

Training Module For Blood Bank Nurses

2015

Ministry of Health and Family Welfare
Government of India



भानु प्रताप शर्मा
सचिव
B.P. SHARMA
Secretary



भारत सरकार
स्वास्थ्य एवं परिवार कल्याण विभाग
स्वास्थ्य एवं परिवार कल्याण मंत्रालय
Government of India
Department of Health and Family Welfare
Ministry of Health and Family Welfare

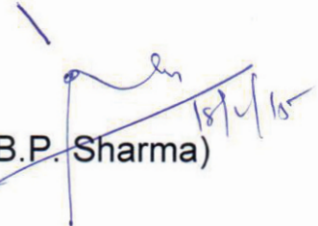
Foreword

Blood Transfusion Services in India have advanced significantly through the Blood Safety Program which has been an integral part of all phases of the National AIDS Control Programme since 1992. This has contributed immensely in improving access to safe and quality blood, and in promotion of Voluntary Blood Donation, and has also led to several advancements in terms of better policies, improved infrastructure and adoption of modern technologies.

Capacity building and training are a vital part of service delivery. Regular and standardized training leads to improvements in the knowledge, skills and standards of personnel providing blood transfusion services. The scope of a standardized training curriculum on Blood Transfusion Service is to train the Medical Officers, Staff Nurses, Counselors and Lab Technicians of the Blood Bank to become totally familiar with the basic techniques of Blood Banking, and to help them adopt techniques which comply with the regulatory framework in the field of Blood Transfusion.

The set of training modules is intended to emphasize Good Laboratory Practices (GLP) and Quality Management Systems (QMS) in Blood Transfusion Services. Training would be imparted through identified centres identified by National AIDS Control Organization, Ministry of Health and Family Welfare. These training centres will work towards capacity building for all cadres of the Blood bank staff across all facilities situated in different regions of the country.

I am confident that this training module would be very useful for all in the field of blood transfusion services.


(B.P. Sharma)



एन. एस. कंग, भा.प्र.से
अपर सचिव

NAVREET SINGH KANG, IAS
Additional Secretary



भारत सरकार

स्वास्थ्य एवं परिवार कल्याण मंत्रालय

राष्ट्रीय एड्स नियंत्रण संगठन

Government of India

Ministry of Health & Family Welfare

National AIDS Control Organisation

Preface

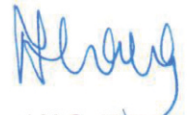
The goals and objectives of the Blood Safety Programme are to ensure the provision of safe and quality blood, even to remote areas of the country. National AIDS Control Organisation (NACO) supports a network of about 1200 Blood Banks in the Government and Charitable sectors through provision of equipment, consumables, manpower and capacity building. Nearly 70% of the country's blood requirement is met through this network. The scenario of blood banking in India owes much of its modernization due to the efforts made during various phases of the National AIDS Control Programme (NACP).

During NACP IV, NACO has identified specific areas for strengthening technical and service quality standards, management structures, partnership mechanisms, and monitoring and evaluation systems to achieve the objective of catering to the country's blood requirements through a nationally coordinated and well networked Blood Transfusion Service.

Blood Transfusion Services Division, NACO and the National Blood Transfusion Council are committed to improve all aspects of Blood Transfusion Services in coordination with State AIDS Control Societies and State Blood Transfusion Councils. With rapid technological advancement in transfusion medicine, there is a felt need for an elaborative and standardized training curriculum so as to comply with the Indian health Policy Framework. The current training curriculum is based on changing needs of transfusion professionals.

This training module has been prepared with an objective of introducing uniform standards in all aspects of blood banking for medical officers, staff nurses, counselors and laboratory technicians working in the blood banks. The module is designed for the better understanding and comprehension of blood banking processes and procedures, in order to improve technical and managerial skills of the personnel.

Appropriate in-service training programmes will facilitate provision of trained manpower to enhance quality of transfusion services and to keep abreast with the latest developments in this fast changing field.


