labeled Rh Positive. AHG anti-D control must be negative (RBCs are not coated with antibody or complement).

(3) *Interpretation.* Table 2-5 shows the results and interpretations of routine ABO serum and cell-testing. Note the different frequencies of ABO groups in different segments of the U.S. population.

Table 2-5: Routine ABO Grouping									
Reaction of Cells Tested With		Reaction of Serum Tested Against			Interpretation ABO Group	Frequency (%) in U.S. Population			
		A Cells	B Cells	C Cells		Whites	African-American	Native American	Asian-American
Anti-A	Anti-B								
O	O	+	+	O	O	45	49	79	40
+	O	O	+	O	A	40	27	16	28
O	+	+	O	O	B	11	20	4	27
+	+	O	O	O	AB	4	4	1	5
+ Agglutination		O No Agglutination							

f. Antibody Screen.

(1) *Principle.*

(a) Donor serum or plasma is tested against individual samples or a pool of reagent red cells of known phenotypes.

(b) The screening cells should express at least the following antigens: D, C, E, c, e, K, k, Fy^a, Fy^b, Jk^a, Jk^b, Le^a, Le^b, P₁, M, N, S, and s.

(c) When clinically significant antibodies are found, blood components (RBCs) should be labeled to indicate the antibody detected ("Contains anti- _____"). Discard plasma.

(2) *Procedure.* Methods must be those that demonstrate clinically significant antibodies. The traditional tube method uses donor serum and screening cells (either pooled or a set of 2 or 3 screening cells - most donor centers opt for the pooled screening cells). Albumin, LISS or PEG may be used when incubating cells. The gel or solid phase technologies may also be used.

g. Serological Test for Syphilis. The screening procedure used to test donor blood specimens is not specific for antibodies to antigens of *Treponema pallidum*, the organism that causes syphilis. Donor units positive on the screening serologic test for syphilis (STS) should not be used for allogeneic transfusion. Before a donor is notified of the test result, it may be desirable to test further (FTA test), to see whether true treponemal antibodies are present. The Rapid Plasma Reagin (RPR) is the most common screening test and is described below.

(1) *Principle.* This screening test detects an antibody sometimes called “reagin,” which is directed against cardiolipin, a widely distributed lipoidal antigen. These antibodies characteristically develop in individuals who have had untreated syphilitic infection, but may also develop in individuals after infection with various bacteria or viruses or after immunization procedures. Persistent antibodies sometimes occur in patients with autoimmune disorders, especially systemic lupus erythematosus (SLE).

(2) *Procedure.* Unheated serum mixed with the reagent suspension of cardiolipin-coated carbon particles is placed on a plastic-coated white card, which is rotated at room temperature. If the serum contains antibodies, easily visible flocculent black clumps will form against the white background. If antibodies are absent, or below the level of detection, the mixture will remain a homogeneous gray suspension.

h. EIA Test for Specific Viral Antigens (HBsAg and HIV-1 Ag).

(1) *Principle.* The enzyme-linked immunosorbent assay (EIA or ELISA) is the test of choice for screening donor blood for HBsAg and HIV antigen. The EIA employs a solid support (e.g., bead or microplate) coated with an unlabeled antiserum against the appropriate antigen. The indicator material is the same antibody, labeled with an enzyme whose presence can be detected by color change in the substrate. If the specimen contains antigen, it will bind to the solid-phase antibody and will, in turn, be bound by the enzyme-labeled indicator antibody.

(2) *Repeat testing.* EIA tests are highly sensitive, which makes them useful as screening procedures, but are subject to false-positive reactions. Before a donor is designated as antigen-positive, which can be devastating to a donor, it is important to determine whether the screening result is repeatable. This caution is usually included in the manufacturer’s package insert, with recommendations for the handling of initially reactive (IR) and repeated reactive (RR) samples. If the initial test is repeated in duplicate and one or both of the duplicate test are reactive, the specimen is described as repeatedly reactive and the unit and all components must be discarded. Become intimately familiar with the algorithms in Annex A.

i. Neutralization Tests to Confirm EIA Tests.

(1) *Principle.* In confirmatory neutralization tests, the reactive specimen is incubated with human serum known to contain antibody specific for the antigen in question. If incubation causes the positive reaction to disappear or to diminish by at least 50%, and all control values are as expected, the presence of antigen is confirmed and the original result is considered a true positive. If incubation with known antibody does not affect subsequent reactivity, the original reactivity is considered a false-positive result.

(2) *Controls.*

(a) Known positive and negative control samples must be tested in parallel with the donor or patient samples.

(b) Parallel incubations must be performed with a preparation known to contain antibody specific for the antigen in question and with a preparation known to be free of both antigen and antibody.

(c) Values for positive and negative control samples must fall within stated limits. If percent neutralization does not meet the specifications stated in the package insert, the run should be repeated.

j. **EIA Tests for Antibodies (Anti-HIV-1/2, -HBc, -HCV, and -HTLV I/II).**

(1) *Principle.* The EIA method is also widely used to screen for the presence of antibodies to infectious diseases. The solid phase (bead or microtiter well) is coated with antigens prepared from the appropriate viral recombinant proteins or synthetic peptides. Most assays use a capture approach. Serum or plasma is incubated with fixed antigen; if present, antibody binds firmly to the solid phase and remains fixed after excess fluid is washed away. An enzyme-conjugated preparation of antigen is then added; if fixed antibody is present, it binds the labeled antigen and the antigen-antibody-antigen complex can be quantified by measuring enzyme activity. One assay for anti-HBc uses an indirect capture method (competitive assay), in which an enzyme-antibody conjugate is added to unknown specimen. Any antibody present in the unknown will compete with the enzyme-conjugated antibody and significantly reduce the level of enzyme fixed, compared to results seen when nonreactive material is present.

(2) *Notes.*

(a) Samples giving nonreactive results on the screening test, as defined by the package insert, are considered negative and need not be further tested.

(b) Samples reactive on the initial screening test must be repeated in duplicate. Reactivity in one or both of the repeated tests constitutes a positive result. If both the duplicate repeat tests are nonreactive, the test is interpreted as giving a negative result.

(c) When units are IR, they must be quarantined until the results of duplicate repeat testing are available. All blood and components from donations found to be positive must be destroyed and records showing the destruction must be maintained.

(d) Supplemental or confirmatory testing may be performed on samples that are RR.

(e) Donors must be notified of any medically significant abnormality detected as a result of laboratory testing. In the Army, most of the notifications are accomplished by preventive medicine personnel, who further work up and/or treat the donor. Test results are confidential and all donors are to read the "Donor Information" provided (figure 1-3), which states their name may be put on a DDR and public health officials may also be notified. The donor must agree to these conditions before phlebotomy (see figure 1-1, Block # 83 "Donor Signature").

k. Test for Antibody to Cytomegalovirus (CMV).

(1) *Principle.* CMV can persist in the tissues and leukocytes of asymptomatic individuals for years after initial infection. Blood from persons without antibodies to the virus has no risk of transmitting infection (only a small fraction of donors who do test positive for CMV actually transmit infection). Immunodeficient patients, to include low birth weight neonates, should be protected from possible infection or reinfection with CMV. One way to accomplish this is to give those patients CMV negative blood. This is an optional test.

(2) *Procedure.*

(a) EIA may be used (see j. above).

(b) Another widely used method is latex agglutination, in which latex particles coated with viral antigens are incubated with the unknown specimen and will form agglutinates visible to the naked eye if antibody is present. Make sure the test you are using is licensed for blood donors. The package insert will state whether the test detects both IgM and IgG antibodies to the virus.

l. Invalidation of Licensed Viral Marker Tests.

(1) *Principle.* The results of a testing run using a licensed viral marker test may be declared invalid if performance did not meet the requirements of the manufacturer's package insert or if the control results do not meet acceptance criteria defined in the package insert. Both the reactive and the nonreactive results obtained in the run must be declared invalid; all specimens involved must be tested in a new run, which becomes the initial test of record. If the batch controls are acceptable and if no error is recognized in performance of the test, the reactive and nonreactive results remain as the initial test of record for the specimens involved. Specimens with reactive results must be retested in duplicate, as required by the manufacturer's instructions.

(2) *Procedure.*

(a) If results on controls fail to meet acceptance criteria, all test results on that run are invalidated. The subsequent assay becomes the initial test of record for all specimens.

(b) If a test procedure is invalidated (as described above), **ALL** results on that run are invalidated, and the subsequent assay becomes the initial test of record. Before the test run is invalidated, the problems observed should be reviewed by a supervisor, reasons analyzed, and corrective action taken, if applicable. The FDA is very strict about run invalidation and requires detailed documentation.

(c) When a run is invalidated, a record of the departure from normal SOP must be prepared, with complete description of the reason for invalidation and the nature of corrective actions taken.

2-4. INFECTIOUS DISEASES

There are over 400 viruses that have been identified that can infect man. The clinical impact of these infections may result in discomfort to even more serious consequences such as death. The modes of infection include animal to human, arthropod to human, and human to human. Human to human transmission of infectious diseases can be caused by the transfusion of blood and blood products. Some diseases that can be transmitted via blood or blood products are syphilis, hepatitis, and AIDS.

a. **Syphilis.** Syphilis is caused by a spirochete called *Treponema pallidum* for which man is the only reservoir host. *T. pallidum* is seen microscopically as a close-coiled, thin, regular spiral organism. Syphilis is ordinarily transmitted by sexual contact. *T. pallidum* appears to enter the skin only through small breaks in the skin, but is capable of passing through intact mucous membranes. Syphilis may be transmitted by blood transfusion when fresh blood is used. Blood stored at 4° C for 3 days or more, however is unlikely to transmit syphilis, because *T. pallidum* is unable to survive under these conditions. Since routine testing on blood donations takes several days to complete, the causative organism is usually dead. The testing for syphilis is a standard procedure for all blood donation, therefore the disease is rarely a problem.

b. **Hepatitis.**

(1) Hepatitis is a term that refers to the inflammation of the liver and is often caused by viral infections. The vast majority of cases of hepatitis are the result of damage to the liver cells caused by viruses, bacteria, fungi, parasites, drugs, toxins, and excessive alcohol intake. There are many viruses that can cause hepatitis. The terms viral hepatitis and acute viral hepatitis are terms generally used to refer to cases caused by specific hepatotropic viruses. These include Hepatitis A, B, C, D, E, F, and G. Transfusion-transmitted hepatitis is the most common major complication of blood transfusions. The incidence of transfusion-transmitted hepatitis has decreased dramatically in the last 20 years. Recipients of multiple transfusions have 2%-4% chance of contracting hepatitis. Risk of acquiring hepatitis is directly proportional to the number of transfusions received. At this time, Hepatitis C or other Non-A and Non-B (NANB) forms are responsible for the majority of transfusion-transmitted hepatitis cases. Anti-HBc is a surrogate test for NANB hepatitis.

(2) Most individuals who acquire HBV or HCV infection have a subclinical infection without obvious symptoms or physical evidence of disease. Others have obvious disease with jaundice, nausea, vomiting, abdominal discomfort, fatigue, dark urine, and elevation of liver enzymes. Some cases will become fulminant (severe) hepatitis, relapsing or chronic hepatitis, or have long-term progression through cirrhosis to hepatocellular carcinoma.

(a) Hepatitis A (HAV). This RNA virus travels the fecal/oral route and causes a self-limiting infection. Diagnostic tests include ALT, Anti-HAV (IgG and IgM). Gamma globulin given within two weeks of infection provides short-term protection, and a vaccine is available.

(b) Hepatitis B (HBV). Transmitted through blood and sexual contact, this DNA virus is extremely infectious, but a vaccine can prevent infection. Diagnostic tests include HBsAg, HBeAg, ALT, HBV DNA, and Anti-HBc. Some patients fail to clear infectious material from the blood stream and become chronic carriers for years or even for life.

(c) Hepatitis C (HCV). No treatment exists that can prevent infection with this RNA virus that spreads through blood and sexual contact. Diagnostic tests include ALT, Anti-HCV, and HCV RNA. More than 80% of people with HCV develop chronic liver disease or are chronic carriers.

(d) Hepatitis D (HDV). This virus can only cause hepatitis when the patient also has HBV. Most cases found have been hemophiliacs, who receive large numbers of blood products. Diagnostic tests include Anti-HDV, and genetic tests.

(e) Hepatitis E (HEV). This RNA virus contaminates water and is endemic to the third world, but occasional appears in the U.S. The mortality rate among infected pregnant patients is about 20%. Diagnostic tests include RNA, ALT, IgG, and IgM.

(f) Hepatitis F (HFV). There is debate whether this is a distinct virus or not.

(g) Hepatitis G (HGV or GBV-C). A recently discovered flavivirus (RNA), which has been associated worldwide with non-ABCDE hepatitis. There currently is not an immunochemical test.

c. Acquired Immunodeficiency Syndrome (AIDS). Acquired immunodeficiency syndrome (AIDS) is characterized as a diverse group of clinical manifestations resulting in the loss of immune function and regulation following infection by the human immunodeficiency virus (HIV). AIDS is caused by at least two types of human immunodeficiency viruses, designated collectively as HIV. HIV-1 was the first AIDS virus discovered. This virus was isolated from patients with AIDS or AIDS-related complex (ARC) and from healthy persons at high risk for AIDS. In 1986, HIV-2 was isolated from patients with AIDS in West Africa. However, HIV-2 has spread into

Europe and there have been rare cases reported in the U.S. At this time, there have been only two reports of possible transfusion associated (TA) HIV-2 infections in Europe. Presently available screening tests now have closed the window period (person has the virus, but tests are negative) to approximately 16-20 days after infection, when the Anti-HIV-1/2 and HIV-1 Ag tests are employed (HIV-1 group O viruses may not be detected).

d. **Human T-Lymphotropic Virus I/II.** The human T-lymphotropic virus types I and II are RNA type C viruses. Transfusion is the most efficient mode of transmission with seroconversion occurring in 35 to 60 % of recipients. Prevalence of HTLV infection shows striking geographic clustering, with pockets of endemic rates in southern Japan, sub-Saharan Africa, Caribbean basin, and Brazil. Transmission is by sexual contact (predominantly heterosexual), parenteral exposure to blood, and by mother-to-child transmission through breast milk.

(1) HTLV-I was the first human retrovirus described. It causes adult T-cell leukemia lymphoma. HTLV-I is also associated with the neurological condition originally called tropical spastic paraparesis (TSP), but now often called HTLV-associated myelopathy (HAM).

(2) HTLV-II has occasionally been associated with HAM, but usually no disease state is exhibited.

Section III. REVIEW AND LABELING

2-5. GENERAL

a. Before the labeling process is completed, records must be reviewed to ensure that blood and all components from unsuitable donors will be quarantined and not issued for transfusion.

b. Among the most important steps in safe transfusion practice are the careful identification and proper labeling of the donor unit and its associated processing tubes. The laboratory that processes blood must ensure that the unique number assigned to the donor appears on the donor card, the primary collection bag, all satellite collection bags, and all tubes used for processing. This allows prompt identification of the correct specimen if any processing tests reveal abnormal or discrepant results. Labels for blood and blood products must comply with the 1989 draft revision of the Guidelines for the Uniform Labeling of Blood and Blood Components, published by the Food and Drug Administration (FDA), in association with American Association of Blood Banks (AABB), American Red Cross (ARC), and Council of Community Blood Centers (CCBC).

c. Manufacturers of blood bags state on the label the anticoagulant and its composition, the name and address of the manufacturer or distributor, lot number, and

other information to help in the label placement procedure (see figure 2-1). The final step in preparing blood and its components for distribution to the patient is accurate labeling of the product in compliance with FDA and AABB regulations. At the time of collection of blood or the preparation of a unit of blood the final container shall have at least:

- (1) The name of component or intended component.
- (2) The unique number assigned to the donor.

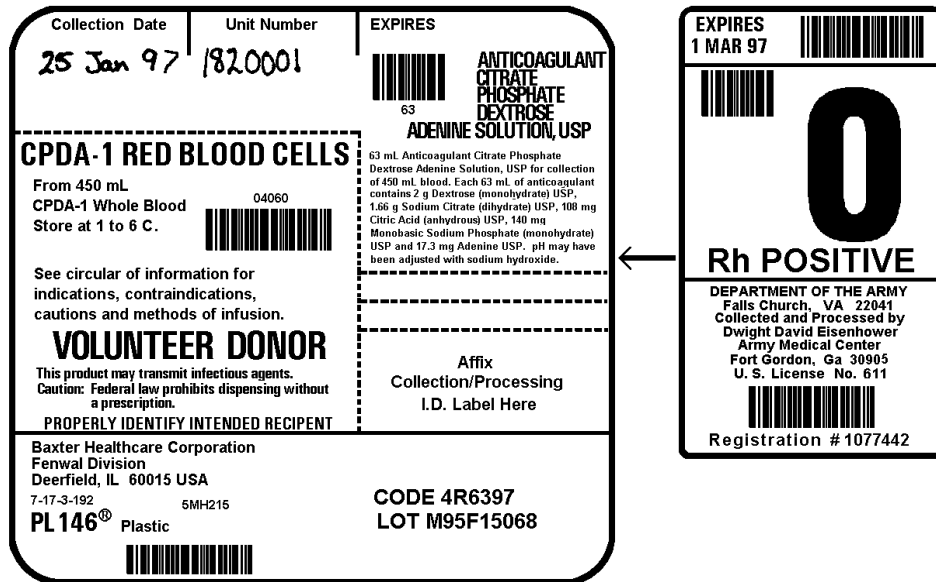


Figure 2-1. Fullface label for RBCs.

- (3) The name of the anticoagulant.
- (4) The amount of blood or product collected from the donor.

2-6. LABELING REQUIREMENTS

a. The presence of a blood group label on a blood component indicates that all screening and laboratory tests have been completed with satisfactory results and the component may be released for transfusion. The following items are required to be firmly attached on the final label in clear, readable letters:

- (1) The proper name of the component.
- (2) The ABO group and Rh type.
- (3) The name and address of the facility that collected and/or prepared the component.

- (4) FDA license or registration number.
 - (5) The donor's unique identification number.
 - (6) The expiration or outdate of the product.
 - (7) Essential instructions to the transfusionist to include:
 - (a) References to information in the Circular of Information.
 - (b) A warning that the product may transmit infectious disease.
 - (c) Cautions that federal law requires a prescription.
 - (d) Reminder to properly identify the patient.
 - (8) Recommended storage temperature.
 - (9) The approximate amount of product in the container.
 - (10) The amount of blood originally collected and the anticoagulant.
 - (11) Results of all tests or a statement that product was tested and found negative for infectious diseases.
 - (12) Appropriate donor classification: volunteer, paid, or autologous.
- b. Labels for pooled components must include:
- (1) All items listed earlier for products.
 - (2) The name of the pooled components.
 - (3) The final volume of the pooled product.
 - (4) The name of the facility preparing the pooled product.
 - (5) The unique numeric or alpha numeric identification for the pooled product.
- c. In addition, the following information must appear on the label itself or on a tag attached to the final product: total number of units in pool and ABO and Rh type (if applicable) of all units in the pool. The unique identification of each unit in the pool and the collecting facility for each unit must be maintained by the facility preparing the pooled product and should not be on the label.

2-7. SPECIFICATIONS FOR LABELS

a. **General.** Manufacturers of blood bags state on the label the anticoagulant and its composition, the name and address of manufacturer or distributor, lot number, and other information to help in the label placement procedures. Bag manufacturers may also bar code information such as the anticoagulant type, bag set configuration (single, double, triple, etc.), and type of plastic used in satellite bags.

b. **Bar Codes and Transmission of information From the Label.** Numbers are used to represent the information encoded in machine-readable symbols. Unique control codes are used to distinguish the numeric code representations, such as between a blood group code and a component name code. They are composed of wide and narrow vertical bars separated by wide and narrow spaces. A pattern of bars and spaces makes up a character in the bar code alphabet. A scanner shines light over a bar code. The pattern is decoded into a numeric code. The numeric code can be translated by the computer to the original non-coded form. The computer from its look up tables in its memory matches the code, the computer displays it on a terminal.

c. **Label Information.** The information most prominently displayed on the label, in both eye-readable form and in machine-readable form, is:

- (1) Blood donor grouping results (ABO and Rh).
- (2) Component name with appropriate qualifiers.
- (3) Unique donation (or unit) number.
- (4) Component expiration date.
- (5) Identification of blood service that collects and processes the blood using FDA registration number.
- (6) Other FDA-required label statements (such as indication that the blood came from a volunteer or paid donor, reference to an instruction circular, and the infectious disease and prescription warnings) are provided in eye-readable form only.

d. **Structure of Bar Coded Messages.** The encoded information is grouped into several separate message areas.

(1) Component Expiration Date: The component expiration date should be placed in the upper right hand corner of the bag label.

(2) Blood Donation (Unit) Number Label.

(3) Blood Grouping/Special Information Code Areas.

(a) Anticoagulants, package, and plastic codes on unprocessed components.

(b) Blood group labels.

(c) Special message labels.

1 "Hold for further processing" (tan) : Used within a blood processing location to indicate that preliminary typing or testing results, such as for Rh, HBsAg or anti-HIV, warrant further or repeat testing before the component can be released for transfusion.

2 "For emergency use only by _____" (orange): Used to identify components which need to be released to a transfusing facility prior to completion of all test results. Results of tests completed are filled in and an indication such as, "not done" or, "pending" is used for incomplete results.

3 "For autologous use only" (green): Used on components collected for autologous transfusion from donors/patients whose blood is being reserved for them. If autologous components are made from patients with an infectious disease or unacceptable test result for a disease marker, such a notation is usually placed on the component in addition to the autologous label (e.g. use of a biohazard label).

4 "Not for transfusion" (gray): Used for blood components that are not to be used for transfusion purposes (for other than biohazard reasons), such as research and reagent production. This label need not be used on noninjectable components for further manufacturing if noninjectable component label is used.

5 "Biohazard" (red): Used to alert handlers of blood components of a known or suspected risk (such as blood from a donor or patient which is reactive for HBsAg or HIV antibody) or undocumented risk (such as blood from a subsequential infected or suspect donor). Biohazard components should be sterilized before disposal, such as by autoclaving.

(d) Attribute labels.

(4) Blood Component (Product) Label.

(5) Center Identification Label.

e. **Colors for Print Characters.**

(1) The ABO blood group shall be printed in black.

(2) Rh positive: Black print on a white background.

(3) Rh negative: White print on a black background.

(4) Red lettering should be a visual match to PM-485 (Biohazard): Black may be used for DOD members using the Digitrax.

f. Colors for Blood Grouping, Special Message, and Attribute Labels.

(1) Use of colors for blood grouping labels is optional. When used, the right half of the label should be visual to match:

(a) Blue, PM-305: Group O.

(b) Yellow, PM-102: Group A.

(c) Pink, PM-182: Group B.

(d) White: Group AB.

(2) Colors, where specified, should always be used on tie-tags, attribute labels, and the right half of special message labels, and be a visual match to:

(a) Tan, PM-155: "Hold for further processing."

(b) Green, PM-358: "For Autologous use only."

(c) Gray, PM-435: "Not for transfusion."

(d) Orange, PM-137: "For emergency use only by _____."

(e) Purple, PM-529: "Irradiated."

(f) Red, PM-485: "Biohazard."

(g) Chartreuse, PM-388: "From a therapeutic phlebotomy."

g. Label Dimensions.

(1) All label dimensions must be within tolerances of plus or minus 0.02 inch (0.5 mm).

(2) All bar codes, lines, and words must be aligned parallel or perpendicular to the top edge of the label, as appropriate.

(3) Lines will appear in black.

2-8. TECHNICAL SPECIFICATIONS FOR THE SYMBOL AND LABEL MATERIALS

a. **Symbol Definition.** The symbol used is a subset of the code Codabar, and as such is a two-level, seven-bit binary encoding system. The two levels are the optical reflectance from a dark pattern printed on a light background. Binary (zeros and ones) encoding takes place in both levels for maximum utilization of space. The symbol is represented by a linear sequence of wide and narrow bars and spaces. When a bar/space is compared to an adjacent bar/space, narrow bars/spaces represent binary "zeros," and wide bars/spaces represent binary "ones." Each symbol character is made up of four bars and three spaces, for a total of seven bits of information per character. The symbol utilizes the 20 characters. Each character is decoded individually, independent of adjacent characters. The symbol code patterns being used are bidirectional, that is, they can be read from right to left, or left to right.

b. **Printing the Symbol.** The following specifications describe the dimensional parameters for the symbol. The standard density of encoded characters is 10 per inch (or 0.4 per millimeter). Each character is represented by seven elements consisting of four dark bars and three light bars. A wide dark bar or wide light space represents a binary "1." A narrow dark bar or narrow light space represents a binary "0." The ratio between the narrow bar or space and the wide bar or space has been designated to yield adequate differentiation while allowing for varying character densities.

(1) *Symbol height.* The minimum height should be 0.320 inch or 8.13 mm.

(2) *Intercharacter spacing.* Intercharacter gaps must be a minimum of 0.008 inch or 0.2 mm; this provides adequate resolution between characters.

(3) *Symbol alignments.* The linear bar code is a series of straight parallel lines nominally perpendicular to a base or reference line. Individual characters should not be misaligned more than 5 mm from adjacent characters.

(4) *Encoded message borders:* The minimum border dimensions are 0.1 inch or 2.54 mm at each end of the message.

(5) *Embossment.* Maximum depression or embossment of the printed symbol should not exceed 0.002 inch or 0.05 mm.

2-9. INTRODUCTION TO ISBT 128

a. A great deal of important information is presented on a blood product label. This information varies from country to country according to licensing regulations, language differences, and local transfusion practice. In today's world of multinational disaster relief programs and military operations, blood collected and processed in one country may be used in another. It is essential that critical information such as blood group, expiration date, and product description be clearly understood by medical personnel transfusing the product. Given the concerns about safety and traceability, it

is also important that these data be easily captured by a computer system. Both of these goals are made more difficult to achieve by the current lack of commonality in blood product labeling standards. The International Society of Blood Transfusion (ISBT) Working Party on Automation and Data Processing supported the adoption of ABC Codabar in the early 1980's. The Working Party recognized that ABC Codabar had reached the end of its useful life, and recognized the need for and benefits of establishing a truly international system for bar codes on blood products. Beginning in 1989, the Working Party has:

(1) Designated a totally new system, named ISBT 128, using the bar code symbology known as Code 128.

(2) Encoded critical information (e.g., donation identification number, ABO/Rh blood groups, product description and expiration date/time) in a uniform manner.

(3) Defined an ISBT specified label so that the bar codes carrying the data listed above appear in the same relative positions on the final label.

(4) Standardized other information to the greatest extent possible to minimize the need for "country-specific" software and the high cost associated with software development. In July 1994, the Working Party submitted the ISBT 128 Technical Specification document to the governing body of the Society, the ISBT council. The new system was accepted, and by July 1998 all blood products produced by countries that adopt this new system should be labeled using ISBT 128.

b. In November 1994, the International Council for Commonality in Blood Banking Automation (ICCBBA) was given the responsibility for the management and distribution of the Technical Specification and the associated databases. The symbology selected for implementation of ISBT 128 is based on Code 128. Code 128 was chosen because:

(1) It is more secure than ABC Codabar. In addition to each Code 128 character being self-checking, there is a built-in check digit. Misreads due to a single substitution error are extremely rare; scanning errors generally produce no-reads rather than misreads. Security of data capture is thereby increased dramatically.