(N.S. Kang)

6th Floor, Chandralok Building, 36 Janpath, New Delhi -110001, Telefax : 011-23325331

E-mail : nacoasdg@gmail.com

अपनी एचआईवी अवस्था जानें, निकटतम सरकारी अस्पताल में मुफ्त सलाह व जाँच पाएँ
Know Your HIV status, go to the nearest Government Hospital for free Voluntary Counselling and Testing



सत्यमेव जयते

K B Agarwal
IAS
Joint Secretary

भारत सरकार
स्वास्थ्य एवं परिवार कल्याण मंत्रालय
एड्स नियंत्रण विभाग
राष्ट्रीय एड्स नियंत्रण संगठन
9वां तल, चन्द्रलोक बिल्डिंग, 36 जनपथ, नई दिल्ली -110001
Government of India
Ministry of Health & Family Welfare
Department of AIDS Control
National AIDS Control Organisation
9th Floor, Chandralok Building, 36 Janpath, New Delhi - 110 001

Message

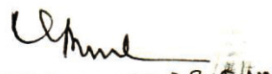
Access to safe blood and maintaining standards in Blood Transfusion Services (BTS) is the predominant responsibility of NBTC. Currently, a network of 1161 blood banks is under the umbrella of NACO support and it is essential to provide regular Training to the Blood Bank staff, throughout the country.

This series of training modules is designed to train the blood bank staff on the basic techniques of Blood Banking which comply with worldwide standards in the field of Blood Transfusion.

The module is intended to incorporate Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP) and quality systems for Blood Bank personnel.

18 Training Institutes have been identified under NACP IV. These Training Institutes will work towards capacity building of the Blood bank staff through standardized training curriculum for all cadres of staff in Blood Banks.

I would like to place on record my appreciation to Dr. R.S. Gupta, DDG BTS Division, Dr. S. D. Khaparde, ex- DDG, the BTS team at NACO and other organizations who contributed to the development of these guidelines.


(K B Agarwal) 29.5.15

Dr. Jagdish Prasad
M.S., M.Ch., FIACS
Director General of Health Services



सत्यमेव जयते

भारत सरकार
स्वास्थ्य एवं परिवार कल्याण मंत्रालय
स्वास्थ्य सेवा महानिदेशालय
निर्माण भवन, नई दिल्ली-110 108
GOVERNMENT OF INDIA
MINISTRY OF HEALTH & FAMILY WELFARE
DIRECTORATE GENERAL OF HEALTH SERVICES
NIRMAN BHAWAN, NEW DELHI-110 108
Tel.: 23061063, 23061438 (O), 23061924 (F)
E-mail : dghs@nic.in

दिनांक/Dated.....

Message

Ensuring the safety and availability of Blood and Blood products is an essential Public Health responsibility. Measures to ensure blood safety also play a major role in preventing the transmission of HIV, Hepatitis virus and other Blood borne pathogens in health care settings.

Access to sufficient and safe Blood and Blood products provided within a National Blood System is a vital component in achieving Universal health coverage. So far, Blood Transfusion Services were available only through established Blood Banks extending up to district level. In 2003, under National Health Mission these services were made available at sub-district level through Blood Storage Units at First Referral Units. These Centres were aimed at meeting the requirements of blood for pregnant women requiring blood transfusions during pregnancy or labour.

For quality, safety and efficacy of Blood and Blood products, well equipped Blood Centres with adequate infrastructure and trained manpower is an essential requirement. To ensure effective clinical use of Blood and to maintain quality standards in Blood Banking procedures, training of clinical staff is important.

18 Training Institutes are identified to enhance quality services in Blood Transfusion Services. These Training Institutes will work towards capacity building of the Blood Banks through standardized Training Curriculum for all cadres of staff in the Blood Banks.

These revised editions of training modules for Blood Bank staff will be a useful resource for standardizing Blood Transfusion services across blood banks situated in different regions of the country. My congratulations to, Dr. R.S. Gupta, DDG, the BTS team at NACO and other organizations who contributed in the development of these modules.

(Dr Jagdish Prasad)



भारत सरकार
स्वास्थ्य एवं परिवार कल्याण मंत्रालय
राष्ट्रीय एड्स नियंत्रण संगठन
9वां तल, चन्द्रलोक बिल्डिंग, 36 जनपथ, नई दिल्ली -110001
Government of India
Ministry of Health & Family Welfare
National AIDS Control Organisation

Dr. R S Gupta

M.D.

Deputy Director General
(NACO)

Tel. : 91-11-23736851
Fax : 91-11-23731746
E-mail : rsgupta.naco@gmail.com

9th Floor, Chandralok Building,
36 Janpath, New Delhi - 110 001

Acknowledgement

The Training Module for Blood Bank Medical Officers and Laboratory Technicians has been developed by Blood Transfusion Services Division, NACO and National Blood Transfusion Council, Ministry of Health and Family Welfare under the guidance and active leadership of Shri. Lov Verma, I.A.S, Ex-Secretary (Health) and Shri. B.P. Sharma, I.A.S, Secretary (Health).

The constant encouragement of Shri. N.S.Kang, Additional Secretary NACO and Shri. K.B. Agarwal, IAS, Joint Secretary, NACO have greatly helped in undertaking this important activity.

A special thanks to Dr. Shobini Rajan, Assistant Director General (BTS); Dr Harprit Singh, National Programme Officer (BTS) and Dr. Shanoo Mishra, Programme Officer Quality (BTS), NACO and other team members for their constant effort and hard work in preparing the module.

It is commendable to note that a comprehensive set of document has been reviewed with the coordinated and concerted efforts of various organizations and individuals from the Apex Training Institutes, PGI Chandigarh, KEM Mumbai and CMC Vellore. A detailed list of contributors is included within this document. My heartfelt thanks to all for their expertise and time spared towards technical review.

I extend my sincere thanks to the U.S. Centers for Disease Control and Prevention- Division of Global HIV/AIDS (CDC-DGHA), India and Christian Medical Association of India (CMAI) for providing technical assistance and support for the preparation of this set of modules.

(Dr. R.S Gupta)

LIST OF CONTRIBUTORS

EXPERT MEMBERS (IN ALPHABETICAL ORDER):

Dr. Ashish Jain

Post Graduate Institute of Medical Education & Research (PGIMER), Chandigarh.

Dr. Atul Sonkar

Sanjay Gandhi Post Graduate Institute of Medical Science (SGPGIMS), Lucknow.

Dr. Charusmita Modi

King Edward Medical Hospital (KEM), Mumbai.

Dr. Debasish Gupta

Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum.

Dr. Dolly Daniel

Christian Medical College (CMC), Vellore.

Dr. Gajendra Gupta

Santokba Duriabhji Memorial Hospital, Jaipur.

Dr. Hari Krishan Dhawan

Post Graduate Institute of Medical Education & Research (PGIMER), Chandigarh.

Dr. Harprit Singh

National Programme Officer , Blood Transfusion Services, NACO, MoHFW and National Consultant Blood Safety, WHO - India

Dr. Jayashree Sharma

King Edward Memorial Hospital, Mumbai.

Dr. Joy Mammen

Christian Medical College(CMC), Vellore.

Dr.Kabita Chatterjee

All India Institute of Medical Sciences (AIIMS), New Delhi.

Dr. K. Selvarajan

Rajiv Gandhi Government General Hospital, Chennai.

Dr. Manisha Srivastava

Bhopal Memorial Hospital and Research Centre (BMHRC), Bhopal.

Dr. M. D. Gajjar

BJ Medical College, Ahemdabad.

Dr. Neelam Marwah

Post Graduate Institute of Medical Education & Research (PGIMER), Chandigarh.

Dr. Narinder Naidu

Indian Red Cross Society, Mumbai.

Dr. Pauline Harvey

U.S. Centers for Disease Control and Prevention - Division of Global HIV / AIDS.

Dr. P. Arumugam
Tamil Nadu Dr. MGR Medical University, Chennai.

Dr. P. Mahalingam
Christian Medical Association of India(CMAI), New Delhi.

Dr. Rekha Hans
Post Graduate Institute of Medical Education & Research (PGIMER), Chandigarh.

Dr. R. K. Chaudhary
Sanjay Gandhi Post Graduate Institute Medical Science (SGPGIMS), Lucknow.

Dr. R. N. Makroo
Apollo Hospital, Mathura Road, New Delhi.

Dr. R. R. Sharma
Post Graduate Institute of Medical Education & Research (PGIMER), Chandigarh.

Dr. Sabita Basu
Tata Medical Centre, Kolkata.

Dr. Sarika
Christian Medical Association of India (CMAI), New Delhi.

Dr. Sanjay Kumar Jadhav
National Adviser (BTS), NACO, MoHFW, & (Senior Technical Advisor, CMAI / CDC /QMS / BB Project)

Dr. Shanoo Mishra
PO-QC, (BTS), NACO, MoHFW.