(2) Code 128 has three subsets: A, B, and C. Alphanumeric characters are available in subset B and allow more flexibility in coding highly variable information. ABC Codabar does not support alphabetic characters.

(3) The double density coding of numeric characters supported by subset C allows more information to be encoded in a given space than ABC Codabar. This is important because of the limited space on a blood container label.

(4) Since many bar code readers in current use can interpret both ABC Codabar and Code 128, many users will not have to replace bar code reading

equipment to implement ISBT 128. Further, most readers can “autodiscriminate” between Codabar and Code 128, so transition should be relatively easy. It will be possible for a given hospital to receive blood products labeled with ABC Codabar from one supplier and with ISBT 128 from another during the transition from ABC Codabar to ISBT 128.

2-10. ISBT 128 TECHNICAL SPECIFICATION

a. The specification document for ISBT 128:

(1) Describes the ISBT standard layout for a blood product label.

(2) Identifies the data identifiers for bar codes used in the blood bank environment.

(3) Defines the data structures that carry information, that is, how a particular bar code will be recognized by a reader, how many characters there are, and whether the characters are letters, numbers, or both.

(4) Includes tables that define how complex bar codes should be translated, such as ABO/Rh Blood Groups and Donation Type.

(5) Defines technical details for the bar code itself, such as the width of the narrowest bars and the minimum height of the bars.

(6) Describes the variation made in Code 128 to support specialized “concatenation.”

(7) Identifies the authority of the ICCBBA, acting for the ISBT, to define other databases, particularly the product code database.

(8) Designates national groups as responsible for the definition of other tables that will have more limited use, such as special testing results.

b. ISBT 128 Specified Label is divided into four quadrants of equal size. Regardless of site of collection, the bar codes should be placed in the same relative positions (see figure 2-2).



Figure 2-2. ISBT 128 – Specified Label.

- (1) Donation Identification Number.
- (2) ABO/Rh Blood Groups (Kell and Rh phenotypes).
- (3) Product Code.
- (4) Expiration Date (and Time).
- (5) Blood Container Manufacturer ID and Description.
- (6) Blood Container Manufacturer's Lot Number.
- (7) Special Testing.

c. The Donation Identification Number and ABO/Rh Blood Groups and the Product Code and Expiration Date bar codes are aligned to support reading these pairs of bar codes at one time. Concatenation (reading of two or more bar codes as if they are a single bar code) of these two pairs of bar codes will support process control. Note that with the exception of the Donation Identification Number, for which the eye-readable information is presented in a specialized way, the data characters in the bar code are printed immediately below the symbol. The manufacturer's information bar codes will be covered by final labeling, but the associated eye-readable information will not be obscured. The eye-readable presentation of the interpreted bar coded information and any other information on the label will be defined by each country to meet its own requirements.

d. Data structure is the term used to define the organization of information in a bar code (or what is in the bar code and how it is arranged). Each bar code in ISBT 128 consists of a data identifier and data characters. A check digit is always added to the bar code and other Code 128 control characters may also be present. Although the control characters may be symbology-specific, the data identifier and data characters can be translated into any full ASCII bar code symbology. Therefore, the data structures that are described below are not limited to Code 128; these structures will accommodate improvements in current or new technology without the need to redesign the structures themselves.

e. Data Identifiers: Every bar code on a blood product will begin with two characters, the data identifier. The first character (secondary data identifier) will always be “=” or “&.” By international agreement, these characters are reserved to mean “this bar code specifies a blood product.” The second character (secondary data identifier) defines what kind of information the bar code contains; for example, the second character distinguishes an ABO/Rh Blood Groups bar code from a Product Code bar code (as an example: the two characters =% at the beginning of a bar code indicate that the bar code carries information about the ABO/Rh blood groups). Data identifiers have been assigned to bar codes in addition to those on a blood product label to further support total process control, e.g., **donor** (not donation) identification number and confidential unit exclusion bar codes.

f. Donation Identification Number (1): This data structure provides for unique identification of any donation worldwide for 100 years. It does this by using a printed 13-character string:

annnn yy xxxxxx

where: **annnn** designates the country/collection facility; **yy** designates the year in which the donation was made; **xxxxxx** is a serial number associated with the donation. As shown in figure 2-2, this string would appear as: W002395122345. Emphasis has been given to the last six characters that indicate a specific collection within the year indicated. A check digit (not included in the bar code) will be printed enclosed in a box to the right of the Donation Identification Number (see illustration of label B). This check digit would be used to support manual data entry. Other characters are incorporated into the bar code, the so-called “flag” characters. These may be used to assist in process control (such as identifying materials used in the collection process: bag 1, bag 2, tube 1, tube 2, etc.) or to support additional checks for accurate data transmission. In either case, the flags are printed in such a way that identifies their special role.

g. ABO/Rh Blood Groups (2): Whether a unit of blood is A Rh positive, O Rh positive or O Rh negative, etc, is defined in the four data characters of this bar code. Because of the critical importance of the ABO/Rh blood groups in transfusion, the codes originally assigned to each of the ABO/Rh blood groups in ABC Codabar have been maintained in ISBT 128. The information has been expanded, however, to include the donation type (autologous, directed), and there is an option to encode Kell and Rh

phenotype information. Special messages, such as “For Research Only,” can be encoded instead of ABO/Rh blood groups information if appropriate.

h. Product Code (3): Several different types of information are carried in the semistructured eight character ISBT 128 Product Code. The first five characters of the code come from an ICCBBA-maintained database table; they identify the product type (such as RED BLOOD CELLS , FRESH FROZEN PLASMA) and attributes associated name with the product (such as irradiated, leukocyte-reduced). The type of donation (volunteer, homologous, autologous) is specified in the sixth character. Characters seven and eight are reserved for encoding information about “divisions” of products (a practice common in pediatric transfusion services where only a portion of a product is given to a patient). The donation type table and the scheme for assigning divisions are included in the Technical Specification.

i. Expiration Date and Time (4): There are two data structures that support the expiration date of the blood product. One provides date only; the second additionally incorporates time. The Working Party has agreed that all countries should adopt a single format for expressing the expiration date in eye-readable form, e.g., 21 JUL 1998 (DD MMM YYYY), since there are national differences in the order in which day /month/ year appear when expressed in numerical format only.

j. Blood Container Manufacturer’s Information (5 and 6): Two 10 character data structures that will identify the manufacturer, provide a description of the container type, and encode the manufacturer’s lot number were proposed by a task force composed mainly of interested manufacturers. These bar codes will be visible on the label of an empty container. Once the information is captured during the collection or processing steps, these bar codes would be covered over. However, the eye-readable data characters would always be visible, as shown in the illustration.

k. Special Testing (7): An optional, ISBT specified five character data structure has been defined to contain the results of special or additional testing, e.g., blood grouping test results. The table to decode the information in these five characters will be nationally defined to meet the needs of each country.

Material on ISBT 128 is from a copyrighted 1995 International Council for Commonality in Blood Banking Automation (ICBBA) document.

Section IV. BLOOD STORAGE/DISTRIBUTION

2-11. FREEZERS AND REFRIGERATORS

a. The same refrigerator may be used to store blood components, blood samples, and reagents for blood bank tests.

- b. Separate, well-demarcated sections must be used if anything other than transfusable components are stored.
- c. In a refrigerator, the temperature in all areas must be between 1 and 6° C; either a fan or the capacity and design of the unit must ensure that the designated temperature is maintained throughout.
- d. The interior should be clean and adequately lighted, and storage areas should be clearly organized and designed for:
 - (1) Unprocessed blood.
 - (2) Labeled blood suitable for allogeneic transfusion (segregate by group and type).
 - (3) Rejected, outdated, or quarantined blood.
 - (4) Autologous blood.
- e. If blood is kept in areas outside the blood bank (such as the OR), it must be stored in refrigerators that meet the same standards.
- f. Temperature records are required for such refrigerators at all times when blood is present. Blood must never be stored in unmonitored refrigerators.

2-12. MONITORING TEMPERATURE

- a. Recording thermometers and audible alarms are required for all blood storage equipment.
- b. The sensor in a refrigerator should be on a high shelf and must be immersed in a volume of liquid no greater than the volume of the smallest component stored. RBC units are usually 250-350 mL, but if split units or pediatric units are stored, the sensors should be kept in a unit of smaller volume. Either a glass container or plastic blood bag may be used.
- c. The alarm signal must be activated to a temperature that allows personnel to take proper action before the stored blood reaches undesirable temperatures. An acceptable range is 1 to 6° C.
- d. The electrical source for the alarm must be separate from that of the refrigerator; either a continuously rechargeable battery or an independent electrical circuit served by an emergency generator is suitable.
- e. In large refrigerators or freezers, it is advisable to have at least two independent thermometers, one immersed with the continuous sensor and the other in

a similar container on the lowest shelf on which blood is stored. The temperatures in both areas must be between 1 and 6° C at all times.

f. Thermometers should be checked periodically. If the thermometer immersed with the sensor does not agree within 1° C with that shown on the automatic recorder, both should be checked against a NIST (NBS) certified thermometer and suitable corrective action taken.

g. When temperature charts from recording devices are changed, they should be dated inclusively and labeled to identify the facility, the specific refrigerator or freezer, and the person changing the charts. Any departure from normal temperature should be explained in writing on the chart beside the tracing.

h. Some refrigerators have automated temperature monitor and digital readout systems, with continuous surveillance at preset areas within the unit.

i. Some blood banks have a central monitor and alarm system capable of monitoring numerous refrigerators simultaneously. When temperatures are monitored continuously, there must be a hard-copy record of the temperature at least every 4 hours. Temperature records must be retained as part of the blood bank records for at least 5 years.

2-13. EQUIPMENT TEMPERATURE QC

a. Thermometers and alarms should be checked periodically for proper functioning. Methods should be documented in local SOP and are in the Methods section of the AABB Technical Manual.

b. Freezers must be equipped with a continuously recording thermometer and an audible alarm. The alarm sensor should be accessible and located near the door of the freezer. A thermocouple that responds at the desired temperature range is useful for ultra-low freezers (< -65° C). A digital recording device measures the difference in potential generated by the thermocouple, and this difference can then be converted to temperature.

c. If there is no source of emergency power independent of standard house circuits, an alternative plan for storing blood and components must be included in the SOP.

d. Alarms must have a continuous power source, which should be tested periodically. There must be written instructions for personnel to follow when the alarm sounds. These instructions should include steps to determine the immediate cause of the temperature change and ways to handle malfunctions, as well as power outages. It is important to list the names of key people to be notified and what steps should be taken to ensure that proper storage temperature is maintained.

2-14. PLATELET STORAGE

- a. Platelets are stored at 20-24° C with continuous gentle agitation. Elliptical, circular, and flat-bed agitators are available. Elliptical rotators are not recommended for use with storage bags made of polyolefin without plasticizer (PL-732 or PL-2209).
- b. If the seal of any bag is broken, the platelets should be used as soon as possible, within 4 hours if stored at 20-24° C.
- c. The temperature in the immediate vicinity of the platelet storage area must be monitored and recorded to ensure continuous maintenance of appropriate storage conditions.
- d. Platelets may also be stored at 1 to 6° C, with an expiration date of 3 days.

2-15. INSPECTION

- a. All stored blood and components should be inspected immediately before issue for transfusion or shipment to other facilities. Pre-issue inspections must be documented; records should include the date, donor number, description of any abnormal units, the action taken, and the identity of personnel involved.
- b. Whole blood or RBC units abnormal in color or other appearance should not be transfused. Contamination should be suspected if the color of the segments is much lighter than that of the bag, if the RBCs look purple, if a zone of hemolysis is observed just above the cell mass, if clots are visible, or if the plasma or supernatant fluid is murky. Units with grossly lipemic plasma are usually considered unsuitable for transfusion. Blood on the outside of the bag suggests a leak and the unit should be quarantined.
- c. Platelets should be inspected before issue or pooling for the presence of grossly visible aggregates; if present, the component should not be used.
- d. FFP and CRYO should be inspected when removed from frozen storage for evidence of thawing and refreezing or a broken container. Unusual turbidity of the thawed component may be cause for discard.

2-16. BLOOD SHIPMENT

- a. BDCs will use standardized forms and operating instructions outlined in the SOP. Whenever possible, standardized blood bank forms (e.g., DD Form 572, Blood Donation Record); SF 518, Medical Record - Blood or Blood Component Transfusion; and DD Form 573, Shipping Inventory of Blood Products) should be used. Records must meet FDA regulations and guidance, as well as that of the appropriate civilian accrediting agencies (AABB and/or CAP).

b. BDCs will ship blood products using standard procedures and the DD 573. Complete one form for each container in the shipment. The shipping facility will maintain one copy of the form and send two copies with the shipment container.

c. BDCs will pack up to 30 liquid RBC units in a reusable cardboard and Styrofoam standard shipping container, known as the "Collins Box" (NSN 8115-00-935-9761), with 14 pounds of cubed WET ice. The ice is double bagged (NSN 8105-01-266-7411) and secured with rubber bands or electrical tie-down straps (NSN 5975-00-074-2072) to maintain temperatures of 1 to 10° C. Up to 18 units of FFP, 72 units of CRYO, or 16 units of frozen RBCs may be packed in the Collins Box. Cover frozen products with 20-30 pounds of pelleted dry ice to maintain temperatures below -40° C for 48 hours. A maximum of 18 units of frozen RBCs can be packed in the frozen blood shipping container (FBSC - NSN 8145-01-357-1551). As many platelets as easily fit into a container will be shipped at room temperature. Some shippers pad the box or use platelet coolants to keep the temperature in the 20-24° C range.

d. Transportation arrangements should be made through the Transportation Management Office (TMO) to allow blood to be received at the ASWBPLs or other destination within 24 hours after shipment. Blood units shipped to an ASWBPL should be received no later than 5 days after they were collected.

e. The shipping BDC will notify the receiver of the incoming shipment either by fax, telephone, or E-mail. The shipment information should include the donor center's name, number of boxes in the shipment, date of arrival, and air bill number. Outbound shipping costs will be borne by the shipping BDC.

f. When the containers are received, the receiver will note shipment conditions and temperature of products, especially those rendering the products unusable, on the enclosed DD 573 or shipping document. The second copy will be returned to the shipper, who should use the information for quality improvement purposes and retain it on file permanently.

2-17. DISPOSITION

a. Exposure to temperatures above 10° C does not necessarily render blood unsuitable for transfusion, but if the units reach temperatures outside the 1 to 10° C range, they should be discarded.

b. The shipping facility should be notified when a receiving facility observes unacceptably high temperatures.

c. Units that are questionable for any reason should be quarantined until a responsible person decides their disposition. Evaluation should include inverting the unit gently a few times to mix the cells with the supernatant fluid. If after resuspension and resettling, the blood no longer appears abnormal, it may be returned to inventory. Appropriate records should be maintained.

d. When blood cannot be released for transfusion, it should be returned to the provider or the nature of the problem should be investigated and the results reported to the blood supplier. Findings may indicate the need for improvement in donor techniques, in screening of donors, or in handling blood units during processing.

e. Disposal procedures must conform to local public health codes for biohazardous waste. Autoclaving and/or incineration is recommended. If disposal is carried out off-site, a contract with the waste disposal must be available and specify that appropriate Environmental Protection Agency, state, and local regulations are followed.

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the exercise, by completing the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson, and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. List four components that can be made from whole blood:

2. Match the method used to prepare the component with the blood component listed below.

- | | |
|--------------------------|--|
| ___1. Platelets | a. Centrifuge component or allow to settle by gravity and express plasma |
| ___2. RBCs | b. Add solution and incubate |
| ___3. FFP | c. Prepared by a light spin followed by a heavy spin |
| ___4. CRYO | d. Centrifuge with a heavy spin, express plasma, and place at -18° C |
| ___5. Rejuvenated RBCs | e. Bedside filtration |
| ___6. Lueko-reduced RBCs | f. Prepared with 2 light spins |
| | g. Thaw plasma to slushy consistency, centrifuge and remove supernatant |

3. _____ is the process of collecting only platelets during a cytopheresis procedure.

4. What is the primary reason for transfusing leukocyte-reduced RBCs?

5. For the anticoagulants listed below, give the expiration dates:

CPD _____ days
CPDA-1 _____ days
AS-1 _____ days
AS-5 _____ days

6. Circle the following infectious disease markers which are usually tested for using EIA methods.

- a. Syphilis
- b. HBsAg
- c. HIV-1 Ag
- d. Anti-HIV-1/2
- e. Anti-HBc
- f. Anti-HCV
- g. Anti-HTLV-I/II
- h. ALT

7. Leukocyte-reduced RBCs should retain ___ % of the original red cells and have a final WBC count below _____/L.

8. 75% of platelet concentrates should have a platelet count of _____/container or greater and Apheresis platelets should have a count of _____/container or greater and a pH at expiration of _____ or greater.

9. When checking for residual glycerol after washing frozen RBCs, there should be \leq _____% hemolysis.

10. Match the causative agent with the infectious disease description. Each answer is used only once.

- | | |
|--|--------|
| (1) Can cause disease only when patient has HBV. | a. HAV |
| (2) Can persist in the tissues and leukocytes of asymptomatic people for years after infection. | b. HBV |
| (3) RNA virus that contaminates water and is endemic to the third world. Mortality rate among pregnant women is 20%. | c. HCV |
| (4) RNA virus that spreads through blood and sexual contact. More than 80% of infected people develop chronic liver disease. | d. HDV |
| | e. HEV |
| | f. HGV |
| | g. CMV |

11. List 8 of the 12 requirements for blood component labels:

12. List the two types of barcode systems used for labeling of blood products:
_____ and _____ .

13. Name the 4 storage areas in the blood bank refrigerator that should be clearly organized and labeled:

14. **T or F:** Units that reach temperatures outside the 1 to 10° C must be discarded.

15. **T or F:** Audible alarms are not required for blood storage equipment.

16. Match the number of units/container and coolant with the list of components below.

- | | |
|-----------------|--|
| (1) RBCs | a. 18 units with 20-30 #s pelleted dry ice |
| (2) Frozen RBCs | b. As many as easily fit in the container; shipped at room temperature |
| (3) Platelets | c. 30 units with 14 #s wet ice |
| (4) FFP | d. 72 units with 20-30 #s pelleted dry ice |
| (5) CRYO | e. 25 units with 20 #s wet ice |
| | f. 16 units with 20-30 #s pelleted dry ice |

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. RBCs, FFP, CRYO, platelets (para 2-2)
2. (1) c (para 2-2)
(2) a
(3) d
(4) g
(5) b
(6) e
3. Plateletpheresis (para 2-2g)
4. Minimize the risk of non-hemolytic febrile transfusion reaction (para 2-2e)
5. CPD 21 days (Table 2-1)
CPDA-1 35 days
AS-1 42 days
AS-2 42 days
6. b, c, d, e, f, g (para 2-3)
7. 80%, $5 \times 10^8/L$ or $5 \times 10^6/L$ (para 2-2e & Table 2-4)
8. 5.5×10^{10} , 3.0×10^{11} , pH 6.0 (Table 2-4)
9. 3% (para 2-2d(2)(f)2c)
10. (1) d (para 2-4)
(2) g
(3) e
(4) c
11. (1) The proper name of the component
(2) The ABO group and Rh type
(3) The name and address of the facility that collected and/or prepared the component
(4) FDA license or registration number
(5) The donor's unique identification number
(6) The expiration or outdate of the product

- (7) Essential instructions to the transfusionist
 - (8) Recommended storage temperature
 - (9) Approximate volume of product
 - (10) Volume of blood originally collected and the anticoagulant
 - (11) Results of all tests or a statement that product was tested and found negative for infectious diseases
 - (12) Appropriate donor classification; volunteer, paid, or autologous
- (para 2-6a)
- 12. Codabar and ISBT 128 (para 2-9)
 - 13. Unprocessed blood
 - Labeled blood suitable for allogeneic transfusion
 - Rejected, outdated, or quarantined blood
 - Autologous blood (para 2-11d)
 - 14. T (para 2-17a)
 - 15. F (para 2-12a)
 - 16. (1) c (para 2-16c)
 - (2) f
 - (3) b
 - (4) a
 - (5) d

End of Lesson 2

LESSON ASSIGNMENT

LESSON 3

Compatibility Testing and Blood Administration

TEXT ASSIGNMENT

Paragraphs 3-1 through 3-40.

LESSON OBJECTIVES

After completing this lesson, you should be able to:

- 3-1. Identify the factors in the immune response and the interaction of antigens, antibodies, and complement of immunohematology.
- 3-2. Identify the applications of and sources of error in the antiglobulin tests.
- 3-3. Identify the aspects of compatibility testing, collection of blood from the transfusion recipient, selection of blood for a recipient, and the investigation of incompatible crossmatches.
- 3-4. Identify the indications, contraindications, reactions, advantages, disadvantages, and administrative guides for red cell products, platelets, coagulation factors, and plasma substitutes.
- 3-5. Identify the common causes of transfusion reactions and methods of investigation.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 3

COMPATIBILITY TESTING AND BLOOD ADMINISTRATION

Section I. THE IMMUNE RESPONSE AND THE INTERACTION OF ANTIGENS, ANTIBODIES, AND COMPLEMENT IN IMMUNOHEMATOLOGY

3-1. BACKGROUND

Immunology, a field once dominated by bacteriologists, has become important to scientists in many other areas. The field of immunohematology came into being when Landsteiner discovered that the blood group antigens (ABO) present on red blood cells would react with their respective antibodies present in plasma, and that this reaction had great clinical significance. Since that time, many discoveries in this field have added to the understanding of immune mechanisms operative in health and disease. It is important that scientists working in areas associated with blood transfusion understand basic immunology and try to be familiar with the recent advances in this field that might relate directly to their work.

3-2. THE IMMUNE RESPONSE

The basis of immunology is memory, specificity, and the recognition of "nonself." The original basis for this was the protection (immunity) afforded by exposure to infectious illness. The first contact with an infectious organism imprints some information (i.e., memory) so that the body will recognize and attack that organism when it encounters it in the future. The protection is usually specific (i.e., only against the original infecting organism). The body also has to recognize that organism as being foreign (i.e., "nonself"). The substance initially responsible for an immune response is known as an **antigen** or more specifically an **immunogen**.

3-3. ANTIGENS

a. Antigens are substances that can induce a specific immunologic response or which can interact with specific antibody or immune cells "in vivo" or "in vitro." The immune response can be either humoral or cellular. Blood group serology is mainly concerned with the humoral response which leads to the production of free antibody in the plasma. The antibodies, under appropriate conditions of reaction (temperature, pH, ionic strength, etc.), will react specifically with the antigen in some observable way (e.g., agglutination, hemolysis).

b. Blood group antigens are chemical groupings present on the red blood cell membrane. We are only just beginning to learn the exact nature of these determinants. The ABH antigens have been the most thoroughly studied and, when present on red blood cells, are predominantly glycolipids. A and B antigens are composed of the same

fatty acids and sugars, the difference in specificity being caused by the terminal sugar in the chain of sugars joined to the fatty acid backbone. The specificity is a result not only of the particular sugar but also the configuration of the end grouping it forms. As the sugars responsible for A or B specificity (N-acetylgalactosamine and galactose, respectively) are structurally identical except for the substitution of a hydroxyl group for an N-acetylamino group at carbon atom no. 2, they serve as a good example of the remarkable specificity of antigen-antibody reactions.

c. Proteins are direct gene products, whereas carbohydrates, such as the A and B antigens, are indirect products of genes (e.g., A or B genes). The direct (protein) products of the A and B genes are enzymes that recognize and then transfer specific sugars from their nucleotide carriers to specific acceptor molecules. Thus, the A gene product is an N-acetyl-D-galactos-aminyltransferase and the B gene product is a D-galactosyltransferase.

d. The biologic role of blood group antigens, if any, is at present unknown. The ABH antigens are widely distributed throughout the body, being present on many types of cells, organs, and body fluids. Some antigens such as Rh and Kell (K) appear to play a part in cell membrane integrity. Rare individuals lacking Rh antigens (Rh_{null}) on their red blood cells often have an associated hemolytic anemia ("Rh-null syndrome") whereas, in contrast, rare individuals lacking A, B, and H antigens (Bombay phenotype) do not. It has been suggested that this is because the ABH antigens are glycolipids projecting above the cell membrane, whereas Rh appears to be lipoprotein, an integral part of the red blood cell membrane. An association between a rare inherited defect of neutrophil bactericidal function (chronic granulomatous disease) and the Kell blood group system has recently been described. Another report suggests a possible relationship between the Duffy blood group antigens and resistance to malaria. There are many other associations of blood groups with disease, particularly malignancy; many of them are purely statistical and their causes unknown.

3-4. ANTIBODY SYNTHESIS

When an antigen enters the body, it may evoke a **humoral** response, in which antibodies are synthesized by plasma cells and released into the body fluids (e.g., plasma), and/or a **cellular** response, in which lymphocytes participate in cell-mediated immunity (e.g., rejection of transplanted tissue and delayed hypersensitivity). That two different responses were present was originally shown by Chase and Landsteiner in the early 1940s when they demonstrated that some kinds of immune reaction could be transferred from one animal to another by the exchange of living cells, whereas others could be transferred by blood serum. The cells required for the former experiment were lymphocytes. It was not until the early 1960s that involvement of the lymphocyte was proven.

3-5. PRIMARY AND SECONDARY IMMUNE RESPONSES

a. Following a first exposure to a foreign antigen, specific antibodies can appear after about five days, rise slowly to a modest level, remain for a variable period, then gradually decline, eventually becoming undetectable, until further stimulation occurs. The first antibodies produced in this primary response are usually IgM, but eventually other immunoglobulins (e.g., IgG) may appear. The type of antigen and the route of administration will influence the pattern observed.

b. After the primary response, a second dose of the same antigen, given days or even years later, will usually elicit an intense and accelerated secondary (memory) response. The serum antibody usually begins to rise within two or three days reaching a peak in about 10 days. In this secondary response, IgM antibody is often transiently produced following a similar pattern to the primary response but the predominant antibody produced is IgG, which rises to a much greater concentration than the IgM and remains in the plasma much longer. The secondary response is sometimes called an **anamnestic** response.

3-6. IMMUNIZATION TO BLOOD-GROUP ANTIGENS

a. Within a few months after birth, an infant makes anti-A, anti-B, and/or anti-A,B if lacking those antigens on its red blood cells. Group O individuals have all 3 antibodies. Such antibodies are termed **naturally occurring** since they have no apparent antigenic stimulus. Experiments in chicks have shown that these antibodies probably develop as a result of exposure to bacterial antigens closely related chemically to blood group antigens (e.g., *Escherichia coli* has an antigen on its membrane closely resembling human B antigen). Naturally occurring antibodies to antigens other than ABO are also encountered, particularly in the I, Lewis, P, and MN systems. These antibodies are usually IgM and react better at lower temperatures.

b. Immune antibodies to blood group antigens usually develop as a result of pregnancy, transfusion, or immunization (intentional sensitization). Following immunization, IgM antibodies are often seen first, followed by IgG antibodies, which often predominate. These antibodies usually react better at 37° C.

c. Antibodies other than anti-A, anti-B, or anti-A,B are usually called "irregular," "atypical," or "unexpected" antibodies. The preferred term is **unexpected**.

d. There is extensive evidence in animals, such as mice, that the immune response is genetically controlled (by the so-called Ir genes). It has been suggested that this may apply in man also. Studies in man on the immune response to the D antigen indicate that approximately 30% D-negative individuals appear to be incapable of forming anti-D even after repeated and/or large transfusions of D-positive blood. The antibody response in individuals who do make antibody will depend on many factors, including the relative potency of the antigen, the route of immunization, and the amount of blood given.

chains and 33% have lambda light chains. IgG can cross the placenta and enter a fetus' circulation.