Dr. Shobini Rajan
ADG, (BTS), NACO, MoHFW.

Dr. Suchet Sachdev
Post Graduate Institute of Medical Education & Research (PGIMER), Chandigarh.

Dr. Sunder Periyavan
National Institute of Mental Health and Neuro-Sciences (NIMHANS), Bangalore.

Dr. Sunil D. Khaparde
DDG, (BTS), NACO, MoHFW.

Dr. Sunil Rajadhyaksha
Tata Memorial Hospital, Mumbai

Dr. Sunita Upadhyaya
U.S. Centers for Diseases Control and Prevention – Division of Global HIV/ AIDS.

Dr. Veena Doda
Ram Manohar Lohia Hospital(RMLH), New Delhi.

Dr. Zarin S. Bharucha
Federation of Mumbai Blood Bank, Mumbai.

CONTENTS



	Acronyms	<i>v</i>
	List of tables	<i>vii</i>
	List of figures	<i>viii</i>
	Introduction to blood transfusion services	<i>ix</i>
01	Blood donor selection	1
	1.1 Components of Donor Selection	2
	1.2 Donor room procedures	4
	1.3 Organization of blood donation camps	27
02	Immunohaematology	34
	2.1 Basics of red cell serology	35
	2.2 ABO and Rh grouping	38
	2.3 Compatibility Testing	38
	2.4 Compatibility test in special circumstances	41
	2.5 Compatibility test in new borns	43
03	Transfusion transmissible infections (TTIS)	49
	3.1 Characteristics of transfusion transmissible pathogens	50
	3.2 Preventive strategies of transfusion transmissible infections	57
04	Biosafety	61
	4.1 Risk to health care workers (HCW)	62
	4.2 Good Laboratory Practices	63
	4.3 Biomedical waste management	66
	4.4 Disinfection	68
	4.5 Autoclaving	68
	4.6 Disposal of blood and laboratory material	69
	4.7 Discarding TTI Reactive Blood Unit	69

05

Blood components	73
5.1 Constituents of blood	74
5.2 Blood component separation	76
5.3 Steps of component separation	77
5.4 Storage and shelf life of components	78
5.5 Storage of blood and blood components prior to transfusion	78
5.6 Criteria for reissue of received back blood bags	80
5.7 Procedure for Tracing a Unit of Blood or Blood Component from Donor to its Final Disposition and its Expiry Date	80

06

Pre-transfusion issues and bedside practices	84
6.1 Procedure for collection of blood sample of the patient for transfusion testing	85
6.2 Procedure for arranging / requisitioning of blood / component from the BTS	85
6.3 Getting blood / blood components issued from BTS for Emergency / Ward / ICU / OT	86
6.4 Administration of blood and blood components	86
6.5 Disposable equipment for administration of blood	91
6.6 Paediatric transfusion: use a special paediatric set for paediatric patients	91
6.7 Blood warmers	91
6.8 Concurrent fluids and medications	91
6.9 Role of the hospital transfusion committee (HTC)	92

07

Transfusion reactions	96
7.1 Immune transfusion reaction	97
7.2 Non immune transfusion reaction	105
7.3 Laboratory investigations	107
7.4 Haemovigilance	108

08

Quality management in blood transfusion services	113
8.1 Terms and Definitions in Quality Management System	114

References	123
-------------------	------------

Annexures	124
------------------	------------



ACRONYMS

3TC	Lamivudine	▲	DGHS	Directorate General of Health Services
ACD	Acid Citrate Dextrose	▲	DHTR	Delayed Haemolytic Transfusion Reaction
AIDS	Acquired Immuno Deficiency Syndrome	▲	DIC	Disseminated intravascular coagulation
AMC	Annual Maintenance Contract	▲	EBV	Epstein Barr Virus
Aph	Apheresis	▲	EDTA	Ethylene Diamine Tetra acetic Acid
AZT/ZDV	Zidovudine	▲	EIA	Enzyme Immuno Assay
BTS	Blood Transfusion Services	▲	ELISA	Enzyme-Linked Immuno Sorbent Assay
CD4	Cluster of Differentiation	▲	FFP	Fresh Frozen Plasma
CDC	Centers For Disease Control and Prevention (United States)	▲	FIFO	First In First Out
CDP/CP	Cryo Deficient Plasma/ Cryo Poor Plasma	▲	FNHTR	Febrile Non-haemolytic transfusion reactions
CMC	Comprehensive Maintenance Contract	▲	GA	General Anaesthesia
CMV	CytomegaloVirus	▲	Hb	Hemoglobin
CMAI	Christian Medical Association of India	▲	HBIG	Hepatitis Immunoglobulin
CRYO	Cryoprecipitate	▲	HBsAg	Hepatitis B surface Antigen
CO ₂	Carbon-di-oxide	▲	HBV	Hepatitis B Virus
CuSO ₄	Copper Sulphate	▲	Hct	Hematocrit
DAT	Direct Anti-globulin Test	▲	HCV	Hepatitis C Virus
D&CA	Drugs and Cosmetics Act, 1940	▲	HCW	Health Care Worker
		▲	HDN	Haemolytic Disease of the Newborn
		▲	HDV	Hepatitis D Virus

Hg	Mercury	▲	PEP	Post Exposure Prophylaxis
HIV	Human Immunodeficiency Virus	▲	PRBC	Packed Red Blood cells
HTC	Hospital Transfusion Committee	▲	PRO	Public Relation Officer
HTR	Haemolytic Transfusion Reaction	▲	PRP	Platelet Rich Plasma
IAT	Indirect Antiglobulin Test	▲	PTP	Post Transfusion Purpura
ICTC	Integrated Counselling and Testing Centre	▲	QMS	Quality Management System
ICU	Intensive Care Unit	▲	RBCs	Red Blood Cells
IH	Immunoematology	▲	RIA	Radio-Immuno-Assay
IV	IntraVenous	▲	RPR	Rapid Plasma Reagin
LPRBC	Leukocyte Poor Red Blood Cells	▲	SAGM	Sodium chloride, Adenine, Glucose Mannitol
MSW	Medical Social Worker	▲	SBTC	State Blood Transfusion Council
NACO	National AIDS Control Organization	▲	SOP	Standard Operating Procedure
NBTC	National Blood Transfusion Council	▲	Sp.gr	Specific Gravity
NCPE	Non Cardiogenic Pulmonary Edema	▲	TA-GVHD	Transfusion Associated Graft Versus Host Disease
NRTI	Nucleoside Reverse Transcriptase Inhibitor	▲	TPHA	<i>treponema pallidum</i> Haemagglutination Assay
O2	Oxygen	▲	TRALI	Transfusion Related Acute Lung Injury
OT	Operation Theatre	▲	TTIs	Transfusion Transmitted Infections
PC	Platelet Concentrate	▲	VDRL	Venereal Disease Research Laboratory
		▲	WB	Whole Blood

List of Tables

Table No.	Title	Page No.
1.1	Hemoglobin concentration and Interpretation	7
1.2	Quality control of CuSO ₄	8
1.3	Deferment of blood donation	11
1.4	Recommended blood bags for various components	18
1.5	Classification of Donor Adverse Reactions	21
1.6	Materials required during an emergency in the post donation period	24
1.7	Required number of beds according to the expected number of donors	28
2.1	Blood Type, Blood Group Antigen and Blood Group Antibodies	35
2.2	ABO and Rh blood group percentage distribution in India	36
2.3	Agglutination pattern of different blood groups	38
2.4	Choice of blood for DVET	44
2.5	Choice of Blood and Blood Components	44
3.1	Transfusion Transmitted Agents	51
4.1	Modes of exposure to blood borne pathogens in the laboratory	62
4.2	PEP for HBV	65
4.3	HIV Post-Exposure Prophylaxis Evaluation	65
4.4	Post-Exposure Chemoprophylaxis	66
4.5	Categories of Bio-Medical Waste	66
4.6	Segregation and Disposal	67
5.1	Storage and Shelf Life of Components	78
6.1	Time limit for transfusion	90
8.1	Schedules and procedures for equipment maintenance and calibration	118