3-8. ANTIGEN-ANTIBODY REACTIONS IN BLOOD GROUP SEROLOGY

a. Antibodies may react with their specific antigens in a number of ways. The following reactions have all been used to demonstrate "in vitro" antigen-antibody reactions in blood transfusion science:

- (1) Agglutination.
- (2) Hemolysis.
- (3) Inhibition.
- (4) Absorption and elution.
- (5) Precipitation.
- (6) Complement-fixation.
- (7) Radioimmunoassay.
- (8) Fluorescence.

b. The first two methods are the most commonly used in blood group serology. Inhibition and absorption/ elution techniques, although not used every day in the routine blood bank, are used regularly in the forensic laboratory (e.g., blood grouping of blood stains) and in reference laboratories. Absorption techniques lead to a decrease in antibody activity following treatment of a serum with red blood cells having the appropriate antigens; elution refers to the technique used to dissociate or remove antibody bound to sensitized red blood cells. Precipitation, complement-fixation, and radioimmunoassay have been utilized for the detection of hepatitis virus. Fluorescence has been used to demonstrate blood group antigens (e.g., ABH) in tissues.

3-9. AGGLUTINATION

a. **Background.** It is convenient to consider antibody-mediated agglutination of red blood cells as involving two distinct stages. First there is physical attachment of antibody to the antigenic determinant on the red blood cell surface. This stage, representing the specific immunochemical reaction, is referred to as sensitization, and may go on to involve the binding or fixing of complement components. The second stage involves agglutination of the sensitized cells. Agglutination results from collision of sensitized cells, allowing cross-linking of cells to occur by the formation of antibody bridges. As the aim of blood group serology is to obtain maximum sensitivity without

loss of specificity, it is important to understand and recognize the factors that influence the complex agglutination phenomenon.

b. **Factors Affecting the First Stage (Sensitization).** Red blood cell sensitization with antibody obeys the law of mass action. Thus, the reaction between antigen on the red blood cell surface and antibody is reversible and the quantity of cell-bound antibody at equilibrium will vary depending on the reaction conditions and the equilibrium constant of the antibody. The reaction conditions should be designed to maximize the quantity of cell-bound antibody at equilibrium in order to facilitate detection of either blood group antigen or antibody. Some of these reaction conditions are described below:

(1) *Temperature.* Most blood group antibodies show their greatest reactivity over a restricted temperature range, some reacting optimally at 4° C, others at 37° C. Antibodies reacting optimally at 37° C have been described as "warm" antibodies and those reacting optimally at lower temperatures as "cold" antibodies. Agglutinins (antibodies) having maximum reactivity at one temperature may have sufficient thermal amplitude to be active at others. Antibody activity is usually tested at room temperature and at 37° C. Antibodies active at 37° C are the most clinically significant, although "cold" antibodies cannot be ignored if they have a wide thermal amplitude (e.g., above 30° C). Antibodies only reacting at lower temperatures may be of importance in patients subjected to hypothermia.

(2) *pH.* The pH optima for antibody reactivity in most blood group systems have not been investigated. For anti-D, the optimum pH lies between 6.5 and 7. Antibodies of other blood group specificities may have different pH optima (e.g., some examples of anti-M react best at pH 5.5).

(3) *Incubation time.* Time is required for the antibody red blood cell reaction to reach equilibrium. The amount of time required to reach this state will depend upon other variables. The rate of antibody-binding is greatest initially, so incubation times for routine laboratory procedures may be relatively short (e.g., 15 to 30 minutes).

(4) *Ionic strength.*

(a) The ionic strength of the reaction medium is one of the physiochemical conditions that plays an important role in the binding of antibody to red blood cell antigens. Ionic strength is a measure of intensity of the electrical field resulting from ions in solution. Electrostatic forces (interaction of positive and negative charges) play an important role in antibody reaction involving red blood cells. Red blood cells carry a large electronegative charge which serves to keep them from spontaneously aggregating. This enables them to function efficiently in oxygen transport by maintaining a maximum surface area available for gas diffusion. When red blood cells are suspended in an electrolyte solution (0.85% NaCl), the cations (positive) are attracted to the negatively charged red blood cells and the red blood cell becomes surrounded by a diffuse double layer ("ionic cloud") which travels with the red blood cell

as if it were part of it. The outer edge of this layer is called the **surface of shear** or the **slipping plane**. The effective charge (potential) of the red blood cell, called the **zeta potential**, is determined at this plane and is responsible for the electrostatic repulsion between one red blood cell and another.

(b) In the first stage of agglutination, reducing the ionic strength of the medium decreases the electropositive clouds of cations surrounding the red blood cells and facilitates the interaction of electro-positive IgG with the negatively charged red blood cell. This absorption of antibody to the red blood cell reduces the electronegative charge of the red blood cell and reduces the zeta potential, thereby accelerating the second stage. Experiments have shown that the initial rate of association of anti-D with D-positive red blood cells is increased 1,000-fold by a reduction of ionic strength from 0.17 to 0.03 (e.g., instead of using 0.9% NaCl, low ionic strength saline [LISS] is used as a red blood cell diluent).

(5) *Antigen-antibody ratio*. The rate at which antibody is bound to the cell, and the quantity of antibody bound, depends on the concentration of cells and of antibody. In general, an increase in sensitivity is obtained by increasing the amount of antibody in relation to antigen. This is often achieved in the blood bank by using less antigen in the form of weaker cell suspensions (e.g., it is a more sensitive technique to add 1 volume of 2% red blood cells to 2 volumes of serum than to add 1 volume of 10% red blood cells to 2 volumes of serum). Some agglutination reactions are weakened or even become negative in the presence of an excess of antibody, the **prozone reactions phenomenon**. The optimal proportion of antigen to commercial antiserum is usually determined by the manufacturer, and the directions issued with each antiserum should be followed.

c. **The Second Stage (Agglutination).**

(1) Once red blood cells are sensitized, they may or may not directly agglutinate. Blood group antibodies were characterized empirically before the immunoglobulin classes were recognized. Those antibodies which could produce agglutination in a saline medium were called "complete" antibodies or "bivalent" antibodies, and those which did not were called "incomplete" antibodies or "univalent" antibodies. Current evidence indicates that all antibodies are at least bivalent; i.e., each molecule has at least two antigen-combining sites. The term **incomplete** antibody is used to denote an antibody that reacts with, but fails to cause visible agglutination of, a saline suspension of red blood cells possessing the corresponding antigenic determinant; such antibodies tend to be of class IgG.

(2) The failure of "incomplete" antibodies to produce agglutination in a saline environment may be a result, in part, of location, number, and mobility of antigenic determinants on the red blood cell surface, of the size and configuration of the antibody molecule, and of the electrostatic forces involved.

(3) It has been suggested that the zeta potential, mentioned previously, is the most important factor in explaining why most IgG antibodies do not directly agglutinate red blood cells, the span of the IgG molecules not being sufficient to bridge adjacent red blood cells under the conditions created by the electrostatic forces keeping the red blood cells apart. The same workers suggested that IgG antibodies agglutinated red blood cells in the presence of albumin or LISS because they raise the **dielectric constant** (charge dissipating power) of the suspending medium, thus lowering the zeta potential, allowing red blood cells to come close enough together for agglutination to occur. They also suggested that proteolytic enzymes (e.g., papain, ficin, bromelin, and trypsin) produce the same final effect by cleaving sialic acid from the red blood cell membrane, thus reducing the zeta potential. It should be noted that IgG antibodies (e.g., IgG anti-A and -B) do sometimes directly agglutinate saline-suspended red blood cells; this may be a result of the large number of antigenic sites present, the orientation of these antigens above the surface of the red blood cell membrane, and/or the clustering of these antigens during the antigen-antibody interaction. Recently some workers have argued that zeta potential may not be the most important factor involved in these reactions.

3-10. HEMOLYSIS

Some blood group antibodies can activate the complement cascade, leading to lysis of red blood cells possessing the appropriate antigens. Antibodies showing this characteristic are termed **hemolysins** and usually will agglutinate or sensitize red blood cells in the absence of complement. Examples of blood-group antibodies that can sometimes act as hemolysins are anti-A, -B, -A, B, -I, -I, -Le^a, -Le^b, -Le^x, -Jk^a, -Jk^b, -PP₁P^k(Tj^a), and -Vel. Some of these antibodies and others may sensitize the red blood cells with complement but not hemolyze them. This complement sensitization can be detected by the antiglobulin test.

3-11. COMPLEMENT

a. The complex complement system is involved in the humoral portions of the inflammatory response and interacts broadly with portions of the clotting sequence, the fibrinolytic system, and the kinin-generating sequence. The function of complement appears to be activation of secondary immunologic actions resulting in cytolysis, phagocytosis, chemotaxis, etc. The complement system consists of at least 20 globulins, many exerting their effect by enzymatic activity. The components are numbered C1 to C9. They contribute about 5% of the total plasma proteins. Most of them are beta globulins and are good immunogens. C3 is by far the most abundant complement protein (1,500 ug/ml) and C4 the next at 450 ug/ml; most of the other components being present only in small amounts. It is C3 and C4 that most interest us in immunohematology, particularly in reference to the antiglobulin test.

b. Two major pathways of complement activation have been identified: the classic pathway and the alternative pathway. The classic pathway is of most importance in blood transfusion science and can be initiated by an antibody/antigen interaction.

Section II. THE ANTIGLOBULIN TEST

3-12. PRINCIPLES OF THE ANTIGLOBULIN TEST

a. In 1945, Coombs, Mourant, and Race described a test that detected nonagglutinating (coating) Rh antibodies in serum and later used the same test to demonstrate "in vivo" coating of red blood cells with antibodies. In 1957, Dacie et al. showed that complement components attached to the red blood cell could also be detected by the test. This test, now known as the antiglobulin or Coombs test, depends on the following simple principles:

NOTE: "In vivo" means something is measured, seen, or tested inside a living organism. "In vitro" means something is measured, seen, or tested outside a living organism after it has been removed from that organism.

(1) Antibody molecules and complements components are globulins.

(2) If an animal (e.g., rabbit or goat) is injected with human globulin (either purified or in whole human serum), the animal will make antibodies to the foreign protein (e.g., antihuman globulin, AHG).

(3) This antiglobulin serum, after suitable treatment, will react specifically with human globulin. If this globulin (e.g., antibody or complement) is attached to the red blood cell membrane, the antiglobulin serum will combine with globulin on adjacent red blood cells and cause agglutination of the sensitized red blood cells. Nonsensitized red blood cells will not react.

b. As mentioned in Section I, most blood group antibodies are IgM or IgG. Most IgM antibodies can be detected by direct agglutination; thus the principal purpose of the antiglobulin test is to detect IgG nonagglutinating (sensitizing) antibodies. In certain circumstances, it may be advantageous to detect red blood cell-bound IgA, IgM, and/or complement components by this test.

c. The antiglobulin test can be used to detect "in vivo" or "in vitro" red blood cell sensitization.

3-13. DIRECT ANTIGLOBULIN TEST

a. The direct antiglobulin test is used for the detection of "in vivo" coating of RBCs with globulins. Washed red blood cells from the patient or donor are directly tested with the antiglobulin reagents.

b. The direct antiglobulin test is useful for:

(1) Diagnosis of hemolytic disease of the newborn.

- (2) Diagnosis of autoimmune hemolytic anemia.
- (3) Investigation of red blood cell sensitization caused by drugs.
- (4) Investigation of transfusion reactions.

3-14. INDIRECT ANTIGLOBULIN TEST (IAT)

a. The indirect antiglobulin test is used to demonstrate antibodies that may cause red blood cell sensitization "in vitro." The antibody containing serum is incubated with specific red blood cells which, following washing, are reacted with antiglobulin serum to see whether red blood cell sensitization has occurred.

b. The indirect antiglobulin test is useful for:

- (1) Detection and identification of unexpected antibodies.
- (2) Crossmatching.
- (3) Detecting red blood cell antigens not demonstrable by other techniques.
- (4) Special studies (e.g., leukocyte and platelet antibody tests).

3-15. POLYSPECIFIC ANTIGLOBULIN REAGENTS

a. Polyspecific antiglobulin reagents are used for routine compatibility tests, alloantibody detection, and the DAT. They contain antibody to human IgG and to the C3d component of human complement. Other anticomplement antibodies may be present, including anti-C3d, anti-C4b, and anti-C4d.

b. Since most clinically significant antibodies are IgG, the most important function of polyspecific antiglobulin is to detect the presence of IgG.

3-16. MONOSPECIFIC ANTIGLOBULIN SERUMS

a. As discussed previously, the antiglobulin serum used routinely in the blood bank for procedures such as compatibility-testing usually reacts with several plasma proteins (particularly IgG and complement). See table 3-1.

b. The main use of monospecific antiglobulin serums is to extend the direct antiglobulin test by evaluating which protein is responsible for the positive direct antiglobulin test obtained with the broad-spectrum reagent. On occasion, monospecific reagents such as anti-IgG and anti-C3d may be of value in the indirect antiglobulin test to show different patterns of reactivity when mixtures of IgG noncomplement-binding and complement-binding antibodies are present (e.g., anti-e and Le^b). The technique

used for testing red blood cells with these reagents is exactly the same as that for broad-spectrum reagents.

CAUTION: Never use anti-IgA, -IgM, -C3, -C4 alone for compatibility testing or for antibody detection.

Table 3-1. Antihuman Globulin Reactions	
Reagent	Definitions*
Polyspecific	Contains anti-IgG and anti-C3d; may contain other anticomplement and other anti-immunoglobulin antibodies.
Polyspecific	Contains rabbit antihuman IgG and murine monoclonal anti-C3b and-C3d.
Anti-IgG	Contains anti-IgG with no anticomplement activity.
Anti-IgG (heavy chains)	Contains only antibodies reactive against human gamma chains.
Anti-C3d and Anti-C3b, Anti-C3d	Contains only antibodies reactive against the designated complement components(s), with no anti-immunoglobulin activity.
Anti-C3d (murine monoclonal) anti-C3b, -C3d (monoclonal)	Contain only antibodies reactive against the designated complement component, with no anti-immunoglobulin activity.
* As defined by the FDA: Code of Federal Regulations 21 CFR 660.	

3-17. FACTORS AFFECTING THE ANTIGLOBULIN TEST

a. Sensitization Phase ("In Vitro" Only).

(1) *Temperature.* Incubation is normally at 37° C, as most clinically significant IgG antibodies react optimally at 37° C. Complement sensitization also occurs optimally at 37° C.

(2) *Medium.* The suspending medium for the red blood cells may be saline, albumin, or low-ionic-strength saline (LISS) serum. There is evidence that a shorter incubation period can be used if albumin is present in the incubation mixture and also that uncommon antibodies are detected in the presence of albumin that fail to react

when red blood cells are suspended in saline. Antibody association is considerably enhanced if red blood cells are suspended in a simple low-ionic-strength medium.

(3) *Proportions of serum to cells.* The same general principles apply here as discussed in paragraph 3-9. Increasing the proportion of antibody to antigen will increase the degree of antibody coating. Two drops of serum to one drop of 2-5% red cells, a proportion of 100:1 - 40:1 in terms of packed red packed blood cells, is commonly used. By increasing this proportion (e.g., to 1000:1) sometimes weak antibodies can be detected that are not detectable in our routine incubation mixtures. In special investigations, such as hemolytic transfusion reaction with no antibody detectable by routine procedures, it might be useful to try increasing the proportion of serum to cells.

(4) *Incubation time.* A period of 15 to 30 minutes of incubation (especially in the presence of albumin) at 37° C permits detection of most clinically significant antibodies. Extension of the incubation period to 30 to 60 minutes may detect a few weaker examples of antibodies undetected after 15 minutes of incubation.

b. Washing Phase.

(1) Washing must be rapid and uninterrupted to minimize loss of cell-bound antibody by elution.

(2) Decant the saline as completely as possible between each washing. Shake to loosen and resuspend the cells completely. Add the saline in a forceful stream. An automatic washer achieves these objectives more efficiently than washing by hand.

(3) Do not cover the mouth of the test tube with the finger or the palm of the hand when mixing. Serum remaining on the fingers after handling the specimen can inactivate the antiglobulin reagent.

NOTE: As little as one drop of a 1:4,000 dilution of human serum can neutralize one drop of antiglobulin serum.

(4) Use adequate volumes of saline. When 10- X 75-mm or 12- X 75-mm test tubes are filled at least three-quarters full of saline, three or four washings are usually adequate.

(5) After the final wash, discard the saline as completely as possible. Resuspend the cells and add the appropriate amount of antiglobulin serum. Mix well and centrifuge. It is important that the antiglobulin serum be added immediately following completion of washing.

3-18. SOURCES OF ERROR

a. False Negative Results.

(1) Inadequate washing of cells will result in neutralization of the antiglobulin serum by trace amounts of residual globulin. A final concentration of only 2 mg of IgG/ml can cause neutralization of the antiglobulin serum. Thus, the red blood cells have to be washed free of unbound IgG until it is below this figure.

(2) Contamination with human serum will neutralize the reagent. If the reagent dropper is contaminated with serum and replaced in the vial, the entire contents of the vial may be neutralized. If the tube is inverted over the thumb or finger in the washing process, serum contaminating the skin may result in neutralization.

(3) Elution of antibody from the red blood cells may take place if the test procedure is interrupted or delayed, particularly during the washing phase.

(4) The optimum temperature for reactivity of the antibody must be maintained during incubation to achieve maximal coating of the cells.

(5) A cell suspension that is too heavy will not permit optimum coating with the antibody; if too weak, reading agglutination may be difficult. A 2% to 5% suspension of red blood cells is preferred.

(6) Test cells, test serum, and antiglobulin serum lose reactivity if improperly stored.

(7) Some antibodies may be detected only in the presence of active complement. Anticoagulants such as ACD, CPD, or EDTA will chelate calcium, preventing activation of complement. Thus, the use of plasma rather than serum may lead to a false-negative reaction. Old or improperly stored serum will also have impaired complement activity.

(8) A prozone reaction should not be a problem with licensed products. Standardization is done by the manufacturer, and his directions for the test must be followed.

(9) Antiglobulin serum may have been omitted.

(10) Undercentrifugation or overcentrifugation (the latter because of the excessive force needed to resuspend cells).

(11) Insufficient incubation time.

NOTE: The lack of agglutination of presensitized red blood cells, added following completion of a negative antiglobulin test, will demonstrate a false-negative determination caused by 1, 2, 6, or 9 above.

b. False-Positive Results.

(1) Cells having a positive direct antiglobulin test cannot be used with reagent antisera that require an antiglobulin phase because all such cells will be agglutinated by the antiglobulin serum.

(2) Bacterial contamination of test cells, or septicemia in a patient, may result in a positive antiglobulin test. If the red blood cells are T-activated, they may react as some antiglobulin sera contain anti-T.

(3) Extreme reticulocytosis has been reported to give a positive result because of transferrin bound to reticulocytes reacting with antitransferrin in the antiglobulin reagents. Most antiglobulin reagents today have little antitransferrin activity.

(4) Saline stored in glass bottles may contain colloidal silica leached from the container; this has been reported to cause false-positive reactions.

(5) Saline stored in metal containers, or used in equipment with metal parts, may contain metallic ions which may bring about nonspecific protein-coating of the red blood cells.

(6) Improperly prepared antiglobulin serum may contain traces of species-specific antibodies. (This should not be a problem if tests are performed with licensed AHG reagents.)

(7) When all the antiglobulin tests are weakly positive, the cause may be improperly cleaned glassware or other form of contamination.

(8) Overcentrifugation may give false-positive results (aggregation vs. agglutination).

(9) Patients' or donors' serums can contain a naturally occurring cold autoantibody (normal incomplete cold antibody) that can sensitize their own or other cells with complement. Usually this only occurs at 4° C, but it may occur up to room temperature. If antiglobulin sera contain potent anticomplement, positive reactions may occur with red blood cells from refrigerated clots. These positive reactions have been found to be largely a result of C4 sensitization and can be avoided if the red blood cells from anticoagulated blood are used. For crossmatching, red blood cells from ACD or CPD segments can be used, and for direct antiglobulin tests EDTA is preferable. These anticoagulants will chelate Ca⁺⁺ and Mg⁺⁺, thus preventing any "in vitro" complement uptake without interfering with the complement already bound to the red blood cell "in vivo."

(10) Red blood cells may be autoagglutinated before they are washed, and this agglutination may persist through washing, leading to a false-positive reaction when antiglobulin serum is added.

Section III. RED CELL ANTIBODIES

3-19. ALLOANTIBODIES

a. Alloantibodies are found in people who, through pregnancy, previous transfusion, or injections, have been exposed to foreign red blood cell antigens. Some people with no known immune stimulus may have unexpected antibodies, usually reacting at low temperatures.

b. Unexpected antibodies may be responsible for the following:

(1) *A discrepancy between ABO and serum-grouping.* This may be caused by any antibody reacting at room temperature with antigenic determinants other than ABO on the reagent red blood cells.

(2) *A positive antibody-screening test.* Properly selected reagent red blood cells should detect 95% or more of clinically significant antibodies.

(3) *An incompatible crossmatch.* The donor's red blood cells contain one or more antigens reacting with antibodies in the serum of the patient.

(4) *A transfusion reaction.* A new antibody in a recently transfused person, an anamnestic response caused by an antibody too weak to demonstrate before transfusion, or an antibody that was missed in pretransfusion testing may cause a transfusion reaction.

(5) *Jaundice in a newborn.* Both the serum of the mother and of the baby and their red blood cells must be studied. Unusual problems sometimes require study of the father's cells and those of other family members.

(6) *A positive direct antiglobulin test.* Antibodies may be identified in the serum or in an eluate prepared from the red blood cells. In some cases, antibodies may be directed against a drug rather than red blood cell antigens.

(7) *A positive autocontrol.* Agglutination may be observed after room temperature (RT) or 37° C incubation and indicate the presence of cold or warm autoantibodies, fatty acid-dependent antibodies, or abnormal proteins causing heavy rouleaux.

c. Antibodies stimulated by red blood cell antigens usually react in a predictable manner, depending on the specificity of the antigen. Some of the antigens stimulate the production of IgM and others of IgG antibodies. The IgM antibodies react by agglutinating the red blood cells while the IgG antibodies sensitize (coat) the red blood cells which can then be agglutinated by antiglobulin serum. Some antibodies (both IgM and IgG) are able to activate complement. If the bound complement proceeds to completion of the sequence, the red blood cells will be lysed. If the sequence is not completed, the cell-bound components can be detected with cell-bound polyspecific or monospecific (C3 or C4) antiglobulin serum.

d. The *Standards for Blood Banks and Transfusion Services* (FM 8-70) requires the serum of all donors and recipients to be tested by methods that will demonstrate hemolyzing, agglutinating, and coating antibodies. An antibody in a recipient that does not react above 30° C has little clinical importance.

e. The D antigen has greater immunogenicity than all other red cell antigens. Of the U.S. population, 85% are D-positive. Rh antibodies have been associated with hemolytic disease of the newborn (HDN).

Section IV. COMPATIBILITY TESTING

3-20. DETERMINATION OF COMPATIBILITY

a. Compatibility testing consists of a series of procedures performed by the blood bank before transfusion to ensure the proper selection of blood for the patient. These procedures should include the following:

(1) A review of the blood bank records for results of previous testing to check for the recipient's group and type and for any unexpected red blood cell antibodies that may have been previously identified.

(2) ABO grouping, Rh typing, and red cell antibody detection on each recipient sample sent for compatibility testing.

(3) ABO grouping, Rh typing, and red cell antibody detection on the unit of blood. (Neither the antibody detection test or Rh typing, if labeled as Rh positive, need to be repeated if it has been performed by the collecting agent.)

(4) Crossmatching.

b. Careful technique and complete concentration are necessary in testing, since incorrect results can directly endanger the life of the recipient.

c. The AABB Standards and the FDA (CBER) require the testing of the donor's cells with the recipient's serum by a method that will demonstrate agglutinating, coating, and hemolyzing antibodies, which shall include the antiglobulin method. Antihuman globulin reagent for the antiglobulin test shall meet FDA standards. An immediate spin (IS) crossmatch is acceptable, if the antibody screen is negative. If the antibody screen is positive, a full crossmatch through AHG phase is required.

d. The crossmatch will detect the following:

(1) Most recipient antibodies directed against antigens on the donor red blood cells.

(2) Most errors in ABO grouping, labeling, and identification of donors and recipients.

e. The crossmatch will not:

(1) Guarantee normal donor cell survival.

(2) Prevent recipient immunization.

(3) Detect all ABO grouping errors.

(4) Detect **Rh typing errors** (unless the recipient's serum contains anti-D from previous immunization).

(5) Detect all unexpected red blood cell antibodies in recipient serum. Clerical errors are more common than technical ones in a blood bank or transfusion service. Nontechnical mistakes, such as inadequate or incorrect identification of the recipient or donor, usually are caused by not adhering to established protocols.

3-21. COLLECTION OF BLOOD FROM RECIPIENT

a. Blood request forms must include the recipient's full name and identification number. Because blood is a drug, and for medical-legal reasons, the name of the responsible physician should appear on the requisition form. Additional information such as sex, amount of blood, or component should also be furnished. Only completed forms may be accepted. Transmittals from a computer program are acceptable. Telephone requests should be confirmed in writing with a properly completed request form.

b. The recipient and the blood sample must be positively identified when the sample for compatibility testing is drawn. One way of positive identification is to ask the patient to state his full name, not merely to confirm it. If the patient is unable to state his name, the wristband must be relied upon totally for information. When a wristband (or other identification attached to the person) is not available, it is necessary to confirm the

identification with a professional person who is familiar with the patient. **Bed labels should not be used in place of wristbands.** The unidentified emergency patient should be given a temporary identifying number, attached to his person, that can be used until positive identification is made.

c. The wristband should then be checked, and the name and identification number should be copied from the source onto the tube label with an indelible marker. If imprinted labels are used, the information on the labels should match the wristband exactly. The date should then be added and the identification compared to the request form. Other pertinent data may appear on the tube label, such as initials of the person responsible for collecting the recipient sample. The tube must be labeled immediately before or after the blood is drawn at the bedside of the recipient. Ordinarily, the sample should not be drawn from tubing used for infusion of intravenous fluid or from the contiguous vein, but from a fresh venipuncture site. If the tubing must be used, it should be flushed with saline and the first 5 ml of blood that is withdrawn should be discarded.

3-22. PRETRANSFUSION TESTING OF THE RECIPIENT

The information on the request form and sample label must be compared by a qualified person before testing can begin. In case of discrepancy or doubt concerning the specimen, a new sample must be drawn.

a. Patient Specimen.

(1) Fresh, not inactivated serum, less than 72 hours old must be used for the crossmatch. If plasma is used, fibrin clots may form and interfere with the test and with complement activation.

(2) When a series of transfusions is to be given over a period of several days, a new sample of the recipient's blood, obtained within 72 hours of the next scheduled transfusion, should be used. This is essential for the detection of antibodies that may appear in the recipient's circulation in response to blood previously transfused. If more than 72 hours have elapsed since the previous transfusion, units of donor blood previously crossmatched must be recrossmatched with a new patient serum specimen before transfusion.

(3) Hemolyzed patient samples should be avoided because they may mask hemolysis of donor red blood cells.