List of Figures

Figure No.	Title	Page No.
1	Copper Sulphate Solution	8
2	Copper Sulphate solution - Specific gravity measurement	8
3	Single Blood Bag	17
4	Double Blood Bag	17
5	Triple Blood Bag System	17
6	Quadruple Blood Bag System	17
7	Penta Blood Bag System	17
8	Cleaning Phlebotomy site with Povidone Iodine	19
9	Cleaning Phlebotomy site with Isopropyl Alcohol	19
10	Sample layout of blood donation camp	29
11	Internal panoramic view of blood mobile	30
12	ABO Blood Group System	36
13	Selection of ABO compatible donor red blood cells	39
14	Appearance of serological markers in HBV infection	53
15	Universal Bio Hazard Symbol	68
16	Colour Coded Bins	68
17	Red Bin with Infected Waste Discard	68
18	Black Bin with General Waste Discard	68
19	Constituents of Blood	74
20	Whole Blood showing color coded label and segments	77
21	Red Cell Concentrate color coded label and segments	77
22	Fresh Frozen Plasma Unit	77
23	Transfusion Reaction	98
24	Concept of Quality Management	115

INTRODUCTION TO BLOOD TRANSFUSION SERVICES

Blood transfusion is an essential and life-saving support within the health care system but the safety and availability of blood and transfusion is not assured. The threats include:

- An insufficient number of voluntary non-remunerated repeat regular blood donors to ensure an adequate supply of safe blood and blood components.
- Risk of the transmission of infections such as HIV, hepatitis B and C, and syphilis through unsafe transfusion.
- Unnecessary transfusions, which needlessly expose patients to the risk of acute or delayed reactions and transfusion-transmitted infections.
- Errors in the transfusion of blood and blood components.

In order to ensure sustainability and overall safety of the entire blood transfusion process, an effective quality management system needs to be implemented.

There are many definitions of quality, one of the simplest and most appropriate being “fit for purpose”. In the context of blood transfusion, this means the setting and meeting of basic national quality standards and then continual quality improvement to ensure the safety of the transfusion process.

This training program is designed to improve the safety and quality of blood transfusion by capacity building in all aspects of blood transfusion.

The fundamental aim of this training is therefore to instill an understanding in the participants that for blood safety, a culture of quality has to be created in BTSs and that all staff needs to be fully aware of this culture and play their part in putting it into practice. An important part of the training course, and a measure of its effectiveness, is to ensure that course participants are aware of their central role in this process and their interest and enthusiasm for quality is aroused. One of the fundamental objectives of the courses is to help participants develop a realistic plan of action for establishing an effective quality system in their blood banks.



Blood safety depends on the following factors

- The incidence and prevalence of transfusion - transmissible infections in the blood donor population.
- The effectiveness of the blood donor education and recruitment programme and procedures for donor selection and screening, including the deferral or exclusion of unsuitable donors.
- The quality of screening of all donated blood for transfusion-transmissible infections.
- The quality of blood grouping, compatibility testing, component preparation and the storage and transportation of blood products.
- The extent to which blood and blood products are prescribed only when there is no alternative to transfusion for the particular patient.
- The reliability of the system for ensuring that patients receive blood that is compatible with their blood group, red cell antibodies and other special requirements.

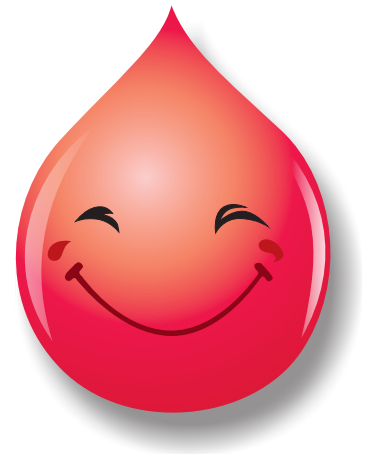
It is therefore important that the quality and safety of all blood and blood products be assured throughout the process from the selection of blood donors to the administration of the product to the patient.

BLOOD DONOR SELECTION

Learning Objectives

When you have completed this chapter you should be able to:

- Identify the donors for blood collection
- Describe the types of donors and the reasons for the deferral of donors
- Perform estimation of Hemoglobin
- Recognize the donor's reaction and its prevention
- Organize blood donation camps



1.1 Components of Donor Selection

Blood collection is the most essential function of a blood transfusion service and proper attention should be given to its arrangement. Blood donation must be made a pleasant and rewarding experience for the blood donor.

i) Donor Recruitment and Retention

Recruitment and Retention of voluntary blood donors is the key to safe and sufficient blood supply. The goal to be achieved is a panel / registry of repeat donors who are well informed, committed and regularly screened for markers of transfusion transmissible diseases. The universal principle is careful planning, organization, knowledge about the communities and their motivating factors, effective communication and campaign. Good service and support of donors as well as good public reputation goes a long way in increasing the voluntary safe blood donors or donation.

The other vital principle is that everyone involved in Blood Transfusion Services (BTS) should advocate for voluntary blood donation. Doctors, nurses, technicians, donor recruiters, PRO/ MSW, driver, attendants as well as paramedics are all part of a team with a common purpose and an important message to get across. The task is to cause 100% voluntary donation, which will take time, but we have the greatest resource - PEOPLE. Success lies in harnessing “PEOPLE POWER”.

ii) Donor Education

- Awareness of the kind of information people need before deciding to donate blood is an important basis for Donor education, motivation and recruitment activities
- Donor education about the need for safe blood is essential for donor recruitment strategy
- Community organizations and individual volunteers play an important role in donor recruitment
- Educational materials in the form of leaflets, posters, films do support donor education. Educational talks delivered at important forums on safe blood will help in motivating the public to donate blood.
- Effectiveness of donor education, motivation and recruitment should be monitored and evaluated on a regular basis.

iii) Donor Care and Satisfaction

The donors are the most important people in any blood transfusion set up as without them the services cannot continue to operate.

- Everyone involved in interviewing and counselling should develop a friendly and tactful approach that encourages donors to be honest and accurate in their answers to questions about their medical history
- The health check should always be handled professionally so that the donors feel they are in good hands
- The environment around the blood donation area should be safe, pleasant and convenient
- It is always essential for the staff to show a high degree of professionalism, to be smart, and to maintain personal hygiene
- They should be good mannered and be capable of conversing freely with the donors at the time of donation.
- An act of carelessness or lack of professionalism by staff during or after donation can be detrimental to the donors coming back to donate blood.

It is important to make the experience of blood donation pleasant for donors by providing

- Hygienic safe environment
- Short waiting time
- Privacy during pre - donation counselling
- Adequate explanation of the procedures
- Reasons for temporary or permanent deferral
- Individual care for each donor
- Sensitivity to their feelings of fear and embarrassment
- A word of appreciation and thankfulness to motivate them to come again.
- Indiscreet comments about donor's previous health check results and deferral should not be made.
- Chatting with other staff and ignoring the donor should be avoided.

Roles and Responsibilities of nurses:

- Should have knowledge of Donor Recruitment and Retention
- Advocate for voluntary blood donation
- Educate donors about the need for safe blood and donor recruitment process
- Develop a friendly approach so that while interviewing or counselling donors, the donors could be honest and accurate in answering questions related to their medical history
- Maintain high professional standards, is smart, clean and maintains personal hygiene



1.2 Donor Room Procedures

1) Location

The blood donation complex should be located at a place which is easily accessible to the general public and the patient's relatives.

2) Types of Donors

- (i) Voluntary blood donors
- (ii) Replacement / Relative donors
- (iii) Professional donors
- (iv) Autologous blood donors
- (v) Donors for special procedures (Plateletpheresis / Plasmapheresis / Erythrocytapheresis / Haematopoietic stem cell collection / Leucopheresis etc)
- (vi) Directed or designated donors



(i). Voluntary Non-remunerated Donors

The voluntary donors give blood voluntarily without receiving any remuneration in the form of money or a substitute for money. Their primary motivation is to help unknown recipients and not to obtain any personal benefit.

They are the safest donors because they are more likely to be free from TTI as they have been educated about the importance of safe blood. Once they become repeat donors, they are screened each time they donate blood thereby reducing the chances of window period donation.

(ii). Replacement Donors

The replacement donors come to the BTS with a request from the physician treating the patient, giving particulars of the patient like name, ward, hospital ID, diagnosis, and an estimate of the blood and blood components likely to be required. Members of the patient's family are under pressure to donate blood and may conceal potentially important information about their health status, particularly the risk of transmitting an infectious disease.

Relatives who cannot find suitable or willing donors within the family may seek replacement donors who are prepared to give their blood for payment. Donors who are paid by the patient's family are less likely to reveal any reasons why they may be unsuitable as donors.

(iii). Professional donors

They give blood in return for money. Though strictly banned by regulations, they still continue to donate blood under the garb of replacement donors. They do not reveal their unsuitability to donate blood. Paid donors present a major risk to the safety of the blood supply for the following reasons.