(4) A washed red blood cell suspension may be prepared. Red blood cells suspended in serum should not be used if the serum contains autoagglutinins, cold agglutinins, or abnormal proteins which cause rouleaux.

b. Preliminary Testing. The following are imperative before crossmatching.

(1) A review of blood bank records for results of previous testing.

(2) ABO grouping and Rh typing. Special care must be taken in testing the recipient who may have received transfusions of an ABO group or Rh type different from his own, since transfused cells may give misleading results.

(3) The screening of recipient sample for unexpected antibodies. This may be performed at the same time as the crossmatch. Identify the antibody if the screen is positive.

3-23. SELECTION OF BLOOD

a. Background.

(1) The blood selected for crossmatch should be of the same ABO group and Rh type specific as that of the recipient when possible; however, there are instances when it is acceptable or even advisable to transfuse red blood cells of a different ABO group, provided that they are compatible. For example:

(a) When group and type specific blood is unavailable, as in transfusing group A blood to an AB recipient.

(b) Use of group O blood for ABO and/or Rh hemolytic disease or for emergency uncrossmatched blood for which the patient's ABO/Rh has not been determined.

(2) It is not necessary to be concerned with subgroups of A unless the patient has a clinically significant anti-A₁ or anti-IH. Anti-IH patients should receive A₁ blood. Anti-A₁, which is active "in vitro" at 30° C or higher has been shown to be capable of extensive red cell destruction. Therefore, these patients should receive A₂ blood.

(3) Matching of the Rh antigens other than D is not recommended unless the patient has a known Rh- antibody, in which case blood lacking the corresponding antigen must be selected, but it is not necessary to type donor blood for additional antigens. Patients who may receive multiple transfusions (e.g., sickle cell patients) should receive phenotypically matched units if possible.

(4) The expiration date of the blood should be noted to be sure that the age of the blood is acceptable for its intended use.

b. Choice of Blood When Group-Specific Blood Is Unavailable. When blood of the recipient's ABO group is unavailable, transfusion with an alternate group, as shown in table 3-2, is acceptable but must be administered as red blood cells, or, if whole blood, must be shown to lack hemolysins directed against cells of the patient's group.

Table 3-2. Blood Choice		
Patient's Group	Alternate Donor Group	
	First Choice	Second Choice
O	None	None
A*	O	None
A ₂ with Anti-A ₁	A ₂	O
B	O	None
AB	A or B+	O
A ₂ B with anti-A ₁	A ₂ or B+	O
* A patient with uninhibitable anti-IH should be transfused with blood of group A ₁ .		
+ Either group may be chosen, but only one of the two should be used for a given recipient. Group A is usually more readily available than group B. If blood of yet another group is needed, use group O.		

c. Changing to Group-Specific Blood After Transfusion of a Different ABO Group.

(1) The decision to change back to group-specific blood at any time is **best based on the presence or absence of anti-A and/or anti-B in subsequent samples of the recipient's blood**. Fresh blood specimens should be obtained on the day of each successive transfusion for evaluation. If crossmatches of a freshly drawn patient sample with group-specific blood indicate compatibility, this blood may be issued (crossmatch must be carried through). Otherwise, transfusion with red blood cells of a different ABO group should be continued. Group-specific transfusions should not be infused through the same infusion set as was used for transfusion of red cells of a different ABO group.

(2) When the emergency is over, the effect of transfused alloantibodies should be evaluated. Such antibodies may cause hemolysis of recipient cells. If Rh-negative blood is unavailable, transfuse Rh-positive blood rather than withholding blood from a patient whose need for blood is critical.

(3) Up to 80% of Rh-negative patients given Rh-positive blood may form anti-D. It is reasonable to attempt prevention of immunization with large doses of Rh Immune Globulin (RhIG) when only one unit of Rh-positive blood has been given

accidentally. One dose (approximately 300 ug) of Rh IG is required for 15 ml of red blood cells; thus, 15 to 20 ml of Rh IG may be required to prevent immunization by 1 unit of blood. Rh-negative blood may be given to an Rh-positive recipient, if necessary. Every effort should be made not to transfuse D-negative women of child bearing age with D-positive blood.

3-24. MASSIVE TRANSFUSION

a. Massive transfusion may be defined as rapid infusion of blood in amounts approaching or exceeding replacement of the recipient's total blood volume within a 24-hour interval. This is encountered in surgical and medical emergencies, and in cardiac and vascular surgery, especially when extracorporeal circulation is used. The exchange transfusion of an infant is also a massive transfusion.

b. An antibody present in the original recipient sample may be weakened or not detectable in a subsequent posttransfusion specimen because of the dilution effect of massive transfusion. It is especially important in this case to select blood that is negative for the corresponding antigen by typing the units with a reagent antiserum before crossmatching.

3-25. TECHNIQUES FOR CROSSMATCHING

a. Background.

(1) There are a variety of techniques available for antibody detection. Some facilities do not perform the IS, room temperature phase of the antibody screen to avoid "nuisance" antibodies (i.e., cold antibodies). If a cold antibody is detected that interferes with the crossmatch, a prewarm technique may be employed.

(2) As stated earlier, immediate spin crossmatch at room temperature is acceptable if the antibody screen is negative. If the antibody screen is positive, the crossmatch must go through AHG phase.

(3) The optimal method for detecting coating antibodies is the use of an antiglobulin test following incubation at 37° C for 15 to 60 minutes. Incubation may be carried out in a potentiating medium of high dielectric constant, such as albumin or LISS. The test is customarily read both before washing and after addition of antiglobulin serum.

b. **Technical Factors.** Technical factors must be considered in the performance of a crossmatch. These include:

(1) Donor red blood cells for crossmatching must be obtained from a sealed segment of tubing integral with the container.

(2) The cells used for crossmatching may be saline-washed.

(3) A 2% to 5% cell suspension is usually recommended.

(4) Reaction tubes are generally 10 or 12 X 75 mm.

(5) The supernatant must be examined for hemolysis against a white background before resuspending the centrifuged cells.

(6) An optical aid such as magnifying lens, mirror, or microscope is advised, but not necessary, for the reading of agglutination.

(7) Hemolysis or agglutination at any stage of the crossmatch indicates an incompatibility.

(8) The person performing the test should be familiar with incubation, centrifugation, antiglobulin technique, sources of error, and reading of hemolysis and agglutination.

(9) All test tubes should be labeled before use with unit and recipient identification.

c. Tube Crossmatch Procedure.

STEP 1. Place 2 drops of recipient serum in a labeled tube.

STEP 2. Add 1 drop of a 2% to 5% saline suspension of donor cells.

STEP 3. Centrifuge; examine for hemolysis and for agglutination; grade and record results. (IS)

NOTE: You may stop here if antibody screen is negative.

STEP 4. Add 2 drops of 22% to 30% albumin or LISS according to manufacturer's directions; mix. Centrifuge; incubate 15 to 60 minutes at 37° C; read and record the results.

STEP 5. Centrifuge immediately upon removing from the incubator; examine for hemolysis and agglutination; grade and record results.

STEP 6. Wash 3 or 4 times with saline. After last wash, decant completely. Add 1 to 2 drops of antiglobulin serum and mix.

STEP 7. Centrifuge; examine for agglutination: grade and record the results. (Use of optical aid is optional at this step.)

STEP 8. Add 1 drop of known sensitized cells to all negative tests. Centrifuge; examine for agglutination; record result. If no agglutination is seen, the

antiglobulin phase must be repeated. If no hemolysis or agglutination is seen in any phase, the blood is considered compatible.

d. **Immediate Spin Technique.** By AABB standards, minimal serological testing (saline crossmatch) is an acceptable method to demonstrate ABO incompatibilities between the donor and the recipient if:

- (1) Antibody detection is negative on the recipient and/or,
- (2) Recipient has no clinical significant antibodies.

3-26. INCOMPATIBLE CROSSMATCH

a. Introduction.

(1) When incompatibility is seen in an early phase of a crossmatch, the testing should be completed to give information as to temperatures and media where reactions occur, the variability of these reactions, and the percentage of incompatible donors. These clues will aid in choosing correct conditions for antibody identification.

(2) It is preferable to determine the cause of the incompatibility rather than to continue blindly. If the need for transfusion is too urgent for this course of action, many random units may be crossmatched. If possible, attempts to identify the antibody should be started while the crossmatch is being completed.

b. **Work Outline for Incompatible Crossmatch.** Preliminary investigation: recheck ABO groups and Rh types of incompatible donors and recipients; recheck pilot sample numbers against donor units; and run an autocontrol with the antibody identification panel.

c. Autocontrol Negative.

(1) Specific cold alloantibodies are suggested if reactions are detected at room temperature, if reactions are weak or negative at 37° C or by antiglobulin technique, or if reactions are stronger at 18° C to 15° C or lower. Under such conditions, do the following:

(a) Identify the antibody or antibodies, if they do not disappear using the prewarm technique.

(b) If anti-A₁ or anti-IH is identified, select blood on the basis of A subgroups.

(c) If a clinically significant antibody is identified, the red blood cells of prospective donors should be tested for this antigen with known reagent antiserum (if available) before transfusion.

(2) Specific warm alloantibodies are suggested if the reactions take place at 37° C and/or are detected by antiglobulin technique. Do the following:

(a) Identify the antibody or antibodies.

(b) Test the cells of prospective donors for the corresponding antigens with a known reagent antiserum.

(c) If the red blood cells from only one donor unit react, and the antibody screening test on the patient is negative, do a direct antiglobulin test on the donor. If the direct antiglobulin test is positive, quarantine the donor blood for further investigation. If it is negative, test the patient's serum for antibodies directed against low-incidence antigens.

(d) When red blood cells from most donors react, there are two possible explanations: there may be an antibody against a high-incidence red blood cell antigen, or multiple antibodies may be present. In either case, the patient's relatives, especially siblings, may be compatible. If not, it may be possible to find compatible donors through a Reference Laboratory or Rare Donor File.

d. Autocontrol Positive.

(1) A cold antibody is suggested if reactions detected at room temperature are weak or negative at 37° C, and/or by antiglobulin technique, or if reactions are enhanced at 18° C to 15° C or lower. Reactions at 37° C and by antiglobulin test may be a result of cold agglutinin if cells and serum were mixed at room temperature before incubating at 37° C. The following procedure is suggested:

(a) If the patient has not been recently transfused, absorb cold autoagglutinins with patient's cells in an ice-slush bath.

(b) Autoabsorption should not be done if the patient has been recently transfused because the transfused donor cells may absorb out a specific alloantibody; therefore, a prewarmed antiglobulin crossmatch should be done.

(c) Use absorbed serum for reverse grouping, crossmatching, and identification of alloantibodies which may have been masked by the cold antibody.

(d) Wash patient's cells with warm (37° C) saline before grouping and typing.

(2) A serum protein abnormality in the patient may cause reactions that are detected at room temperature, enhanced at 37° C, and negative by antiglobulin test. This pattern suggests a protein abnormality causing rouleaux formation, particularly when enhanced in albumin. The patient's diagnosis and results of protein tests can be informative here. More rarely, with a high-protein method, the albumin-agglutinating

phenomenon may be present. The direct antiglobulin test is usually negative in this situation. If a protein abnormality is being considered, the following procedure is suggested:

- (a) Use saline-reactive antiserum to Rh-type patient.
- (b) Do a saline-antiglobulin test as the main index of compatibility between donor and patient.
- (c) Repeat albumin phase using albumin without the caprylate stabilizer when albumin-agglutinating phenomenon is suspected.
- (d) Check donor's cells for polyagglutinability.

(3) A warm antibody is indicated if the reactions are detected at 37° C, by antiglobulin technique, or by antiglobulin technique only. The direct antiglobulin test is usually positive with a warm autoantibody. Consider the following:

(a) Determine whether the autoantibody has demonstrable specificity or whether it may be masking an alloantibody.

1 Specific antibody may be seen with autoimmune hemolytic anemia, or with alloimmunization and coating of transfused donor red blood cells (the direct antiglobulin test may appear mixed-field). It is helpful to know the specificity (IgG or complement) of the protein coating the red blood cells. If IgG is coating the red blood cells, antibody can usually be eluted from the patient's cells; however, if only complement is coating the patient's cells, antibody will not be eluted. The results must be carefully interpreted.

2 When there is specificity, blood lacking the corresponding antigen should be selected for transfusion if possible. Many specific warm autoantibodies are directed against Rh antigenic determinants.

3 When the specificity of antibody on the red blood cells differs from that in the serum, it may be necessary to crossmatch with an eluate as well as serum.

4 Patients with autoimmune hemolytic disease may have a positive direct antiglobulin test without demonstrable circulating antibody. This is because all antibody has been absorbed onto the red blood cells and therefore tests done with the patient's serum will appear compatible. To be more certain of compatibility, eluates prepared from the patient's coated cells may be used for crossmatching.

5 When antibody specificity cannot be determined, blood can be crossmatched by the titration technique. The patient's serum can then be absorbed with the cells of the weakest reacting donor and the absorbed serum tested for additional antibodies. The donor cell may also absorb out an underlying alloagglutinin.

Responsibility for transfusion of blood that is incompatible "in vitro" should be shared by the blood bank physician and the patient care physician.

(b) The patient cannot be phenotyped with antisera requiring the antiglobulin technique because of the positive direct antiglobulin test. There may also be spontaneous agglutination with high-protein antiserum. Elution at 45° C before testing may help to remove enough antibody from the cells to allow typing.

e. **Some Technical Causes of Apparent Incompatibility.** False positive reactions may be caused by dirty glassware, bacterial contamination, chemical or other contaminants in reagents (including saline), fibrin clots, and overcentrifugation.

3-27. LABELING AND RELEASE OF CROSSMATCHED BLOOD

a. The prescribed compatibility record must be completed. A label or tag must be attached directly to each compatible unit of blood and must remain attached at least until the transfusion is completed. This label and any other accompanying forms must be completed.

b. The expiration date and appearance must be checked just before release of a unit of blood. Release forms should be compared with the blood label and request forms, and the release record must be filled out.

c. Final identification of the recipient and the blood container rests with the transfusionist, who must positively identify the patient (and donor blood) and compare the information with the compatibility report form.

3-28. RETENTION AND STORAGE OF BLOOD SAMPLES

The recipient's blood specimen and a donor sample must be sealed or stoppered and kept for at least 7 days following transfusion at 1° C to 6° C. Most transfusion services keep all specimens for 10 days: in 3 days the clot can be used for crossmatching and for the 7 day post transfusion requirement.

3-29. RELEASE OF BLOOD IN EMERGENCY SITUATIONS

a. In an emergency, the patient's physician must weigh the risk of transfusing uncrossmatched or incompletely crossmatched blood against the hazard of waiting for completed crossmatch tests.

b. If the urgency of the situation warrants release of blood before the crossmatch is completed, the physician must indicate the urgent nature of the situation which requires the omission of the crossmatch. Such a release does not absolve the blood bank from its responsibility to issue properly grouped and labeled blood. In emergency situations:

(1) If necessary, issue uncrossmatched blood and have physician sign for the blood. Notify a blood bank physician that uncrossmatched blood has been released.

(a) If there is not time to determine the patient's blood group, issue group O Rh-negative blood that has most of the plasma removed or is free of hemolytic anti-A and anti-B. O Rh-positive blood may be issued only if O Rh-negative is not available.

(b) Group specific blood should be given and, if time permits, test the patient in the transfusion facility without relying on previous records. Evidence of the patient's blood group must not be taken from cards, dog tags, drivers' licenses, or other such records.

(2) Begin the routine compatibility testing procedure. If the clinician cannot wait the length of time required for a complete crossmatch, release the blood and continue the crossmatch after release.

(3) Complete the compatibility testing. If incompatibility is detected at any stage of the testing, immediately notify the patient's physician and the blood bank physician.

Section V. BLOOD ADMINISTRATION

3-30. BACKGROUND

The development of methods for preserving red blood cells and other blood components has made transfusion readily available. Despite the relative ease of transfusion, it may have serious complications and should be undertaken only after considering the etiology and course of the patient's disease and clinical condition. If transfusion therapy is indicated, the specific blood fraction that is lacking should be identified and a specific blood component used to replace that deficit. Usually the patient is best served when specific blood component therapy is utilized.

3-31. TRANSFUSION OF BLOOD PRODUCTS CONTAINING RED BLOOD CELLS

a. Indications for Transfusion of Red Blood Cells (Human) and Whole Blood (Human).

(1) The most common reasons for transfusion are replacement of red blood cells for oxygen-carrying capacity or restoration of blood volume. In deciding whether a patient requires red blood cell transfusion, the clinical condition of the patient is of primary importance. The amount of blood loss that can be tolerated without replacement depends upon the condition of the patient. If blood loss has been acute, the patient may have a normal or nearly normal hemoglobin, but may nevertheless require transfusion for the restoration of blood volume. If blood loss is judged sufficient

to require transfusion, it is not necessary to wait until symptoms such as pallor, diaphoresis, tachycardia, or hypotension develop. On the other hand, transfusion should not be initiated too rapidly because it seems clear that in most "normal" patients, the loss of approximately 1,000 ml can be replaced by colloid or crystalloid solutions alone.

(2) When anemia has developed over a long period of time, the patient adjusts to lower hemoglobin levels and may not require transfusion despite very low hemoglobin levels. The condition of the patient is of primary importance, not the laboratory values. There is no evidence that it is necessary to transfuse a patient to a "normal" hemoglobin prior to surgery, nor is there any specific hemoglobin value above which patients feel better or wound-healing is improved. In patients with chronic anemia, attempts should be made to diagnose and treat the anemia. Transfusion should be used only as a last resort, since it may suppress erythropoiesis.

b. Red Cell Products.

(1) *Whole blood (WB)*. Whole blood is the product of choice for acute massive blood loss in many hospitals. Others prefer to use colloid or crystalloid solutions followed by red blood cells. Very few DOD hospitals keep whole blood. In acute massive blood loss, the blood volume deficit is as important as the loss of red blood cells and transfusion therapy must replace this volume deficit. Whole blood may be required for certain special circumstances such as exchange transfusion; however, exchange transfusion can be performed with red blood cells and either albumin or fresh frozen plasma.

(2) Red blood cells (RBCs).

(a) Red blood cells are the product of choice to restore or maintain oxygen-carrying capacity. Patients who have chronic anemia, congestive heart failure, or are elderly or debilitated tolerate poorly rapid changes in blood volume. Transfusing red blood cells increases oxygen-carrying capacity with minimal expansion of blood volume. Nonhemolytic transfusion reactions occur less frequently after transfusion of red blood cells than after whole blood, probably because most platelets, granulocytes, and plasma are removed.

(b) The use of red blood cells in surgery is more controversial. Some surgeons and anesthesiologists feel that the blood loss that occurs during surgery is acute and should be replaced with whole blood. Other surgeons, anesthesiologists, and most immunohematologists believe that usually surgical blood loss occurs under controlled conditions and can be replaced with red blood cells and saline. Investigations have shown no increased morbidity or mortality from the use of red blood cells, and this practice is common in many hospitals. In addition, a number of studies have shown that 1,000 to 1,200 ml of operative blood loss can be replaced by electrolyte and/or colloid solutions without the use of red blood cells. Thus, the loss of 2 units of blood during "routine" surgery could be replaced with red blood cells. The use

of red blood cells allows platelet concentrate and plasma products to be produced from the same unit of blood. Because this is a much more efficient use of the original unit of blood, red blood cells are always preferred unless there is a specific indication for the use of whole blood.

(3) *Leukocyte - poor RBCs*. See lesson 2.

(4) *Frozen RBCs*. See lesson 2. Deglycerolized RBCs are expensive to prepare and have a limited shelf life after thawing (24 hours).

c. **Effects of Red Blood Cell Transfusion.**

(1) *Circulation*. When a unit of whole blood is transfused rapidly (30 to 60 minutes) to a patient with a normal blood volume, the blood volume is increased by this amount. After approximately 24 hours, the blood volume has returned to its pretransfusion level. If plasma alone is transfused, the blood volume may readjust more rapidly. Some patients, such as those with chronic renal disease, may require prolonged periods to readjust their blood volume.

(2) *Hemoglobin*. The effects of red blood cell transfusion on the recipient's hemoglobin and hematocrit will be affected by the recipient's blood volume, pretransfusion hemoglobin and hematocrit, the clinical condition of the patient (stable, bleeding, etc), and the hemoglobin and hematocrit of the donor unit. One unit of RBCs should raise the Hgb by 1 gm/dl (Hct by 3%).

(3) *Red blood cell production*. Transfusion of red cells may result in a decrease in the recipient's own red blood cell production because of a suppression of erythropoietin. Thus, many patients with a stable chronic anemia may receive little benefit from red blood cell transfusion since their hemoglobin rapidly falls to pretransfusion levels because of diminished production of their own red cells.

d. **Survival of Transfused Red Blood Cells**. The normal red cell has a life span of approximately 120 days. Each unit of blood contains red blood cells of all ages between 1 and 120 days. As the unit of blood is stored, the red blood cells continue to age and these senescent red blood cells are removed from the circulation within 24 hours after transfusion. Thus, when stored blood is transfused, there is a slight decrease in the proportion of red blood cells surviving 24 hours after transfusion. Approximately 70 to 80% of red blood cells stored in CPD for 21 days or CPDA-1 for 35 days survive following transfusion. The remaining red blood cells survive normally and are destroyed linearly with a mean half-life of 50 to 60 days. The survival of transfused red blood cells is affected by the recipient's health and may be decreased in patients with active bleeding (and iatrogenic blood loss), hemolytic anemia resulting from defects extrinsic to the red blood cell (autoantibodies, alloantibodies, and hypersplenism), and chronic renal or liver failure.

3-32. TRANSFUSION OF PLATELETS

a. Indications for Platelet Transfusion.

(1) The decision whether to transfuse platelets depends upon the clinical condition of the patient, the cause of the thrombocytopenia, the platelet count, and the functional ability of the patient's own platelets (see table 3-3). Patients with transient thrombocytopenia from chemotherapeutic treatment of malignancy form the largest group of patients receiving platelet transfusions. There is little risk of spontaneous hemorrhage in these patients when the platelet count is over 30,000/mm³. Although there is some disagreement as to the value of prophylactic platelet transfusion, many physicians advise platelet transfusions to prevent serious bleeding in these patients when the platelet count is less than 20,000/mm³.

Table 3-3. Thrombocytopenia and Platelet Therapy.	
Cause	Therapy
Amegakaryocytic thrombocytopenia (e.g., leukemia, hypoplastic, or aplastic anemia)	Platelets useful in treating hemorrhage and for prophylaxis to prevent bleeding episodes
Immune thrombocytopenia purpura (e.g., ITP)	Platelets of little value because of rapid destruction in the spleen.
Dilutional thrombocytopenia (e.g., massive transfusion with bank blood)	Platelets of value in replacement (usually after 15 to 20 units transfused)
Disseminated intravascular coagulation (DIC)	Platelets of value only when combined with efforts to stop DIC or treat the cause
Functional platelet abnormalities	Platelets from normal donors may achieve hemostasis during hemorrhage, surgery, and dental extractions

(2) In patients with immune thrombocytopenic purpura, transfused platelets usually have a very short survival and, thus, may not be helpful. However, platelet transfusion may be effective in controlling serious active bleeding, especially in surgery. The most effective forms of treatment may be corticosteroids or splenectomy.

(3) In patients with thrombocytopenia secondary to drug idiosyncrasy, the offending drug should be discontinued and the patient closely observed. Because

transfused platelets will have a shortened survival, they are advisable primarily for treatment of active hemorrhage.

b. Outcome of Platelet Transfusion.

(1) Some patients produce platelet antibodies as a result of previous pregnancy or transfusion. Platelets collected from random donors will have a shortened survival in these patients and, thus, may not be effective in preventing or controlling bleeding. For further discussion, see platelet compatibility, below.

(2) It has been shown that from 1 to 3 hours after infusion the platelet count increases approximately $12,000/\text{mm}^3$ when 1×10^{11} platelets are transfused into a patient with 1 m^2 body surface area (BSA) (e.g., a 30-kg, 6-year-old child). The expected "bump" from a 6-pack of platelets is approximately $15,000/\text{mm}^3$ in an average adult (1.8 m^2 BSA).

(3) Many patients do not show the expected increment in peripheral blood platelet count following transfusions because platelet survival is affected by the clinical condition of the patient. If active bleeding is occurring or splenomegaly exists, the transfused platelets are sequestered at the bleeding site or in the spleen and do not remain in the circulation. In patients who have platelet antibodies such as those with idiopathic thrombo-cytopenic purpura or sensitization to antigens of the HLA system, survival of circulating platelets is extremely brief, sometimes only a matter of minutes. Fever, infection, and disseminated intravascular coagulation are additional clinical conditions that cause a shortened platelet survival.

c. Selection of ABO and Rh Type for Platelet Transfusion.

(1) ABO antigens are present on the surface of the platelet and the recovery of A_1 platelets transfused into group O patients may be decreased. In patients with lymphocytotoxic antibodies against donor cells, however, the increment in peripheral blood platelet count is the same following transfusion of HLA-compatible platelets whether ABO-compatible or ABO-incompatible. Until these inconsistencies can be resolved, it is advisable to transfuse ABO-compatible platelets whenever possible. If ABO-compatible platelets are not available, ABO-incompatible platelets should be used rather than withholding platelet transfusions.

(2) Incompatibility between donor plasma and recipient red blood cells usually is not clinically important because of the small volume of plasma (20 to 50 ml) from each individual platelet concentrate. If large numbers of platelet concentrates are being transfused to an adult, or the patient is a small child, incompatible donor plasma may cause a positive direct antiglobulin test and red blood cell hemolysis. When group-compatible platelets are unavailable, consideration may be given to removing additional plasma from the platelet concentrate before transfusion or to giving group-compatible plasma rather than group-compatible platelets. A crossmatch is not necessary prior to platelet transfusion unless the platelet product contains many red blood cells.

(3) Rh antigens are not found on platelets; however, patients may become sensitized to Rh antigens from the red blood cells contaminating the platelet concentrate. The risk of forming anti-D has been shown to be approximately 8% after 80 to 110 units of platelets. Because of the life-threatening nature of most cases of thrombocytopenia, platelets from Rh-positive donors can be administered to Rh-negative recipients; however, Rh-negative women in the childbearing age with a nonmalignant disease should not receive platelet concentrates from Rh-positive donors because of the effect of possible anti-D on future pregnancy. Circulation of platelets from Rh-positive donors in recipients with preformed anti-D is normal; thus, the only concern is possible reaction to contaminating Rh-positive red blood cells. If the platelet concentrates are properly prepared, red blood cell contamination is 0.4 ml or less and, thus, a red cell hemolytic reaction would not be expected even in a recipient with a preformed anti-D antibody.

d. **Platelet Compatibility.** In addition to ABO antigens, platelets contain the HLA antigens found on most tissues of the body and additional antigens which are unique to platelets. Some patients may develop antibodies to these HLA or platelet antigens following transfusion, pregnancy, or organ transplantation. When this occurs, transfused platelets have a decreased recovery and a shortened intravascular survival. These transfused platelets are ineffective in controlling hemorrhage. Compatible platelets may be obtained by HLA-matching of patient and donor. The most likely source of HLA identical or compatible donors would be the patient's family; however, large files of HLA-typed donors are being developed for clinical research purposes. HLA-matching of patients with unrelated donors may become practical. HLA-matching using the lymphocytotoxicity assay may not be the best method of determining platelet compatibility; however, it is the only one currently available on even a limited scale. Thus, in patients who are unresponsive to the transfusion of platelets collected from random donors, selection of donors based on HLA-typing may provide platelets with better posttransfusion recoveries and survival.

e. **Administration of Platelets.**

(1) Patients with platelet or HLA antibodies may have febrile nonhemolytic reactions to incompatible platelets. These reactions may be caused by incompatible platelets or by leukocytes which invariably contaminate the platelet preparation. In addition, platelets may be trapped in the pulmonary capillaries causing dyspnea and pulmonary edema. This is particularly likely if aggregates of platelets are infused. If the platelets are properly prepared, they will contain very few aggregates.

(2) Platelet administration sets contain a filter which is similar to a standard blood filter but housed in a small drip chamber or a needle syringe device. Only approximately 3% of platelets are lost by passage through these filters. Microaggregate filters may trap a large proportion of platelets and should not be used for platelet administration.

3-33. BLOOD PRODUCTS USED TO REPLACE PLASMA COAGULATION FACTORS

a. Single Coagulation Factor Deficiency.

(1) Factor VIII.

(a) Deficiencies of coagulation factors may exist as isolated or combined deficiencies and may be acquired or inherited. Isolated inherited deficiencies of each of the coagulation factors have been described, although the most common is hemophilia A or Factor VIII deficiency. Opinions differ regarding the level of Factor VIII that is desirable to be attained in the management or prevention of bleeding episodes.

(b) One unit of Factor VIII equals the Factor VIII activity of 1 ml of fresh normal pooled plasma. Factor VIII levels are usually reported as a percentage of normal (table 3-4).

(c) In addition to cryoprecipitated Factor VIII and fresh-frozen plasma, a number of lyophilized preparations are available for treatment of Factor VIII deficiency. These preparations are assayed and labeled for Factor VIII activity and can be stored at 4° C for extended periods. Since they are made from large plasma pools, they may carry a higher risk of hepatitis than a comparable amount of Factor VIII administered as cryoprecipitate.

Table 3-4. Blood Components and Fractions Containing Factor VIII.			
Blood Components	Volume (ml)	Units* Factor VIII per Container	Units* Factor VIII per ml
Fresh whole blood (24 hr)	517.5	225	1.0
Fresh liquid plasma	225	225	1.0
Fresh-frozen plasma	225	190	.08
Cryoprecipitate	10	100	10.0
Commercial concentrate	20 to 30	200 to 1000	10 to 33
* One unit of Factor VIII is that amount of Factor VIII activity in 1 ml of fresh normal plasma.			

(2) *Factor IX.*

(a) Isolated inherited deficiency of Factor IX is called hemophilia B and is clinically similar to hemophilia A. Factor IX is stable when stored at 4° C or at -20° C. Thus, bank blood, liquid plasma, or fresh-frozen plasma can be used to replace Factor IX; however, it is difficult to replace large amounts of Factor IX because of the volume of these products.

(b) Within the past few years, commercial preparations containing concentrated Factor IX (II, VII, IX, X complex) have become available and can be used when large amounts of Factor IX must be administered. Disease transmission is a major risk of transfusion of Factor IX concentrates.

(3) *Fibrinogen.*

(a) Hypofibrinogenemia may occur as an isolated inherited deficiency or may be acquired associated with obstetrical complications, disseminated intravascular coagulation, and some forms of cancer. In acquired hypofibrinogenemia, treatment should be directed toward the underlying cause of disease rather than toward replacement of fibrinogen. Many physicians provide fibrinogen replacement during correction of the underlying disorder.

(b) Commercial fibrinogen preparations, formerly available, are no longer manufactured because of the high risk of transmitting hepatitis B. Cryoprecipitate is used as a source of fibrinogen for replacement therapy. Each bag of cryoprecipitate, from a single donor, contains approximately 250 mg of fibrinogen. A quality assurance program should be established so that this fibrinogen content will be known in each unit of cryoprecipitate.

b. Deficiency of Multiple Coagulation Factors.

(1) The most common combination deficiency of coagulation factors involves those dependent upon vitamin K for synthesis. Deficiency of these factors (prothrombin, VII, IX, X) most commonly occurs in patients with liver disease or lack of vitamin K. Inhibition of vitamin K may occur when excessive amounts of oral anticoagulant drugs (coumarin) have been taken. Vitamin K deficiency may occur when intestinal flora are reduced (neonates, antibiotic therapy), in malabsorption syndromes, or when bile fails to reach the intestinal lumen (bile duct obstruction, biliary fistula). This type of coagulation disorder is best managed by treating the underlying condition with or without vitamin K administration; however, the coagulation factors can be replaced using plasma of any age since those coagulation factors do not deteriorate during storage of whole blood at 1° C to 6° C.

(2) Commercial concentrates containing Factor IX (II, VII, IX, X complex) should not be used to replace an acquired deficiency of multiple factors because of the high risk of hepatitis that is associated with these concentrates.

c. Administration and Blood Group Compatibility of Products Used to Replace Coagulation Factors.

(1) In the transfusion of plasma products, procedures of patient blood product identification, venipuncture, infusion solutions, and the use of filters are the same as described for red blood cell transfusion. Since serious reactions may occur during the transfusion of plasma products, the nurse should obtain the patient's vital signs before initiating transfusion. The patient should be reevaluated approximately 15 minutes later to ensure that the transfusion is proceeding uneventfully and should be evaluated at the end of transfusion to determine whether any adverse reaction has occurred. The rate of administration should be as rapid as possible but this depends upon the patient's ability to tolerate the volume being infused. Fresh-frozen plasma need not be ABO-identical but should be compatible with the recipient's red blood cells and can be given without regard to Rh type. Compatibility testing is not necessary if fresh frozen plasma has been tested for unexpected red blood cell antibodies.

(2) Cryoprecipitate should also be administered as ABO-compatible whenever possible. Although the volume of each unit is small, most therapy involves many units, and, thus, the volume of plasma being infused becomes significant. Cryoprecipitate can be administered without regard to Rh type. While compatibility-testing is not necessary, ABO-incompatible cryoprecipitate and commercial concentrated preparations of Factor VIII contain anti-A and anti-B, which may cause a positive direct antiglobulin test and/or a hemolytic anemia if massive doses are administered. In addition, the recipient's fibrinogen may become elevated by the fibrinogen contained in the preparation.

3-34. PLASMA SUBSTITUTES

a. In recent years, plasma substitutes have become popular since they provide volume and colloid without the risk of hepatitis or acquired immunodeficiency syndrome (AIDS). Five percent normal serum albumin in saline and 5% plasma protein fraction (PPF) are available in 250 and 500 ML containers (see table 3-5). Except for electrolyte concentrations, they are quite similar. Both are useful for the treatment of hypovolemic shock, burns, and other clinical conditions in which both volume and colloid must be replaced. Albumin is also available as a concentrate with little sodium chloride added (25% salt-poor albumin). Considerable caution must be used since the albumin concentration may raise the oncotic pressure in the vessels dramatically, drawing large volumes of water from the tissues into the vascular space. This may, in turn, produce cardiac overload.

b. The value of any of these albumin solutions in the treatment of chronic hypoalbuminemic states such as cirrhosis or protein losing enteropathy has not been established.

Table 3-5. Plasma Substitutes.												
	Vol. (ml)	Protein		Electrolytes (mEq)			Coagulation Factors		Hepatitis Risk	Sensitization Risk	X-Match Interference	Storage (yr)
		Albumin	Globulin	Na	K	Cl	Stable	Labile				
Plasma preparations												
Single donor plasma	250	8.0-13.0	2.0-8.0	35	1	25	+		Yes	Occasionally	No	5
Single donor, fresh frozen plasma	250	8.0-13.0	2.0-8.0	35	1	25	+		Yes	Occasionally	No	1
Heat-treated protein preparations												
Normal serum albumin 5%	250	12.5	-	35	0	25	-		No	Rare	No	3
Normal serum Albumin (salt-poor)	50	12.5	-	5	0	3.5	-		No	Rare	No	3
Plasma protein Fraction	250	11	1.5	22.5	0.5	12.5	May cause bleeding		No	Rare	No	3
Plasma substitutes												
5% dextral 70	250	-	-	35	1	35	May cause bleeding		No	Yes	Yes	4
Gelatins	250	-	-	35	-	35	May cause bleeding		No	Yes	Possible	?
Hydroxyethyl starch 6%	250	-	-	35	-	35	May cause bleeding		No	No	Possible	?
Crystalloid												
Lactated Ringer's	250	-	-	35	1	27	-		No	No	No	Indefinite

3-35. SPECIAL SITUATIONS INVOLVING TRANSFUSION

a. Massive Transfusion.

(1) Massive transfusion can be defined as transfusion of the patient's blood volume during a 12-hour interval. The effects of massive transfusion upon the recipient may be due to the biochemical and functional characteristics of stored blood:

(a) Platelets deteriorate during storage of whole blood.

(b) Coagulation Factors V and VIII deteriorate during storage of whole blood.

(c) The oxygen saturation curve of hemoglobin shifts and oxygen is less readily released to the tissues.

(2) Transfusion of large amounts of blood depleted of platelets and Factors V and VIII may create deficiencies in the recipient because of dilution of the recipient's blood with this depleted stored blood. However, usually Factor VIII is rapidly replaced by the patient and Factor V levels do not fall below that needed for hemostasis. In addition, the hemostatic process which occurs in the bleeding patient consumes the patient's own platelets and coagulation factors and compounds the depletion state. Oxygen delivery by transfused cells stored more than two weeks in CPD may be diminished immediately following transfusion but oxygen release improves approximately 24 hours following transfusion.

(3) Patients undergoing massive transfusions should be followed closely with coagulation studies including a platelet count. If coagulation abnormalities or thrombocytopenia develop these deficiencies should be replaced with the appropriate blood components. It is usually not possible to correct these deficits with fresh whole blood. Fresh-frozen plasma, platelet concentrates, and red blood cells will also be more readily available than fresh whole blood. Coagulation Factor IX concentrates should not be used in these situations.

(4) Despite dilution of the patient's blood with donor plasma, continued compatibility-testing is recommended. If it is necessary to change to a different blood group in massive transfusion, the patient's history and clinical situation should be considered as well as the potential blood supply. It is sometimes more desirable to switch Rh types (for instance from Rh-negative to Rh-positive) than to switch ABO group. However, age and sex may also be important to consider. For example, when transfusing a young, Rh-negative woman, it is usually preferable to switch ABO groups, if feasible, before switching Rh.

(5) The likelihood of development of hypocalcemia resulting from the infusion of large amounts of citrate during massive transfusion has been overemphasized. Administration of calcium during massive transfusion is probably not necessary.

(6) Warming of blood may be necessary if large amounts of blood are being transfused rapidly.

b. Pediatric Transfusions.

(1) Transfusion indications are the same for children as for adults. If transfusions of small volumes of blood are to be administered, one donor unit can be collected into a multiple container and divided into small volumes as needed.

(2) Premature and newborn infants usually require very small volumes of blood such as 30 to 60 ml of whole blood or red blood cells, although an additional 30 ml is required to fill the administration set. In some hospitals, this has led to the use of "syringe" transfusions.

(3) Transfusion of small volumes of blood should be carried out at a facility where well trained personnel perform proper medical histories and pretransfusion and compatibility testing of the blood. Blood for these special transfusions can be collected into a multiple bag and divided; or 480 to 490 ml can be collected into a double bag and 30 to 60 ml removed into the satellite bag for pediatric transfusion. Small collection containers with CPD anticoagulant in 150 ml primary with a 150 ml satellite bag are now available. Thus, one donor could give up to three times during a 2-month interval and each donation split into two to four parts.

(4) Compatibility testing for neonates (newborn children less than a year old) are different from those for adults. Initial testing must include ABO and Rh typing of the neonatal recipient's red blood cells. An antibody screening test, which may be done either on the newborn or mother's serum or plasma, is also done. If the antibody screen is negative and group O or ABO specific, or compatible with both mother and child to include the same Rh type, then compatibility testing and further typing may be omitted during the first 4 months of life.

3-36. ADMINISTRATION OF BLOOD PRODUCTS

NOTE: Once a blood transfusion has been ordered, the procedure should be explained to the patient in order to minimize his apprehension. The following steps are important to ensure a safe and efficient transfusion.

a. Blood Administration Sets.

(1) Red blood cells, whole blood, platelets, granulocytes, fresh-frozen plasma, and cryoprecipitate should be administered through a filter because fibrin clots and other particulate debris may be present. Most standard blood and platelet filters have a pore size of approximately 170 to 260 micrometers, but there is some variation in the surface area of the filter and the arrangement of the filter and drip chamber. Filters with a larger surface area may allow more rapid infusion of red blood cells because, although the pore size is the same, there is more filtration area. The filter chamber

should be filled with blood in order to utilize all this surface area. The frequency with which filters should be changed depends upon the type of blood product being infused and, if red blood cells are involved, the age of the product. As debris accumulates on the filter, the rate of infusion is slowed. In addition, platelets may adhere to the debris on the filter.

(2) A single filter can usually be used for administration of 2 to 4 units of red blood cells. Because of the hazards of hemolysis and bacterial contamination, once a filter has been used and contains blood or debris, it should not be left for extended periods and then reused.

b. Venipuncture.

(1) Blood products should be administered intravenously although other routes (intraperitoneal, intra-arterial, intrabone marrow) are possible. A vein should be selected which will be large enough to accommodate the infusion needle but is comfortable for the patient. Veins in the antecubital fossa are probably more accessible and most widely used; however, infusion in these veins limits the patient's ability to flex the elbow during transfusion. Veins on the forearm or hand are equally suitable for infusion, although venipuncture in these areas is often more painful to the patient.

(2) The administration set should be cleared of air before venipuncture. Venipuncture can be performed with a needle attached to a syringe or attached directly to the blood administration set. Red blood cells or whole blood should be administered using a needle of 19 gauge or larger. Other blood products such as platelets, cryoprecipitate, fresh-frozen plasma, and albumin can be administered through smaller needles.

(3) For pediatric patients, blood is often infused through a 23-gauge, thin wall, scalp vein needle. Because the red blood cells may run slowly through a small needle, the unit may be divided in the blood bank. One part can be released for transfusion and the remainder of the unit stored in the blood bank. This prevents prolonged exposure of the red blood cells to room temperature.

c. Issuing the Blood Product.

(1) The venipuncture should be started before or at the time the blood component is being obtained from the blood bank. Thus, the blood component can be infused immediately after it has arrived at the nursing station, minimizing the chance of improper storage after the component leaves the blood bank.

(2) When the blood component is released from the blood bank the technologist should:

(a) Compare the ABO, Rh type, and unit number on the component labels with the same information on the compatibility or recipient tag.

(b) Compare the product name with the blood request form to be certain the component being released is the same as that ordered by the physician.

(c) Record the name of the individual to whom the component was released.

(d) Carry out the steps as in paragraphs 3-36a and b above.

d. Starting the Transfusion and Infusion Solutions.

(1) Blood products except platelets and thawed cryoprecipitate or fresh-frozen plasma should be stored in a regulated blood bank refrigerator until immediately before transfusion. Do not place blood components in the ward refrigerator or near a cold window, since freezing and thawing will cause red blood cell hemolysis. If the transfusion cannot be started shortly after the blood arrives at the nursing station, it should be returned to the blood bank for storage. Since it is impossible to monitor the temperature of the blood while it is outside the blood bank and to be sure that the blood has not reached a temperature higher than 10° C, it is customary to establish a time limit within which blood may be out of the control of the blood bank and returned for reissue. One study showed that blood in a room temperature environment required approximately 30 minutes to warm from 2° to above 6° C.

(2) Sodium chloride injection USP (normal saline) is the only solution suitable for use in the transfusion of blood products containing red blood cells, platelets, or leukocytes. "In vivo" hemolysis of red blood cells exposed to various IV solutions seems to be primarily dependent upon the amount of red blood cell swelling that occurs "in vitro." Five percent dextrose in water is not satisfactory for filling or flushing blood administration sets because red blood cell clumping and swelling with subsequent hemolysis may occur. Lactated Ringer's solution also is unsatisfactory because calcium in the Ringer's solution may cause the formation of clots. Great care must be taken to ensure that drugs which are toxic to blood components are not infused through the same administration set as the blood component.

(3) Sometimes it is difficult to infuse red blood cells because the high hematocrit decreases the flow rate. This problem can be avoided by adding normal saline to the red blood cell units at the time the transfusion is started. The technique is as follows:

(a) A Y-type infusion set must be used.

(b) Perform the venipuncture and begin the infusion with normal saline connected to one lead of the Y infusion set.

(c) The second lead of the Y infusion set should be clamped closed.

(d) Connect the unit of red blood cells to the second lead of the Y set.

(e) Lower the unit of red blood cells below the bottle of normal saline.

(f) Open the clamp on the lead to the red blood cells and allow the desired volume of saline to enter the unit of red blood cells. This volume will usually be 50 to 100 ml.

(g) Clamp the lead coming from the saline bottle.

(h) Hang the unit of red blood cells diluted with saline beside the bottle of normal saline.

(i) If it is desirable, the red blood cells remaining in the infusion set at the end of transfusion can be rinsed into the patient by opening the lead from the saline bottle.

e. Identification of Patient and Blood Product.

NOTE: Before beginning the transfusion, it is extremely important to identify correctly the patient and the blood product. It is necessary for two persons to carry out the steps listed below, thus, cross-checking the information.

(1) Identification of the blood product.

(a) Check the ABO group and Rh type on the label on the blood container to be certain it agrees with the compatibility record.

(b) Check the number on the label on the blood container to be certain it also agrees with the compatibility record.

(c) Check the blood compatibility record for the patient's name and hospital number.

(2) Identification of the patient.

(a) Check the name and hospital number on the patient's wrist identification band against the information on the compatibility record.

(b) When possible, ask the patient to identify himself by stating his name. Never ask, "Are you Mr. _____?"

(c) The personnel who identifies that the correct blood product is being administered to the patient should then sign the compatibility record and that record should be placed in the patient's chart at the completion of the transfusion as verifiers.

NOTE: Do not begin the transfusion until any discrepancy in the above information is resolved.

f. Rate of Infusion.

(1) The rate of infusion depends upon the clinical condition of the patient and the product being transfused. In most administration sets, 15 drops equals 1 ml. Most patients who are not in congestive heart failure or in danger of fluid overload tolerate the infusion of one unit of red blood cells in 1 2 to 2 hours.

(2) The transfusion should be completed in less than 4 hours because of the dangers of bacterial proliferation and red blood cell hemolysis at room temperature. If the desired volume of red blood cells will not be infused within 4 hours, the original unit should be divided and 1 portion stored in the blood bank until it is needed.

Section VI. INVESTIGATION OF ADVERSE EFFECTS

3-37. BACKGROUND

a. A transfusion reaction is any unfavorable event occurring in a patient during or following transfusion of blood products that can be related to that transfusion. Since compatibility-testing is performed for the detection of antibodies to red blood cell antigens, adverse effects of transfusion are most commonly caused by leukocytes, platelets, and plasma proteins. In addition, every transfusion carries a risk of alloimmunization as well as transmission of disease. All the care in crossmatching blood in the laboratory can be negated by the administration of blood to the wrong patient.

b. All transfusion reactions should be reported to the blood bank and evaluated to the extent considered appropriate by its medical director. Major adverse effects, e.g., hemolytic transfusion reactions and disease transmission, must be reported to the Center for Biologics Evaluation and Research (CBER), Food and Drug Administration (FDA).

c. Whenever a transfusion reaction involving more than just hives is suspected, the transfusion should be immediately discontinued, but the intravenous line kept open. The remaining blood, a new sample from the recipient, plus the reaction report should be sent to the blood bank for prompt investigation. The detailed clinical management of adverse effects of blood transfusion may be obtained elsewhere, but table 3-6 contains suggested treatment regimens.

Table 3-6. Management of Transfusion Reactions.

Findings	Treatment
Urticaria (hives) only	Intramuscular antihistamines
<p>Fever and/or chills.</p> <ol style="list-style-type: none"> 1. Examine patient's blood for: intravascular hemolysis (plasma red or pink caused by free hemoglobin) or extravascular hemolysis (direct antiglobulin test). 2. Examine donor plasma for bacteria and submit for culture. 	<ol style="list-style-type: none"> 1. Stop transfusion, keep I.V. open. 2. If laboratory tests are negative, treat with antipyretics. With positive findings, start prophylactic treatment as below:
<p>Shock, hemoglobinria, oliguria, and/or diffuse bleeding.</p>	<ol style="list-style-type: none"> 1. Stop transfusion, keep I.V. open. 2. Maintain blood pressure with vasopressor if necessary. 3. Maintain urine flow over 100 ml/hr. <ol style="list-style-type: none"> a. Mannitol 25 gm I.V.* or diuretic. b. Fluids. 4. Replace clotting factor deficits when indicated, e.g., with fresh- frozen plasma and/or platelets as appropriate. 5. Antibiotics and hydrocortisone for septic shock.
<p>* Infuse I.V. 100 cc of 25% mannitol solution within a 15 minute period. This dose will initiate a diuresis of 1 to 3 ml of urine per minute in an adequately hydrated patient. The same dose may be repeated if urine flow drops below 100 ml per hour for any subsequent 2-hour period. Mannitol may be discontinued when the patient can maintain a urine flow of 100 ml per hour without its use.</p>	
<p>SPECIAL NOTE: If the history, physical findings, and clinical course are such that a hemolytic transfusion reaction is suspected as highly probable, mannitol infusion should be started even prior to or concurrent with laboratory investigation, since under the conditions of use prescribed above, no direct adverse sequelae from the use of mannitol will occur. If diffuse bleeding is due to disseminated intravascular coagulation, consider using heparin before replacing clotting factor deficits.</p>	

3-38. IMMEDIATE EFFECTS

a. **Circulatory Overload.** Sudden increases in circulating blood volume are not well tolerated by certain patients, e.g., infants and individuals with chronic anemia. Whole-blood transfusion or volume expanders like 25% albumin may precipitate congestive heart failure manifested by coughing, cyanosis, and difficulty in breathing. Congestive heart failure because of circulatory overload may be the most preventable adverse effect of transfusion therapy, although it is infrequently reported to the laboratory. Patients susceptible to circulatory overload should be transfused with concentrated red blood cells at a rate no faster than 1 ml per kilogram of body weight per hour.

b. Febrile Nonhemolytic Reactions.

(1) Febrile reactions, often preceded by chills, constitute the bulk of transfusion reactions investigated by the blood bank. These reactions are generally considered to be a result of cytotoxic or agglutinating antibodies in either donor or recipient plasma directed against antigens present on lymphocyte, granulocyte, or platelet cell membranes. While reactions are usually mild and result principally in recipient anxiety and discomfort, in rare instances pulmonary infiltrates, leukopenia, shock, and even death have been reported. Leukocyte-poor (or frozen, thawed, washed) red blood cells should probably be given to recipients who display two or more chill/fever reactions to transfused red blood cells.

(2) Chills and fever, primarily a result of the leukocytes contaminating platelet concentrate preparations, may be seen in patients who receive repeated platelet transfusions. Removal of leukocytes from platelet concentrates may diminish febrile responses in immunized recipients and improve posttransfusion platelet recovery and survival. The use of HLA-compatible or identical donors may also be effective in preventing reactions and in improving posttransfusion platelet recovery and survival in immunized recipients. Chill/fever reactions are frequently seen during transfusion of granulocytes collected by filtration leukapheresis and, to a lesser extent, those prepared by differential centrifugation.

c. Allergic Reactions.

(1) Allergic reactions following blood or plasma transfusions occur less frequently than leukocyte chill/fever reactions and are usually relatively mild. Most consist of local erythema, hives, and itching, which develop during transfusion and which can be easily treated with, or prevented by, administration of antihistamines.

(2) More severe reactions characterized by flushing, nausea and vomiting, diarrhea, changes in blood pressure, and frank anaphylaxis have been reported in persons without immunoglobulin A (IgA). These patients have developed IgG antibodies against IgA and react to all blood products containing IgA, e.g., plasma. Patients with known anti-IgA antibody should be transfused only with blood or plasma

obtained from themselves or from other IgA-deficient donors or with extensively washed red blood cells.

NOTE: The American National Red Cross, Washington, D.C., AABB Rare Donor file, and Canadian Red Cross, Toronto, Ontario, maintain registries of IgA-deficient donors. While an antihistamine, e.g., diphenhydramine (Benadryl), may be sufficient for some allergic reactions, use epinephrine for any anaphylactic reactions.

d. Hemolytic Transfusion Reactions.

(1) Hemolysis of transfused red blood cells occurs infrequently but may cause a severe reaction accompanied by hemoglobinemia, hemoglobinuria, hypotension, disseminated intravascular coagulation, acute renal failure, and death. Initial recipient symptoms are not diagnostic of hemolysis and often consist of flushing, a feeling of apprehension, chest or back pain, chills, fever, and nausea or vomiting. During anesthesia, the development of diffuse bleeding may be the only evidence of a hemolytic reaction. Red blood cell destruction may be primarily intravascular, as seen with ABO-incompatible red blood cell infusion, or predominantly extravascular as in Rh incompatibility. Intravascular hemolysis usually occurs much more rapidly and is more likely to result in recipient harm than the relatively slow extravascular removal of red blood cells by the reticuloendothelial system. A late complication of acute hemolytic transfusion reactions may be renal failure.

(2) All transfusion reactions should be investigated, primarily to detect the small number of reactions in which there is hemolysis (primarily caused by destruction of transfused erythrocytes). The investigation described below is applicable to most transfusion reaction workups (see table 3-7). If a reaction occurs which involves more than just urticaria, the blood infusion should be stopped immediately but the intravenous line should be kept open, e.g., with physiologic saline. If urticaria (hives) is the **only** manifestation of a transfusion reaction, treatment with an antihistamine will usually suffice; this is the only situation in which the blood can continue to be infused. Next, a properly identified sample of blood (preferably an anticoagulated **and** a clotted sample) obtained from the recipient, the blood bag (clamped or sealed off), and the compatibility slip should be sent to the blood bank with a description of the transfusion reaction.

(a) The first thing blood bank personnel must do is a "clerical" check of the labels and preissue records. If the "wrong" unit of blood was issued, much of the further testing and activity may be totally unnecessary. Record these "paper" findings.

(b) Second, the post-reaction, anticoagulated sample should be examined for evidence of hemolysis and the direct antiglobulin test performed. If there is no hemolysis and the direct antiglobulin test is negative, it is unlikely that a hemolytic reaction has occurred; however, if hemolysis is noted in the post-reaction specimen, or if the direct test is positive (and was negative prior to transfusion), the physician caring

for the recipient should be notified immediately so that he may begin appropriate therapy. Then the blood bank should search further for the etiology.

Table 3-7. Schedule of Investigation of Suspected Transfusion Reactions.		
<p>1. Clerical check for "paper" errors, e.g., blood to the wrong patient.</p> <p>2. Specimens needed:</p> <ol style="list-style-type: none"> Pre-reaction blood of recipient. Post-reaction blood of recipient (anticoagulated and clot tubes). Blood from integral donor tubing or container implicated in reaction. Posttransfusion urine (<u>spun</u> specimen). <p>3. Investigation procedures (letters refer to specimens listed above):</p>		
Immediate	Definitive	Corroborative
Examine for visible hemolysis (a,b,c,d).+	Repeat crossmatch (a,b,c)	Identification of any unexpected antibody or incompatibility. Bacteriologic smear and culture (c).
Repeat ABO (a,b,c). Repeat Rh (a,b,c). Direct antiglobulin test (a,b).	Repeat antibody-screening (a,b,c).	Optional: haptoglobin (a,b). methemalbumin (a,b). bilirubin (b). creatinine. Direct antiglobulin test (c).
Adapted from Huestis, Bove, and Busch. With permission from Little, Brown, and Co.		
* The procedures and specimens listed are applicable to most situations. Of course, circumstances may vary and require different approaches in particular cases.		
+ Examine the anticoagulated tube from b as it is less likely than the clot tube to show spurious "in vitro" hemolysis and can be more rapidly evaluated (spin and observe).		
Verify the presence of the implicated rbc antigen on the donor cells (c) and the lack of this antigen on the recipient's cells (a) for any identified antibody in (b). Absence of a <u>donor</u> antigen posttransfusion, which the patient lacked pretransfusion, is also evidence that the donor unit has been eliminated; this may also be reflected in the failure of the anticipated rise in hemoglobin in the recipient after the transfusion.		

(c) Third, a complete evaluation should be initiated. This evaluation should include a crossmatch, using both prereaction and post-reaction serum samples versus red blood cells from integral tubing or obtained from inside the blood bag. The ABO (direct and reverse) and Rh type of the recipient and the cells in the bag should also be (re)determined; the plasma in the bag should be examined for the presence of hemolysis, which may indicate improper handling of the blood following collection or the presence of bacterial contamination. If the latter is suspected, the unit of blood should be cultured at both 37° C and at room temperature. **Remember, hemolysis may occur without serologic evidence of incompatibility.**

(3) Two minor points to keep in mind regarding evaluation of a hemolytic transfusion reaction are (1) testing for haptoglobin and (2) follow-up serologic tests if no red blood cell antibody is detectable. With visible hemolysis, the haptoglobin-binding capacity of serum is already exceeded and the level is nil. Documenting this absence of haptoglobin is thus rarely of value. If no antibody is detected at the time of hemolysis because of immune destruction of red blood cells, it may have all been consumed during the reaction. Testing serum samples drawn a few days later will often reveal the amnestic return of the antibody.

e. **Reactions Caused by Bacterial Contamination.**

(1) Contamination of blood or components with bacteria occurs very rarely. Transfusion of blood with bacteria may produce a severe and life-threatening reaction characterized by the rapid onset of chills, high fever, vomiting, diarrhea, marked hypotension, and often acute renal tubular necrosis. In the past, most severe reactions were caused by gram-negative organisms capable of proliferating at refrigerator storage temperatures; gram-positive organisms were infrequently implicated, presumably because of their inability to multiply at those temperatures. Open procedures for leukapheresis, plateletpheresis, red blood cell glycerolization, and deglycerolization all have the potential for introduction and proliferation of bacteria; components prepared by these techniques must be used within 24 hours. Contamination of I.V. solutions or wash solutions used with blood components should also be considered when a reaction to bacteria is suspected.

(2) Blood should be examined routinely to detect evidence of bacterial contamination; look for an unusual color or the presence of hemolysis. **If bacteria are suspected to be the cause of a transfusion reaction, the blood from the bag, the patient, and all IV solutions used should be cultured.** Although the appearance of microorganisms on a gram-stained smear provides proof of bacterial presence, the absence of visible microorganisms does not rule out the possibility of contamination of a blood product.

3-39. DELAYED EFFECTS

a. **Hemolytic Transfusion Reactions.** Delayed hemolytic reactions occur and usually result in extravascular removal of transfused cells from the circulation days to weeks following transfusion. Occasionally, abrupt intravascular hemolysis may occur with certain antibodies, such as anti-JK^a and anti-JK^b. Cells that were compatible at the time of infusion may be destroyed following antibody production. The direct antiglobulin test is usually positive although the indirect antiglobulin test may be negative until all transfused cells have been eliminated from the circulation. In general, delayed reactions, except for the very uncommon ones that produce intravascular hemolysis, tend to be asymptomatic and are only manifested by a mild, gradual anemia and a transiently positive direct antiglobulin test.

b. **Viral Hepatitis.** The occasional occurrence of posttransfusion hepatitis remains a serious consequence of blood transfusion. There is currently no known, completely effective method for detecting the infectivity of all blood products capable of transmitting hepatitis. A system for recording and reporting all cases of suspected posttransfusion hepatitis is required.

c. **Autoimmune Deficiency Syndrome (AIDS).** AABB and FDA have made recommendations to reduce the potential spread of AIDS through blood transfusion. These recommendations are as follows: (1) transfusion of blood and blood components should be given only for clear medical indications; (2) blood donors should be carefully screened and individuals in high-risk groups should be educated to abstain from donation; and (3) autologous transfusion should be employed as widely as possible. The safety of the blood supply is fortified by a 4-point program: (1) voluntary blood donation, (2) careful medical history and physical examination to eliminate high risk donors, (3) a sensitive test for HIV Ag/Ab, and (4) a confidential self-exclusion procedure.

d. **Other diseases.** An infectious mononucleosis-like syndrome characterized by splenomegaly, atypical lymphocytes, and fever, thought to be caused by cytomegalovirus infection, is occasionally seen following transfusions of large amounts of blood. Diseases such as malaria and syphilis can be transmitted by transfusion. The importance of the medical history in rejecting donors with inapparent malaria cannot be overestimated as there is no practical laboratory screening test to detect donors with malaria. Since the treponemal spirochete does not survive 72 hour refrigeration, fresh blood or other blood products such as platelet concentrates which are not stored refrigerated prior to use have the greatest risk of syphilis transmission.

e. **Alloimmunization.** The transfusion of blood products always entails exposure to foreign antigens. Immunization to red blood cell, platelet, leukocyte, and protein antigens may occur against those antigens which the patient lacks.

3-40. RECORDS OF TRANSFUSION COMPLICATIONS

Federal regulations require that fatalities attributed to transfusion complications, e.g., hemolytic reactions or viral hepatitis, and transfusion associated AIDS, be reported to CBER of the Food and Drug Administration. In addition, records must be kept of reports of transfusion complications (including those investigated) and cases of transfusion associated hepatitis AIDS for periodic reporting to the FDA.

Continue with Exercises

EXERCISES, LESSON 3

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. When an antigen enters the body, the response may be humoral or:
 - a. Delayed.
 - b. Cellular.
 - c. Immediate.
 - d. Anaphylactic.

2. Which antiglobulin test is used in diagnosis of hemolytic disease of the newborn and autoimmune hemolytic anemia?
 - a. Direct.
 - b. Indirect.

3. Which antiglobulin test is used in crossmatching, detection of unexpected antibodies, and detection of antigens not identifiable by other means?
 - a. Direct.
 - b. Indirect.

4. What is the reason for a false negative result if an inadequate washing of cells for antiglobulin test is done?
 - a. Complement blocks the action of antiglobulin.
 - b. Contaminants block the reaction sites of red cell antibodies.
 - c. Trace amounts of residual globulin neutralize antiglobulin serum.
 - d. The electronegativity of the red cells repels the antiglobulin molecules.

5. Before crossmatching, what should be known about the recipient?
- Rh type.
 - ABO group.
 - Results of previous testing.
 - Results of antibody screening test.
 - All the above.
6. What components are used to perform a crossmatch?
- The donor's cells and the donor's serum.
 - The recipient's serum and the donor's cells.
 - The recipient's serum and the donor's serum.
 - The recipient's cells and the donor's serum.
7. The person performing a crossmatch procedure realized the donor was group O and the recipient was group A with no evidence of unexpected antibodies. At which phase of the procedure would you expect to see a reaction?
- When the albumin is at 37° C.
 - Immediately during the spin of saline.
 - Immediately during the spin of the albumin.
 - None of the above.
8. A crossmatch will detect:
- Most Rh typing errors.
 - All ABO grouping errors.
 - All unexpected antibodies.
 - Antibodies in the recipient's serum which react with antigens on the donor's red cells.
 - All the above.
9. Great care must be taken during collection of the recipient's blood to ensure positive identification of the:
- Donor's ABO group and Rh type.
 - Donor and donor unit of blood.
 - Patient's ABO group and Rh type.
 - Patient and patient blood sample.

10. What must be done during pretransfusion testing if a discrepancy is noted between the blood request form and the label on the recipient's blood sample?

- a. Cancel the transfusion.
- b. Draw a new blood sample.
- c. Relabel the blood sample.
- d. Rewrite the blood request form.

11. For pretransfusion testing, the recipient's serum should be less than days old to help ensure the presence of complement.

- a. 3.
- b. 4.
- c. 6.
- d. 8.

12. Units of blood held for several days must be recrossmatched with a new serum specimen if the last transfusion given was over _____ hours.

- a. 12.
- b. 24.
- c. 48.
- d. 72.

13. The donor and recipient should have the same ABO group and Rh type **EXCEPT** when there is:

- a. Unavailability of such blood.
- b. ABO or Rh hemolytic disease.
- c. All the above.

14. After transfusion of nongroup-specific blood, changing to group-specific blood is permitted only if crossmatches with a freshly drawn patient sample indicate:

- a. Compatibility.
- b. Incompatibility.

15. A full crossmatch includes:
- A 37° C phase.
 - An antiglobulin serum phase.
 - A room temperature phase (saline).
 - All of the above.
16. After addition of sensitized cells to a negative crossmatch, the antiglobulin test must be repeated if there is:
- Agglutination.
 - No agglutination.
17. If there is no time to determine the patient's blood group, group O Rh-negative blood may be given if:
- Most of the plasma is removed.
 - An emergency release form is signed.
 - All the above.
18. Once uncrossmatched blood has been released for transfusion, you should the crossmatch.
- Complete.
 - Discontinue.
19. Transfusions are most commonly given to restore:
- Nutrients and oxygen.
 - White blood cells and antibodies.
 - Immunity and platelets for clotting.
 - Blood volume or red blood cells for oxygen transport.
20. Blood transfusions should be used only _____ since they may suppress erythropoiesis (production of red cells).
- In anemia.
 - After surgery.
 - As a last resort.
 - When erythropoiesis is normal.

21. What is the product of choice for a patient with severe anemia requiring restoration of oxygen-carrying capacity?

- a. Platelets.
- b. Whole blood.
- c. Red blood cells.
- d. A plasma substitute.

22. What are the disadvantages of frozen red cells?

- a. Loss of cell viability and damage to proteins.
- b. Additional cost and limited storage period after thawing.
- c. Difficulties of running tests and of assessing viability.
- d. Lack of experience with an inadequate research of their use.

23. Why does the largest group of patients receive platelet transfusions when they have thrombocytopenia? This is because of:

- a. Hemophilia.
- b. Massive blood loss.
- c. Chemotherapy for malignancy.
- d. Tissue damage requiring large amount of clotting.

24. What is one advantage of commercial plasma substitutes (plasma protein fraction of 5% Albumin in saline).

- a. No risk of hepatitis.
- b. Usefulness in severe anemias.
- c. The presence of most clotting factors.
- d. Usefulness in congestive heart failure.

25. Which route should blood products be administered?

- a. Intravenous.
- b. Intradermal.
- c. Intramuscular.
- d. Intra-arterial.

26. What is the only fluid used for flushing and filling blood administration sets?
- Dextrose and Ringer's injection.
 - Dextrose injection (5% in water).
 - Dextrose and sodium chloride injection.
 - Sodium chloride injection (normal saline).
27. Which specimen is needed to investigate suspected transfusion reactions?
- Post-reaction sample of recipient's urine.
 - Pre- and post-reaction samples of the patient's blood.
 - Blood from integral donor tubing or implicated container.
 - All the above.
28. Whenever bacterial contamination is suspected as the cause of a transfusion reaction, it is necessary to perform a microscopic examination and culture of the:
- Donor pilot sample.
 - Recipient's pre-reaction blood sample.
 - Recipient's post-reaction urine.
 - Blood from the bag and from the patient.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 3

1. b (para 3-4)
2. a (para 3-13b(1) and (2))
3. b (para 3-14b)
4. c (para 3-18a(1))
5. e (paras 3-20a, 3-22b)
6. b (para 3-25c)
7. d (Table 3-2)
8. d (para 3-20d)
9. d (para 3-21)
10. b (para 3-22)
11. a (para 3-22a(1))
12. d (para 3-22a(2))
13. c (para 3-23a(1)(a) and (b))
14. a (para 3-23c(1))
15. d (para 3-25c)
16. b (para 3-25c Step 8)
17. c (para 3-29b(1), (1)(a))
18. a (para 3-29b(2))
19. d (para 3-31a(1))
20. c (para 3-31a(2))
21. c (para 3-31b(2)(a))
22. b (para 3-31b(4))

23. c (para 3-32a(1))

24. a (para 3-34a)

25. a (para 3-36b(1))

26. d (para 3-36d(2))

27. d (Table 3-7)

28. d (para 3-38e(2))

End of Lesson 3

GLOSSARY

AABB: American Association of Blood Banks. It is a blood bank accrediting agency.

Acquired Immunodeficiency Syndrome (AIDS): The HIV virus infects monocytes and helper T cells producing a wide range of cellular immunologic defects.

Adsol: Anticoagulant (CPD plus additive solution).

Adulterated: Made inferior or impure.

Agglutination: The clumping together of red blood cells or any particulate matter resulting from interaction of antibody and its corresponding antigen.

Aggregate: A cluster or clump.

AJBPO: Area Joint Blood Program Office. Manages blood issues in a specific geographical area.

Albumin: The protein found in the highest concentration in human plasma. It is used as a diluent for blood typing antisera and potentiator solution in serologic testing to enhance antigen-antibody reactions.

Allo: Prefix indicating differences within a species. For example, an alloantibody is produced in one individual against the red cell antigens of another individual.

Allogeneic: Blood or blood products donated for transfusion to the general public.

Anamnestic Response: An accentuated antibody response following a secondary exposure to an antigen. Antibody levels from the initial exposure are not detectable in the patient's serum until the secondary exposure, when a rapid reissue in antibody titer is observed.

Anaphylaxis: An allergic hypersensitivity reaction of the body to a foreign protein or drug.

Anemia: A condition in which there is reduced O₂ delivery to the tissues. It may result from increased destruction of red cells, excessive blood loss, or decreased production of red cells.

Antibody (Ab): A protein substance developed in response to, and interacting specifically with, an antigen. In blood banking, it is found in serum, from either a commercial manufacturer or a patient. It is secreted by the plasma cells.

Antibody Screen: Testing the patient's serum with group O reagent red cells in an effort to detect atypical antibodies.

Anticoagulant: An agent that prevents or delays blood coagulation.

Antigen (Ag): A substance that is recognized by the body as being foreign, thus it can elicit an immune response. In blood banking, antigens are usually found on the blood cell membrane.

Antihemophilic Factor (AHF): Term that is sometimes used to describe cryoprecipitate as well as commercially prepared Factor VIII concentrates.

Antihuman Globulin Test : Test to ascertain the presence or absence of red cell coating by immunoglobulin (IgG) and/or complement. A positive result is agglutination. **DAT (direct)** detects *in vivo* cell sensitization and **IAT (indirect)** detects Ag-Ab reactions that occur *in vitro*.

Antihuman Globulin (AHG): An antibody prepared in rabbits or other suitable animals that is directed against human immunoglobulin and/or complement. It is used to perform the antihuman globulin or Coombs' test. The serum may be either polyspecific (anti-IgG and anti-complement) or monospecific (either anti-IgG or anti-complement).

AO: Area of Operations.

Apheresis: A method of blood collection in which whole blood is withdrawn, a desired component separated and retained, and the remainder of the blood returned to the donor.

AS-1: Anticoagulant Adsol (CPD plus additive solution) of Fenwal that has a shelf life of 42 days. Several BDCs within DOD were licensed for AS-1 in 1996.

AS-5: Anticoagulant Adsol (CPD plus additive solution) of Terumo that has a shelf life of 42 days. Several BDCs within DOD were licensed for AS-5 in 1996.

ASBP: Armed Services Blood Program directed by the ASBPO.

ASBPO: Armed Services Blood Program Office. A tri-Service staffed DOD field operating agency responsible for ensuring implementation and coordination of ASD(HA)-established blood program policies and management of blood resources.

ASD(HA): Assistant Secretary of Defense (Health Affairs).

Asymptomatic: Without symptoms.

ASWBPL: Armed Services Whole Blood Processing Laboratory. There are two: ASWBPL- East is at McGuire AFB, NJ and ASWBPL-West is at Travis AFB, CA. Ships blood from CONUS to TO.

Atypical Antibodies: Any antibody other than anti-A, anti-B, or anti-A,B (naturally occurring antibodies).

Auto-: Prefix indicating self.

Babesiosis: A disease caused by the intraerythrocytic parasite *Babesia microti*.

BBP: Blood Bank Platoon; part of a MEDLOG Bn.

BDC: Blood Donor Center. Service operated; collects and manufactures blood products.

BLDSHIPREP: Blood Shipment Report. Used to notify receiving facility of a blood shipment to include approximate arrival time and place, contents of shipment, tracking information and POC. Uses USJMTF standard format.

BLDREP: Blood Report. Due as of 2359Z everyday during a contingency operation from each level of the blood distribution system to document current inventory and future requirements. Uses USJMTF standard format.

Blood Establishment: Facilities which manufacture blood and blood products, includes blood collection and processing facilities as well as those facilities primarily involved in the transfusion of blood products.

Bombay: Individuals who possess normal A or B genes, but are unable to express them because they lack the gene necessary for production of H antigen, the required precursor for A and B. They often have a potent anti-H in their serum which reacts with all cells except other Bombays.

BPD: Blood Product Depot. Facilities that store frozen blood; may also serve as a BSU.

BSU: Blood Supply Unit.

BTC: Blood Transshipment Center. Located at an airhead and operated by the USAF; may receive and store up to 7200 units of blood (2 pallets).

Buffy Coat: The red cells settle to the bottom and, between the plasma and the red blood cells, there is a light-colored layer that contains mostly white blood cells, which is the buffy coat.

CAP: College of American Pathologists. It is a laboratory certifying agency.

CBER: Center for Biologics Evaluation and Research, the branch of the FDA that oversees blood manufacture and practices.

CCBC: Council of Community Blood Centers.

CGMP: Current Good Manufacturing Practices are the methods used in, and the facilities or controls used for, the manufacture, processing, packing, or holding of a drug (including, but not limited to, blood products) to ensure that such product meets the requirements of the Food, Drug and Cosmetic (FD&C) Act as to safety; and that it has the identity and strength, and meets the quality and purity characteristics that it purports or is represented to possess.

Chagas Disease: Disease endemic in South and Central America, which is caused by the protozoan parasite *Trypanosoma cruzi*.

Codabar: Bar code symbology currently in use to produce bar codes for blood product labels.

Code 128: Bar code symbology to be used with blood labels. Code 128 is replacing Codabar.

CMV: Cytomegalovirus. One of a group of species-specific herpes viruses.

Collins Box: DOD shipping container. Will maintain temperatures of 1 to 10° C for 30 units of RBCs, packed with 14 pounds of wet ice, for 48-72 hours.

COMMZ: Communications Zone of the battle field (echelon IV).

Compatibility Testing: All pretransfusion testing performed on a potential transfusion recipient and the appropriate donor blood. This testing is an attempt to ensure that the product will survive in the recipient and induce improvement in the patient's clinical condition. The crossmatch is between recipient's serum and donor's cells.

Complement: A series of proteins in the circulation that, when sequentially activated, causes disruption of cell membranes. Activation occurs via one of two pathways, and once activated, the components are involved in a great number of immune defense mechanisms including anaphylaxis, chemotaxis, and phagocytosis. Red cell antibodies that activate complement may be capable of causing hemolysis.

Component Therapy: Transfusion of specific components for treating a patient rather than whole blood. These components, such as red blood cells, platelets, and plasma, are separable by physical means, such as centrifugation.

CONUS: Continental US.

Cord Cells: Fetal cells obtained from the umbilical cord at birth.

CPD: Citrate phosphate dextrose is the anticoagulant preservative solution. It has been replaced by CPDA-1 in routine use. It has a shelf life of 21 days.

CPDA-1: Citrate phosphate dextrose adenine is the anticoagulant preservative solution most commonly used by DOD. It has a shelf life of 35 days.

Critical Control Point: Area that affects the safety and quality of blood if not performed correctly.

Crossmatch: Testing a patient and prospective donor for compatibility. Recipient serum is tested with donor cells.

Cryoprecipitate (CRYO): A concentrated source of coagulation factor VIII prepared from a single unit of donor blood. The product also contains fibrinogen, factor XIII and von Willebrand's factor.

Cryoprotectant: A substance that protects blood cells from damage caused by freezing and thawing. Glycerol and DMSO are examples.

CSH: Combat Support Hospital.

CUE: Confidential Unit Exclusion. A bar code or eye readable flag that the donor thinks their blood may not be safe for transfusion. A method for a donor to anonymously self-exclude.

Cytopheresis: A procedure utilizing a machine by which one can selectively remove a particular cell type normally found in peripheral blood of a patient or donor.

DA: Department of the Army.

DBSS: Defense Blood Standard System (computer system).

DD Form 572: Blood Donation Record.

DD Form 573: Shipping Inventory of Blood Products.

DDR: Donor Deferral Registry. An FDA required document, used to preclude drawing or using units from previously deferred donors.

Deglycerolization: Removal of glycerol from a unit of red cells after thawing. Required to return the cells to a normal osmolality.

DEPMEDS: Deployable Medical Systems. A modular hospital system. Portions may be deployed separately.

DOD: Department of Defense.

Donor: An individual who donates blood.

Dosage: A phenomenon where by an antibody reacts more strongly with a red cell carrying a double dose (homozygous) rather than a single dose (heterozygous) of an antigen, e.g. CC rather than Cc.

DMOC: Division Medical Operations Center.

DMSO: (1) Division Medical Supply Office: will store and distribute blood in the division area. (2) Dimethyl sulfoxide: a cryoprotectant.

EAC: Echelons above Corps.

EIA or ELISA: Enzyme-linked immunosorbent assay. The methodology most BDCs employ to test for infectious disease markers.

Endemic: A disease that occurs continuously in a particular population but has a low mortality; used in contrast to epidemic.

Enzyme: A substance capable of catalyzing a reaction. Proteins that induce chemical changes in other substances without being changed themselves.

EPA: Environmental Protection Agency.

FDA: Food and Drug Administration. Has jurisdiction over the blood industry.

FDA Form 483: Report document upon which citations for violations of FDA regulations, including GMP violations, are recorded.

Febrile Reaction: A transfusion reaction caused by leukoagglutinins that is characterized by fever of 1 C or 2 F or more.

FFP: Fresh Frozen Plasma. A frozen plasma product from a single donor that contains all clotting factors, especially the labile factors V and VIII. Useful for clotting factor deficiencies other than hemophilia A and hypofibrinogenemia.

FH: Field Hospital. A hospital located in the rear that is used to hold patients until they can be evacuated out.

Gamma Globulin: A protein found in plasma and known to be involved in immunity.

Glycerol: A cryoprotectant agent.

Glycerolization: Adding glycerol to a unit of red cells for the purpose of freezing.

Gonorrhea: A sexually transmitted disease that causes inflammation of the genital mucous membranes. Infection is caused by *Neisseria gonorrhoea*.

Graft-versus-Host Disease (GVD): A disorder in which the grafted tissue (lymphocytes) attacks the host tissue.

HBcAg: Hepatitis B core Antigen, referring to the nucleocapsid of the virion.

HBeAg: Hepatitis B envelope Antigen, DNA polymerase of the nucleus of the virion.

HBsAg: Hepatitis B surface Antigen.

Hematocrit: The percentage of red cells in whole blood.

Hematoma: A swelling or mass of blood confined to an organ, tissue, or space and caused by a break in a blood vessel (may be due to phlebotomy).

Hemoglobin: The iron containing pigment of the red blood cells. Its function is to carry O₂ from the lungs to the tissues.

Hemolytic Disease of the Newborn (HDN): A disease characterized by anemia, jaundice, enlargement of the liver and spleen, and generalized edema (hydrops fetalis). Due to maternal IgG antibodies that cross the placenta and attack fetal red cells when there is a feto-maternal blood group incompatibility. Usually caused by ABO or Rh antibodies.

Hemophilia: An hereditary blood disease characterized by greatly prolonged coagulation times. There are 3 types, which are due to deficiencies of Factor VIII, IX, and XI.

Hemorrhage: Abnormal internal or external bleeding.

Hepatitis: Inflammation of the liver.

Hepatitis B Immune Globulin (HBIG): An immune serum given to individuals exposed to the hepatitis B serum (NOT given prophylactically).

HIV: Human Immunodeficiency Virus. The causative agent of AIDS.

HLA: Human Leukocyte Antigen.

HTLV: Human T-Cell Lymphotropic Virus.

HTR: Hemolytic Transfusion Reaction.

Icterus: A condition characterized by yellowish skin, eyes, mucous membranes, and body fluids caused by deposition of excess bilirubin.

Immunodeficiency: A decrease from the normal concentration of immunoglobulins in serum.

Incubation: *In vitro* combination of antigen and antibody under certain conditions of time and temperature to allow antigen-antibody complexes to occur.

Intraoperative salvage: A procedure to reclaim a patient's blood loss during an operation by reinfusion.

Intravascular: Within the blood vessel.

ISBT: International Society of Blood Transfusion.

In vitro: In a test tube.

In vivo: In the living body.

Jaundice: A condition characterized by yellowing of the skin and the whites of the eyes. One cause is excess hemolysis, which results in increased circulating bilirubin. Another cause is liver damage caused by hepatitis.

JBPO: Joint Blood Program Office. Manages blood at the unified command level.

Key Element: Individual step for each control point.

Leishmaniasis: Infection with a species of *Leishmania* affecting the skin, nasal cavities, and pharynx.

Low-Ionic-Strength Solution (LISS): A type of potentiating medium in use for serologic testing. Reducing the ionic affinity of the antigen for its corresponding antibody such that sensitivity can be increased and incubation time can be decreased. The solutions contain glycine and glucose in addition to saline.

Malaria: An acute and sometimes chronic infectious disease caused by the presence of parasites within red cells. The parasite is *Plasmodium*, which is introduced through bites of infected female *Anopheles* mosquitoes or through blood transfusion.

Manufacture: All steps in the manufacture and preparation of products and includes, but is not limited to, filling, testing, labeling, packaging and storage by the manufacturer.

MASH: Mobile Army Surgical Hospital.

MEDLOG Bn: Medical Logistics Battalion.

Mixed Field: A type of agglutination pattern in which there are numerous small clumps of cells amid a sea of free cells.

MSBOS: Maximum Surgical Blood Ordering Schedule. Specifies type and screen or number of units crossmatched for a particular procedure.

Mosaic: An antigen that is composed of several subunits, such as the D antigen. A mixture of characteristics that may result from a genetic crossing over or mutation.

MTF/MTE: Medical Treatment Facility (USA) / Medical Treatment Element (USAF).

Multiparous: Having borne more than one child.

Neonate: A newborn infant up to 6 weeks of age.

Neutralization: Inactivating an antibody by reacting it with an antigen against which it is directed. Methodology of HIV-1 Ag and HBsAg confirmation tests.

NIST (or NBS): National Institute of Standards and Technology (old title: National Bureau of Standards).

Nonresponder: An individual whose immune system does not respond well in antibody formation to antigenic stimulation.

OCONUS: Outside the continental U.S.

Panagglutinin: An antibody capable of agglutinating all red blood cells tested, including the patient's own cells.

Pancytopenia: A reduction in all cellular elements of the blood, including red cells, white cells, and platelets.

Panel: A large number of group O reagent red cells that are of known antigenic characterization and are used for antibody identification.

Phlebotomy: To take blood from a person.

Plasma: The liquid portion of whole blood containing water, electrolytes, glucose, fats, proteins, and gases. Plasma contains all the clotting factors necessary for coagulation, but in an inactive form. Once coagulation occurs, the fluid is converted to serum.

Platelet: A round or oval disk, 2-4 microns in diameter, that is derived from the cytoplasm of the megakaryocyte, a large cell in the bone marrow. Platelets play an important role in blood coagulation, hemostasis, and blood thrombus formation. When a small vessel is injured, platelets adhere to each other and the edges of the injury and form a plug that covers the area and stops the loss of blood.

Platelet Concentrate (PC): Platelets prepared from a single unit of whole blood or plasma and suspended in a specific volume of the original plasma. Also known as random donor platelets.

Plateletpheresis: A procedure utilizing a machine by which one can selectively remove platelets from a donor or patient.

Polyclonal: Antibodies derived from more than one antibody-producing parent cell.

Polyspecific Coombs' Sera: A reagent that contains antihuman globulin sera against IgG immunoglobulin and C3d (complement).

Prophylaxis: Measures taken to prevent disease.

Prozone: Incomplete lattice formation resulting from an excess of antibody molecules relative to the number of antigen sites. This results in false-negative reactions.

Psoriasis: Chronic inflammatory skin disease characterized by formation of scaly red patches.

QA Unit: One or more individuals designated by, and reporting directly to, top management with defined authority and responsibility to ensure that all quality assurance policies are carried out in operations.

Rabies: An acute infectious disease of animals characterized by involvement of the central nervous system resulting in paralysis and finally death.

RBCs: Red Blood Cells.

Recipient: Refers to a patient who is receiving a transfusion of blood or a blood product.

Reverse Grouping: Testing a patient's serum with commercial or reagent A and B red cells to determine which ABO antibodies are present.

Rh Immune Globulin (RhIG): A concentrated, purified anti-D prepared from human serum, which is given to Rh₀(D)-negative mothers after they have given birth to an Rh₀(D)-positive baby or after abortion or miscarriage. It acts to prevent the mother from becoming immunized to any D-positive fetal cells that may have entered her circulation and thereby prevents formation of anti-D by the mother.

Rouleaux: Coinlike stacking of red blood cells in the presence of plasma expanders or abnormal plasma proteins.

Screening Cells: Group O reagent red cells that are used in antibody detection or screening tests.

Sensitization: A condition of being made sensitive to a specific substance (antigen) after the initial exposure to that substance. This results in memory cells that rapidly produce antibodies following a second exposure to the antigen. See Anamnestic Response.

Sepsis: Pathological state, usually febrile, resulting from the presence of microorganisms or their poisonous products in the blood stream.

SF Form 518: Medical Record - Blood or Blood Component Transfusion.

Shelf Life: The amount of time blood or blood products may be stored upon collection.

Single Donor Platelets: Platelets collected from a single donor by apheresis.

SOP: Standing Operating Procedures are detailed written and approved instructions for how a process is to be performed.

Storage Lesion: A loss of viability and function associated with certain biochemical changes that are initiated when blood is stored *in vitro*.

Stroma: The red cell membrane that is left after hemolysis has occurred.

STS: Serologic Test for Syphilis.

Syphilis: An infectious chronic venereal disease characterized by lesions and is caused by *Treponema palladium*.

Tachycardia: Abnormal rapidity of heart action, usually a heart rate over 100 beats per minute.

Tare Weight: Weight of an empty container.

TBTC: Transportable Blood Transshipment Center.

Tetany: A nervous affection characterized by intermittent spasms of the muscles of the extremities.

Titer: A measure of the strength of an antibody by testing its reactivity at increasing dilutions against the appropriate antigen.

TMMMC: Theater Medical Material Management Center. Provides centralized, theater-level inventory management of Class VIII materials to include blood. Primary mission for blood is to help transport throughout the theater.

TMO: Transportation Management Office.

TO: Theater of Operations.

Transfusion: The injection of blood or a blood component into the blood stream.

Transfusion Reaction: An adverse response to a transfusion.

Type and Screen: Testing a patient's blood for ABO group, Rh type, and atypical antibodies. The sample is then retained in the event the subsequent crossmatching is necessary.

Urticaria: A vascular reaction of the skin similar to hives.

USJMTF: U.S. Joint Message Text Format.

Vaccine: A suspension of infectious organisms or components of them that is given as a form of passive immunization to establish resistance to the infectious disease caused by that organism.

Validation: Establishing documented evidence that provides a high degree of assurance that a specific process consistently produces a product that meets its predetermined specifications and quality attributes.

Voice Template: Alternative format used for standard reports.

WAIHA: Warm Autoimmune Hemolytic Anemia.

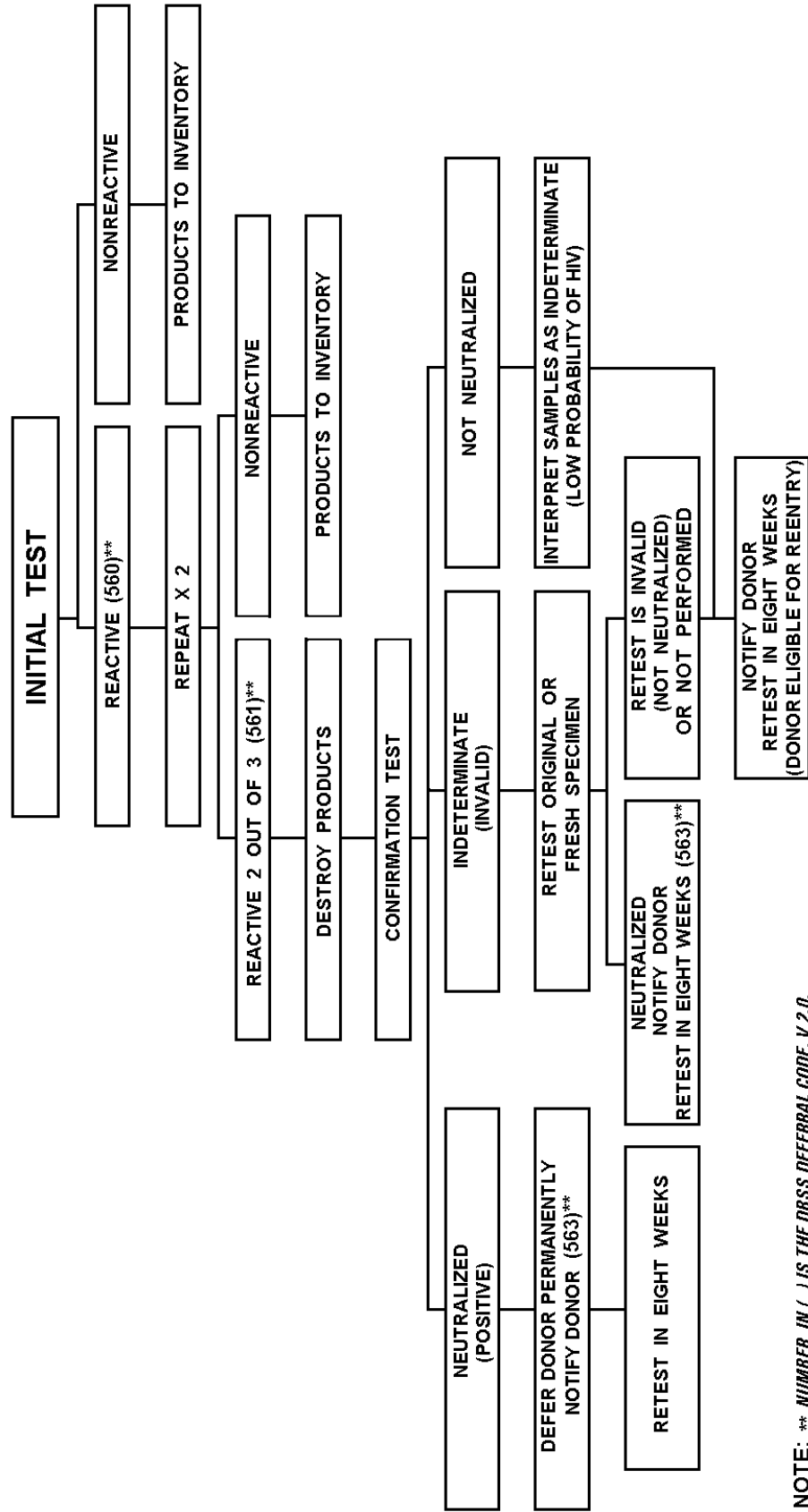
Wharton's Jelly: A gelatinous intercellular substance consisting of primitive connective tissue of the umbilical cord.

WBC: White Blood Cell.

Xeno-: Prefix indicating differing species.

Zeta Potential: The difference in charge density between the inner and outer layers of the ionic cloud that surrounds red cells in an electrolyte solution.

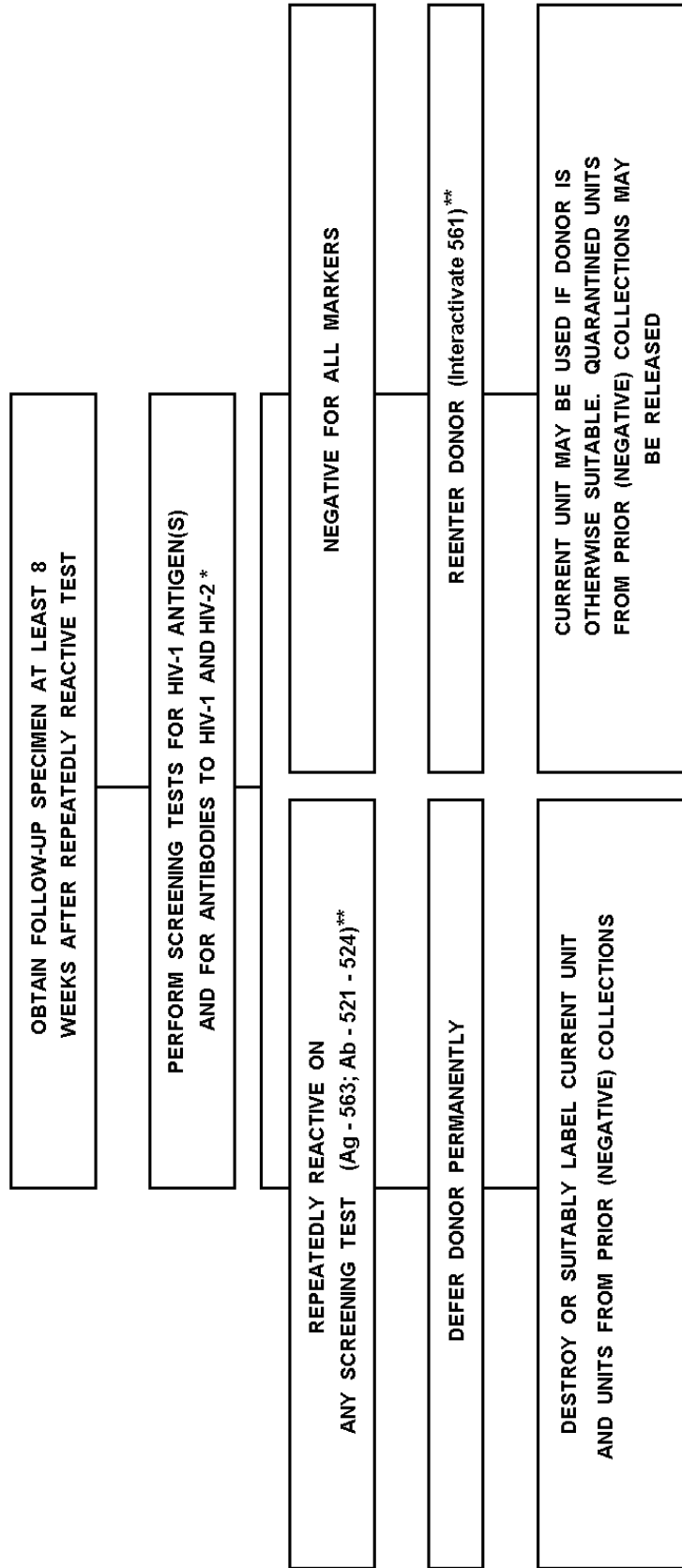
ANNEX A-1: HIV-1 ANTIGEN TESTING



NOTE: ** NUMBER IN () IS THE DBSS DEFERRAL CODE, V 2.0.

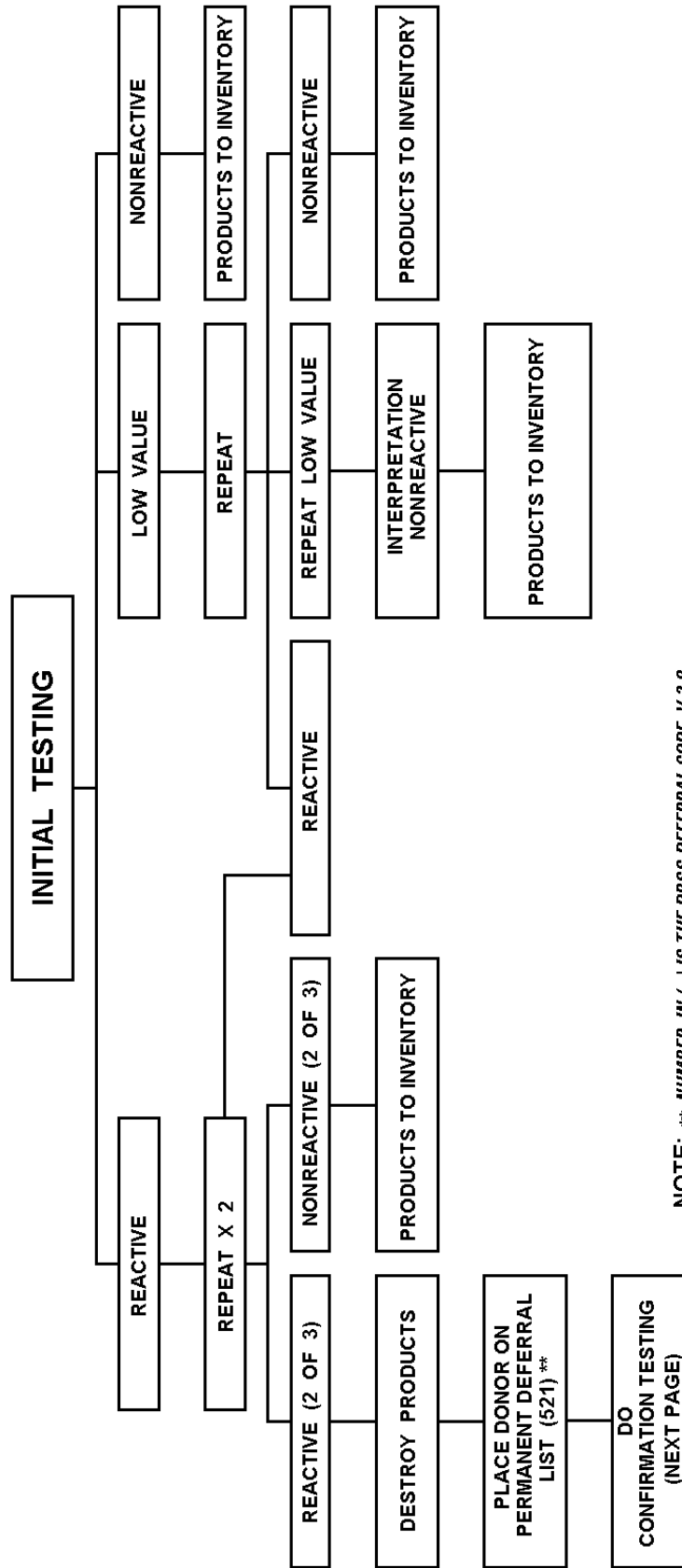
ANNEX A-2: FDA RECOMMENDATIONS FOR DONOR REENTRY AND FOR DISPOSITION OF QUARANTINE UNITS FROM PRIOR (NEGATIVE) COLLECTIONS FOLLOWING A REPEATEDLY REACTIVE SCREENING TEST FOR HIV-1 ANTIGEN(S)

Donor is eligible for reentry based on a NEGATIVE or INDETERMINATE test for HIV-1 antigen(s) including Neutralization Testing.



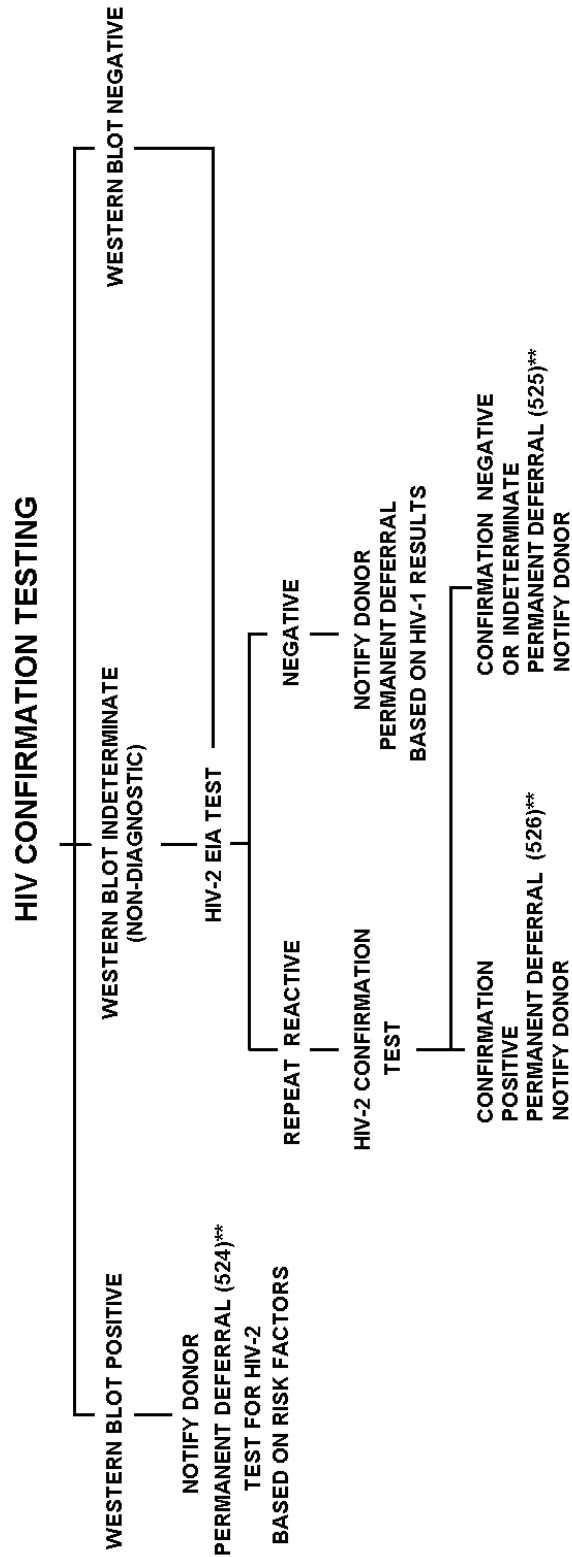
NOTE: * IF RETESTING OF THE DONOR IS NOT PERFORMED WITHIN SIX MONTHS, ANY QUARANTINED UNITS FROM PRIOR COLLECTIONS SHOULD BE DESTROYED OR SUITABLY RELABELLED. ** NUMBER IN () IS THE DBSS DEFERRAL CODE, V.2.0.

ANNEX A-3: ANTI-HIV-1/2 TESTING



NOTE: ** NUMBER IN () IS THE DBSS DEFERRAL CODE, V 2.0.

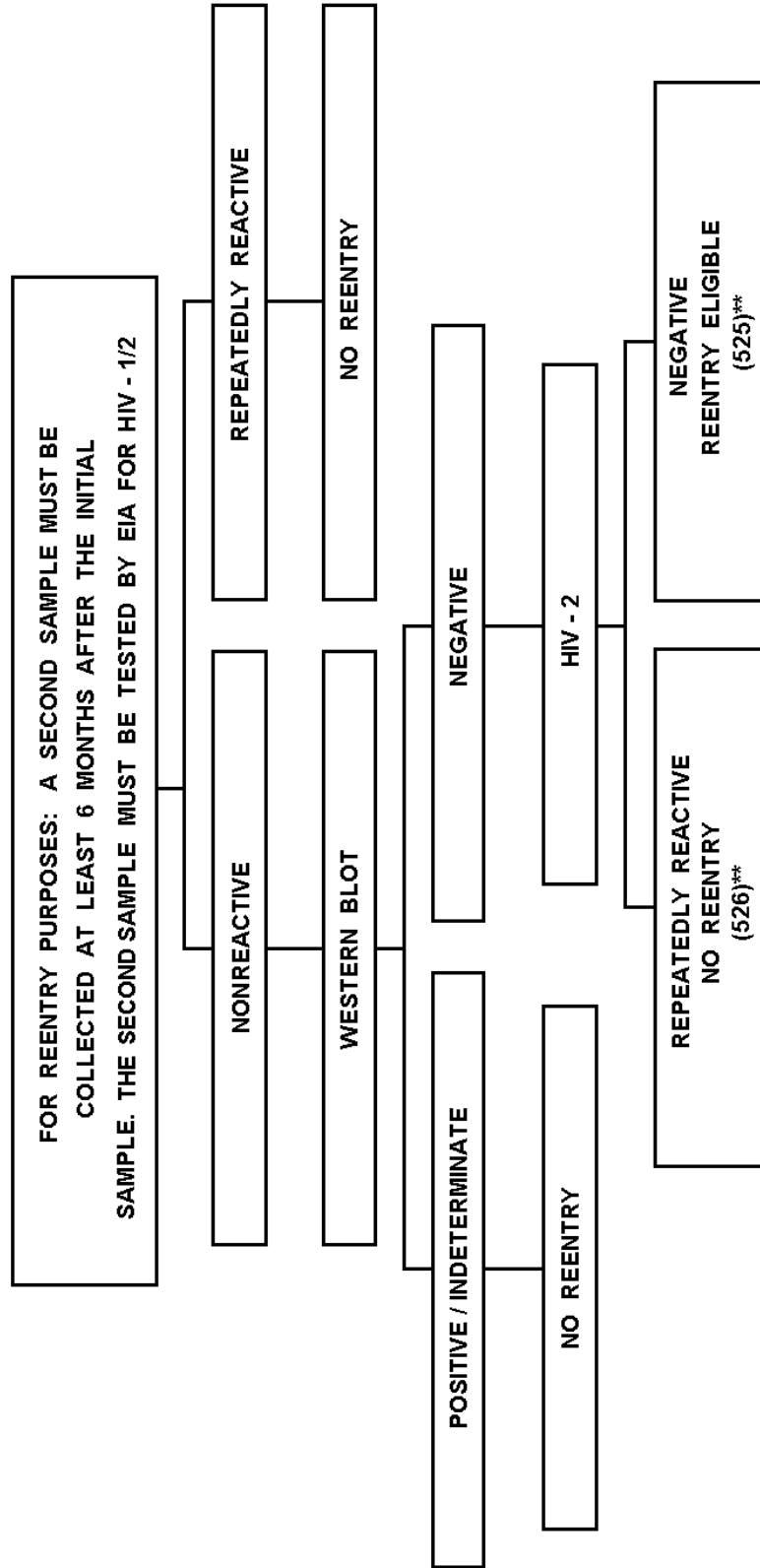
ANNEX A-4: HUMAN IMMUNODEFICIENCY VIRUS ANTIBODIES CONFIRMATION TESTING



NOTE: ** NUMBER IN () IS THE DBSS DEFERRAL CODE.

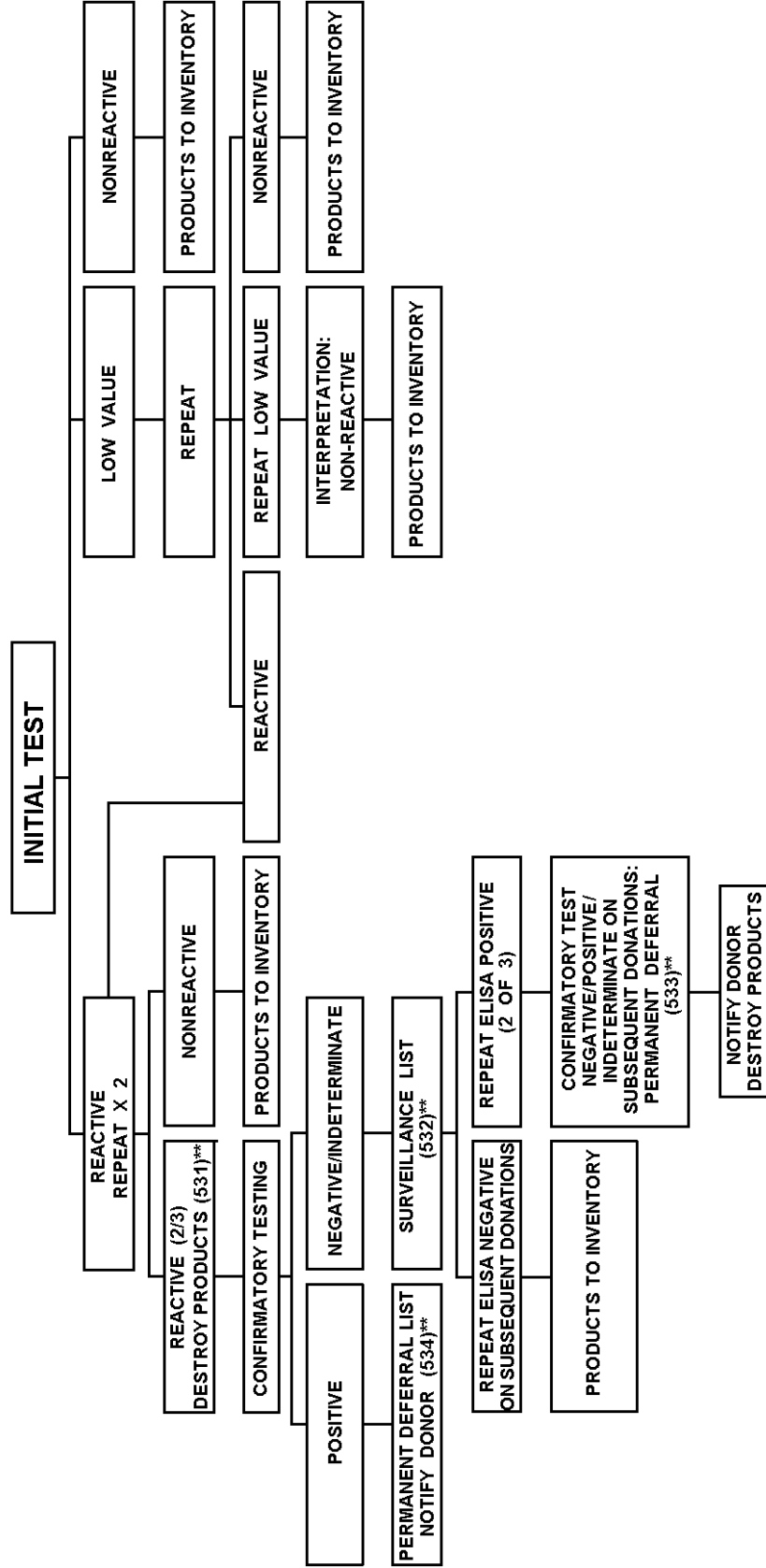
ANNEX A-5: HUMAN IMMUNODEFICIENCY VIRUS HIV 1/2

REENTRY FOR DONORS PREVIOUSLY POSITIVE FOR ANTI-HIV 1/2 IS POSSIBLE BY FDA MEMORANDUM. HOWEVER, IT IS NOT ROUTINELY DONE. IT IS SUGGESTED BEFORE YOU REENTER SUCH A DONOR, YOU SHOULD DISCUSS THE ISSUE WITH YOUR RESPONSIBLE HEAD OR HIS REPRESENTATIVE. THE FOLLOWING ALGORITHM IS PROVIDED TO INDICATE CURRENT REQUIREMENTS FOR REENTRY AT THIS TIME.



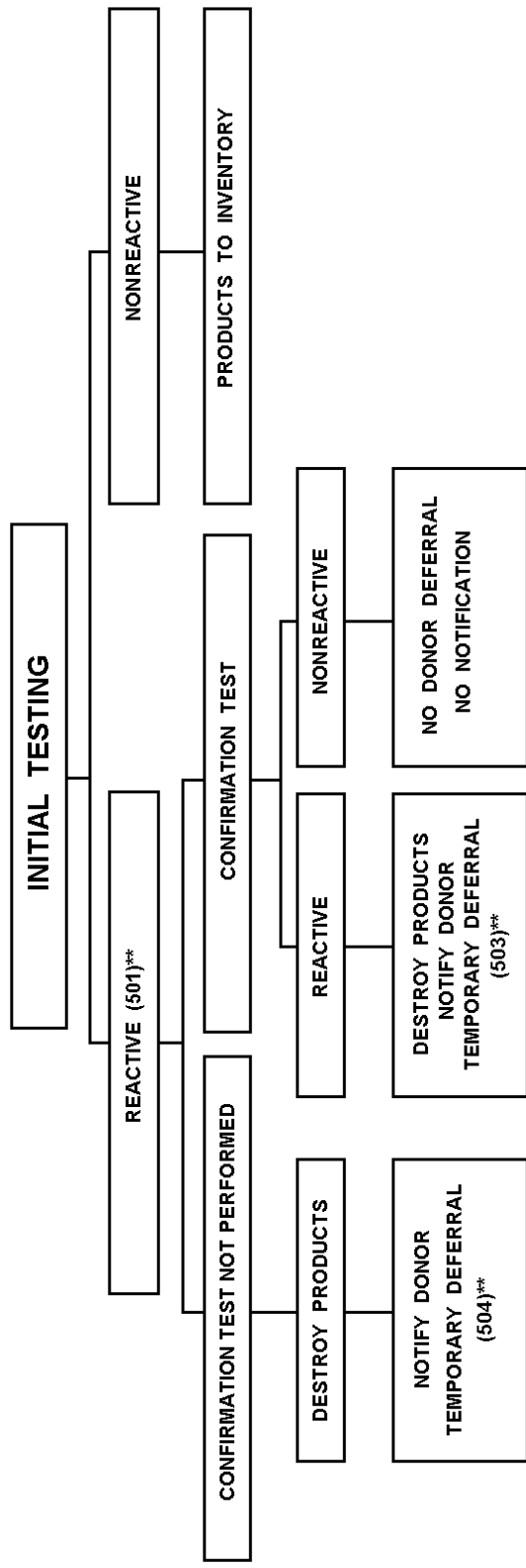
NOTE: ** NUMBER IN () IS THE DBSS DEFERRAL CODE, V 2.0.

ANNEX A-6: ANTI-HUMAN T-L YMPHOTROPIC VIRUS I & II TESTING



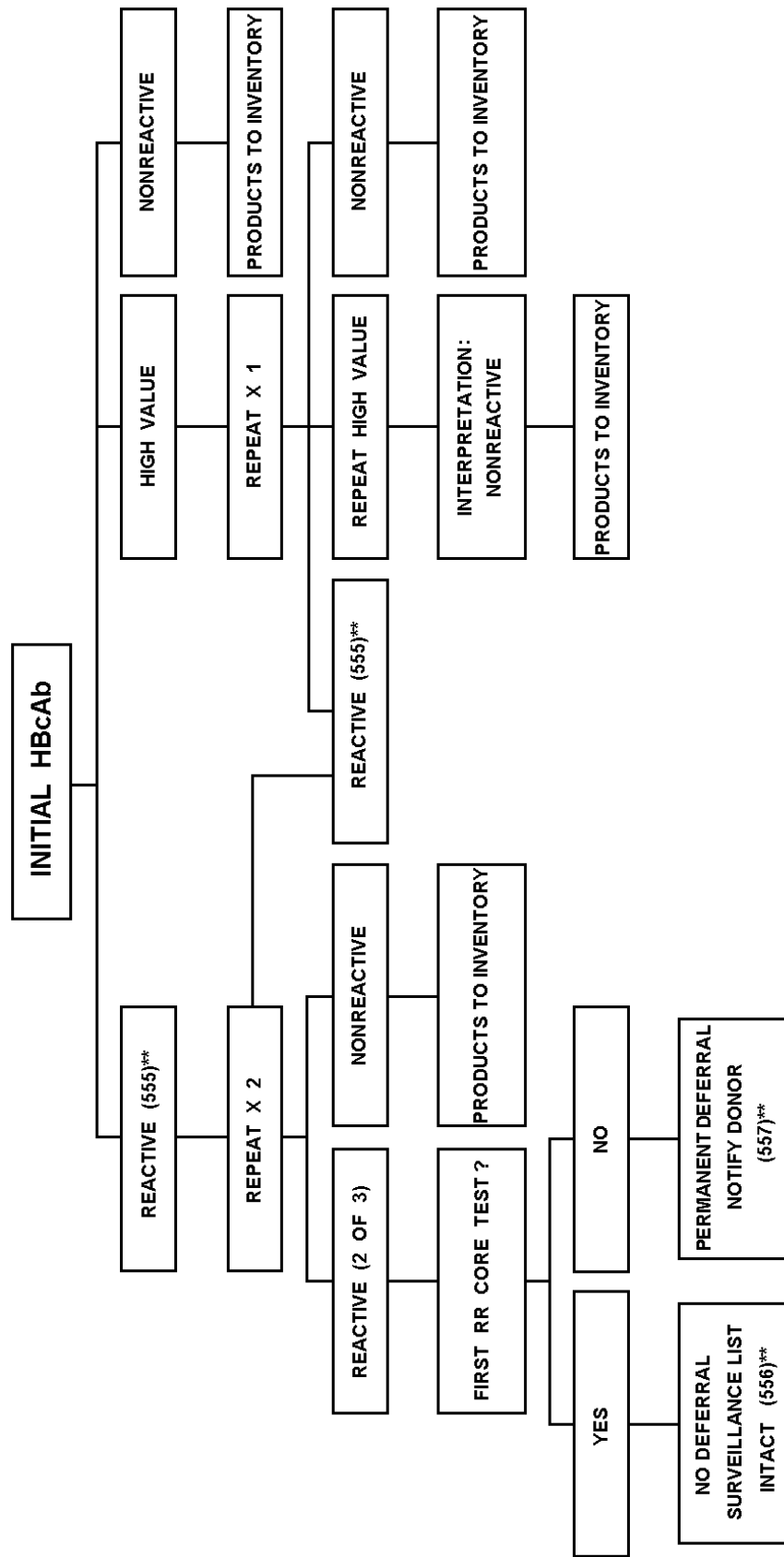
NOTE: ** NUMBER IN () IS THE DBSS DEFERRAL CODE, V 2.0.

ANNEX A-7: RPR TESTING



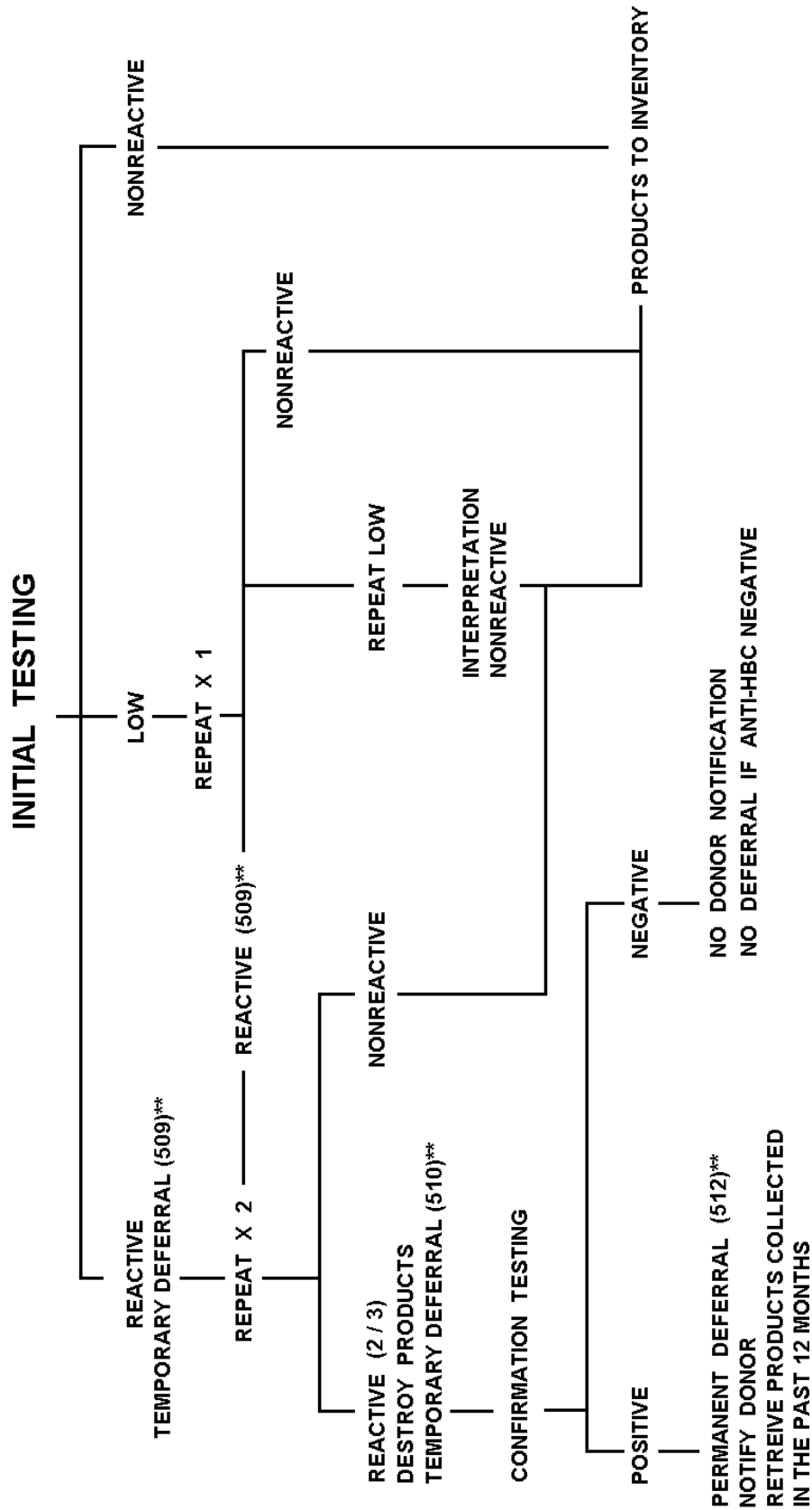
NOTE: ** NUMBER IN () IS THE DBSS DEFERRAL CODE, V 2.0.

ANNEX A-8: HEPATITIS B CORE ANTIBODY TESTING



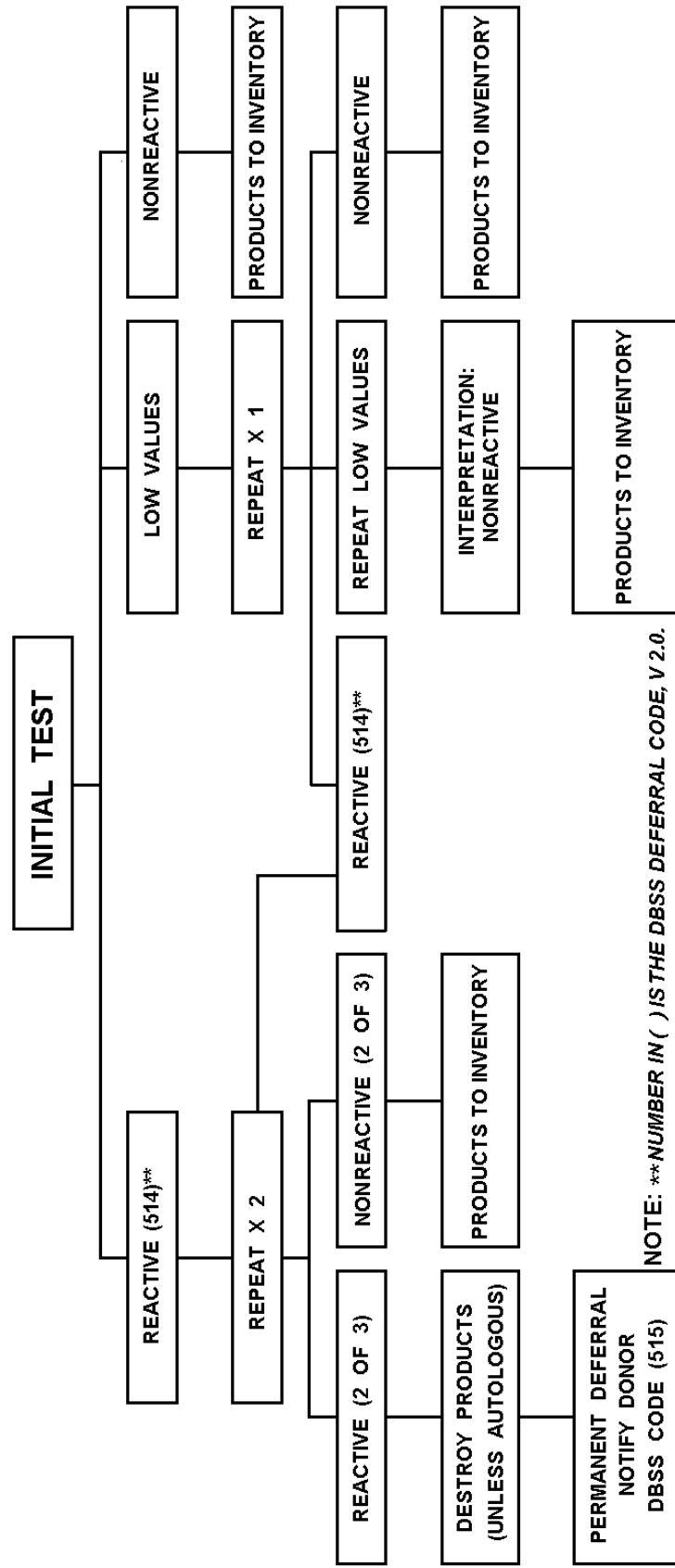
NOTE: ** NUMBER IN () IS THE DBSS DEFERRAL CODE, V 2.0.

ANNEX A-9: HEPATITIS B SURFACE ANTIGEN



NOTE: ** NUMBER IN () IS THE DBSS DEFERRAL CODE.

ANNEX A-10: HEPATITIS C VIRUS TESTING



NOTE: **NUMBER IN () IS THE DBSS DEFERRAL CODE, V 2.0.

ANNEX B

OFFICE SYMBOL

DATE

MEMORANDUM FOR Juana Doe, XXX-XXX-XXXX

SUBJECT: Blood Donor Test Results: Unexpected Antibody: Antibody's Name

1. Thank you for your recent blood donation to the Somewhere Blood Donor Center. As you probably know, we perform a number of tests on all of our blood donors. One of these tests detects the presence of unexpected antibodies. Laboratory testing on a sample of blood you donated revealed the presence of unexpected antibody called **Anti-?**.

2. What does this mean?

a. An unexpected antibody is a protein made by your body after being exposed to foreign red blood cells, usually through pregnancy or blood transfusion. In your case, you apparently have developed an anti-? Due to exposure to red blood cells that carry the ? Factor (or antigen). In rare circumstances the antibody may form without any prior exposure.

b. This antibody will not affect your health and is no cause for alarm. Its presence is only significant during pregnancy or if you require a blood transfusion. Approximately ? percent of the people with your blood type have the ? factor on their red blood cells. Consequently your blood is incompatible with these individuals. Conversely, your blood should be compatible with the remaining ?% of people with your blood type. Thus, obtaining compatible blood for you, even in an emergency, should present no difficulty. If a person with an **anti-?** becomes pregnant and the unborn baby has inherited the ? factor from the father, both the mother and her baby may require closer monitoring throughout the pregnancy.

3. What should you do? No action is required at this time. In the event that you may require a transfusion in the future, I recommend that you maintain this letter for reference. At your convenience you should notify your physician of these findings. You are still eligible to donate blood, but it is recommended that you inform the donor center of your antibody prior to donating blood.

4. If you need further information, you may discuss the matter with your physician or you may discuss it with me at x-xxxx. Thank you for your continued participation in the Armed Services Blood Program.

Sincerely,

ANNEX C

OFFICE SYMBOL

DATE

MEMORANDUM FOR DONORS' NAME, TELEPHONE NUMBER

SUBJECT: Blood Donor Test Results: RPR

1. Thank you for your recent blood donation to the _____. As you probably know, we perform a number of tests on all of our blood donors. One of these tests is a screening test for syphilis called the RPR (Rapid Plasma Reagin). Testing of the blood you donated on _____ (date of donation) was positive for the RPR test. Your blood also tested positive on the more accurate and sensitive confirmatory test for syphilis called FTA (Fluorescent Treponema Antibody). All other testing performed on your blood was within normal limits (HbsAg, HbcAb, anti-HCV, anti-HIV, anti-HTLV-I, and HIV-1 Ag).

2. **What does this mean?** Positive test for RPR and FTA indicate that you have been exposed to the causative agent for syphilis at some time in the past.

3. **What should you do?**

a. Even though you may feel perfectly healthy, it is advised that you obtain a medical evaluation of your positive RPR and FTA to determine if further studies are necessary. Your case has been confidentially forwarded to _____ at the _____ Preventive Medicine Department. He/she will contact you in the near future about further evaluation and follow-up. If you have any questions before you are contacted, please feel free to call _____ (Name of person that letter was forwarded to) at the Preventive Medicine Office, telephone _____.

b. Donors with a positive test for syphilis are not eligible to donate blood until one year after initiation of treatment for syphilis and the RPR and FTA test are negative. Consequently, your name has been added to our list of donors who are indefinitely deferred from donating blood.

4. I want to thank you again for your voluntary efforts to help others. Thanks also for your understanding of our task to keep the safest blood supply possible. We truly regret that we can no longer accept you blood donations. If you have any questions feel free to call me or _____ at _____.

Sincerely,

ANNEX D

OFFICE SYMBOL

DATE

MEMORANDUM FOR (PATIENT'S COMPLETE NAME & TELEPHONE NUMBER)

SUBJECT: Blood Donor Test Results

1. Thank you for your recent blood donation to the _____ (name of the facility). As you probably know, we perform a number of tests on all of our blood donors. During the testing of your _____ (date of donation) donation, the test for the antibody to the Human Immunodeficiency Virus 1/2 (HIV) was weakly positive.

2. **What does this mean?** Based on scientific data, I feel that this test result is a false positive. A false positive test result is one which indicates that the HIV antibody is present, when in reality it is absent. False positive reactions for HIV antibody are relatively common. For this reason, all initially positive tests are referred to a reference laboratory for more extensive testing. A battery of confirmatory tests was performed. The result of this testing indicates that **your blood is negative** for HIV1/2 virus.

3. **What should you do?**

a. Federal guidelines require that donors who have tested positive for HIV, even false positive donors, must refrain from donating blood in the future. Because of your false positive test for HIV, you are no longer eligible to donate blood in the future. Consequently, your name has been added to our confidential donor deferral list.

b. We have confidentially forwarded your case to _____ (name of person that case was forwarded) at the (name of hospital or clinic) Preventive Medicine Section, telephone _____.

4. In summary, since initial HIV testing of your blood was only weakly positive and since the confirmatory testing was negative, it is felt that your test result is a false positive. Therefore, there should be no cause for concern regarding your own health. You are being notified because it is felt that all donors have a right to know which tests are performed on their blood and the results of these tests. Thank you for your understanding of our efforts to keep the safest blood supply possible. We truly regret that we can no longer accept your blood donations. If you have any questions feel free to call me or (name of key person) at (telephone number).

Sincerely,

ANNEX E

OFFICE SYMBOL

DATE

MEMORANDUM FOR DONORS' NAME, TELEPHONE NUMBER

SUBJECT: Blood Donor Information: Post Transfusion Hepatitis

1. Thank you for your support of the (Facility name) Blood Program. We are sending you this letter because you were one of several blood donors who donated blood that was transfused to a patient who developed hepatitis after receiving the blood transfusion. When this occurs, it is customary to contact all of the donors of blood transfused to the patient during the preceding six months. We do this so as to obtain an updated history on the donors and to perform certain laboratory tests related to hepatitis.

2. **What does this mean?** This should not alarm you. We have checked your blood once and found to be normal. It is unlikely that we will find an abnormality at this time. However, this repeat check should be done for the ultimate protection of the patient. It is known that the majority of donors who transmit hepatitis are not themselves sick. The recipient of the blood may, however, become ill because he lacks the resistance to the hepatitis virus.

3. **What you should do?**

a. Even though you may feel perfectly healthy, it is necessary that you receive further evaluation and testing. We have confidentially forwarded your case to _____ at the _____ Preventive Medicine Department. He/She will contact you in the near future about further evaluation and follow-up. If you have any questions before you are contacted by _____, please feel free to call him at the _____ Preventive Medicine Department, telephone _____.

b. Because of the remote possibility that your blood can transmit hepatitis to the recipient, we have placed your name on our confidential donor deferral list. You will remain ineligible to donate blood in the future until the completion of your evaluation and approval by the Medical Director of the Blood Bank.

4. I want to thank you again for your voluntary efforts to help others. Thanks also for your understanding of our task to keep the safest blood supply possible. If you have any questions feel free to call me or _____ at _____.

Sincerely,

ANNEX F

OFFICE SYMBOL

DATE

MEMORANDUM FOR Preventive Medicine, ATTN: Mr. Lucio Doe, Somewhere Army Medical Center, Fort Nowhere, Home State

SUBJECT: Notification of Abnormal Blood Donor Test Results

1. During routine blood donor testing the following significant result(s) was obtained. This blood donor has been permanently deferred due to significant testing results. It is requested that appropriate follow-up of this blood donor be initiated.

DONOR INFORMATION		TEST	SCREENING	CONFIRMATION
DONOR'S NAME		HBsAg		
DONOR'S SSN		HBcAb		NA
UNIT/ADDRESS		Anti-HCV		NA
RANK		Anti-HIV		
DUTY PHONE		Anti-HTLV-1		
DONATION DATE		RPR		
OTHER		HIV-1/2 Ag		

2. For your reference the requirements for blood donor deferral are provided. It should be noted that the DA Blood Program has not approved a re-entry protocol for any of these deferral reasons.

a. Test requiring Mandatory Permanent Deferral:

1. HbsAg: Deferred if confirmed positive by neutralization
2. HbcAb: Deferred after second positive donation (no confirmatory test available)
3. Anti-HCV: Deferred after first positive donation (no confirmatory test available)
4. Anti-HIV: Deferred after first positive donation, regardless of confirmation testing results
5. Anti-HTLV-I: Deferred after first confirmed positive donation or after second non-confirmed positive donation
6. HIV-1 Ag: Permanently deferred if confirmed positive by neutralization. If screening test is not confirmed, donor is deferred and retesting is encouraged after 8 weeks. If all testing is negative at 8 weeks, donor is eligible for re-entry.

b. The tests requiring indefinite deferral are RPR/FTA and HIV-1 Ag. Donors with reactive RPR and FTA can be readmitted one year after completion of necessary treatment and documented seronegativity (FTA). See explanation above for HIV-1 Ag deferral.

3. POC in the blood bank is the undersigned at (phone number).

NOCANDO DOE
Technical Supervisor
Somewhere Blood Donor Center

BIBLIOGRAPHY

1. Anderson, D.M. (ed). Dorland's Illustrated Medical Dictionary, 28th ed. Philadelphia: W.B. Saunders, 1988.
2. FM 8-10-3. Division Medical Operations Center. AMEDDC&S, Ft Sam Houston, TX: Mar 1991.
3. FM 8-10-9. Health Service Logistics in a Theater of Operations. AMEDDC&S, Ft Sam Houston, TX: Feb 1992.
4. FM 8-70. Standards for Blood Banks and Transfusion Services, 17th ed. AABB, Bethesda, MD: 1996.
5. FM 8-55. Planning for Health Service Support. AMEDDC&S, Ft Sam Houston, TX: Jan 1994.
6. Food and Drug Administration. Code of Federal Regulations (CFR) Title 21, Parts 600-799 and Parts 200-299, 1995.
7. Harmening, D.M. Modern Blood Banking and Transfusion Practices, 3rd ed. Philadelphia: F.A.Davis, 1994.
8. Joint Pub 4-02.1. Health Service Support Logistics in Joint Operations, 2nd draft. Joint Chiefs of Staff Office, Washington, D.C.: 15 Feb 1994.
9. Rudman, S. Textbook of Blood Banking and Transfusion Medicine. Philadelphia: W.B. Saunders, 1995.
10. Steane, E.D. (ed). An Introduction to ISBT 128. International Council for Commonality in Blood Banking Automation, Inc (ICCBA). Bethesda, MD: 1995.
11. TM 8-227-3. Technical Manual, 11th ed. AABB, Bethesda, MD: 1993.
12. TM 8-227-3. Technical Manual, 12th ed. AABB, Bethesda, MD: 1996.
13. TM 8-227-11. Operational Procedures for the Armed Services Blood Program Elements. ASBPO, Falls Church, VA: 1 Sep 1995.

COMMENT SHEET

SUBCOURSE MD0867 Blood Donor Operations I

EDITION 101

Your comments about this subcourse are valuable and aid the writers in refining the subcourse and making it more usable. Please enter your comments in the space provided. ENCLOSE THIS FORM (OR A COPY) WITH YOUR ANSWER SHEET **ONLY** IF YOU HAVE COMMENTS ABOUT THIS SUBCOURSE..

FOR A WRITTEN REPLY, WRITE A SEPARATE LETTER AND INCLUDE SOCIAL SECURITY NUMBER, RETURN ADDRESS (and e-mail address, if possible), SUBCOURSE NUMBER AND EDITION, AND PARAGRAPH/EXERCISE/EXAMINATION ITEM NUMBER.

PLEASE COMPLETE THE FOLLOWING ITEMS:

(Use the reverse side of this sheet, if necessary.)

1. List any terms that were not defined properly.

2. List any errors.

paragraph error correction

3. List any suggestions you have to improve this subcourse.

4. Student Information (optional)

Name/Rank _____

SSN _____

Address _____

E-mail Address _____

Telephone number (DSN) _____

MOS/AOC _____

PRIVACY ACT STATEMENT (AUTHORITY: 10USC3012(B) AND (G))

PURPOSE: To provide Army Correspondence Course Program students a means to submit inquiries and comments.

USES: To locate and make necessary change to student records.

DISCLOSURE: VOLUNTARY. Failure to submit SSN will prevent subcourse authors at service school from accessing student records and responding to inquiries requiring such follow-ups.