- Paid donors undermine the voluntary non remunerated system of blood donation which is the foundation of a safe blood supply.
- The highest incidence and prevalence of transfusion-transmissible infections are generally found among commercial or paid donors.
- They are often under nourished, in poor health and may donate their blood more frequently than it is recommended. This may have harmful effects on their own health as well as present a risk to the recipients.

Professional donors should be rejected and may be identified by the following criteria:

- Nervousness and aggressive behaviour
- Vague answers
- Needle marks / scars on antecubital areas of both arms
- Mismatched in socioeconomic status of donor and patient
- Unwillingness to bring other donors

(iv). Autologous Donors

They are donors who donate blood for themselves, to be used at a later date. Recipients who serve as their own donors receive the safest possible blood since the risks of TTI and alloimmunization are completely eliminated.

(v). Aphaeresis donors

They are a special category of donors who willingly donate only the specific blood component required. They need to be screened thoroughly before putting them on the aphaeresis machine.

3) Measurement of Hemoglobin

(i). Hemoglobin Estimation by Copper Sulphate (CuSO₄) Test

Principle: This is a semi quantitative test based on specific gravity a drop of blood with hemoglobin concentration of not less than 12.5 g/dL sinks in a CuSO₄ solution with a specific gravity of 1.053.

30 ml of copper sulphate working solution (sp.gr.1.053) in a clean, dry beaker is used for determining hemoglobin. The working solution is changed after testing 25 samples.

Procedure:

1. The fingertip is cleaned thoroughly with a spirit swab and allowed to dry.
2. Medial side of the left ring finger of the donor is pricked using a sterile lancet.
3. The first drop of blood is wiped and next drop of blood is allowed to fall into a beaker containing CuSO₄ solution of specific gravity 1.053 from a height of at least 1 cm.
4. If blood drop sinks to the bottom of the solution then the hemoglobin is more than 12.5 g/dL.
5. If blood drop floats for more than 15 seconds then the hemoglobin is less than 12.5 g/dL.

Preparation of CuSO_4 for Hemoglobin Estimation

To prepare 100 ml of copper sulphate working solution (Sp.gr.1.053)

- i. Carefully weigh 159.6gms of pure air dried crystals of CuSO_4 and put it in a conical flask and add distilled water to make it to 1000ml of stock solution.
- ii. Cap the flask and mix well to ensure that the copper sulphate has dissolved.
- iii. Specific gravity of the stock solution made is 1.100.
- iv. Add 52 ml of prepared stock solution to 48 ml of distilled water to make 100 ml of working solution.
- v. Check the specific gravity (of 1.053) by hydrometer.
- vi. Solution should be stored at room temperature in tightly capped containers to prevent evaporation.

Quality control of CuSO_4

1. Check the copper sulphate working solution against a light source for presence of precipitate and cloudiness.
2. Check the specific gravity of the solution using a hydrometer.
3. Copper sulphate being a coloured solution, the marking on the hydrometer. Corresponding to the upper meniscus of the solution should be 1.053 for 12.5g/dL of hemoglobin.
4. Arrange the blood samples according to hemoglobin concentration in a rack
5. Obtain samples of known hemoglobin values.
6. Transfer 30 ml of copper sulphate working solution in a tube.
7. Mix the sample of known hemoglobin concentration by inversion technique.
8. Allow one drop of blood to fall gently into the copper sulphate solution.
9. Repeat the procedure for all blood samples.
10. Record the results in the record book.

Table 1.1: Hemoglobin concentration and Interpretation

Results	Hemoglobin concentration	Interpretation
Blood drop floats	Hemoglobin < 12.5gm/dL	Defer
Blood drop sinks	Hemoglobin \geq 12.5gm/dL	Accept

Note: Drop to be observed in 15 seconds

Table 1.2: Quality control of CuSO₄

Date of Preparation of working solution _____ Technician _____

Date	Specific gravity CuSO ₄	Hemoglobin estimation			Signature of Doctor
		CuSO ₄ method (Hb < or ≥ 12.5 gm/dL)	By Cell Counter	Any other – Hemoglobin meter / Colour strip	

CuSO₄ (stock solution)

Date of preparation: _____

Volume of stock solution prepared: _____

Weight of dry crystal of CuSO₄ used: _____

Specific gravity: _____

Technician name: _____

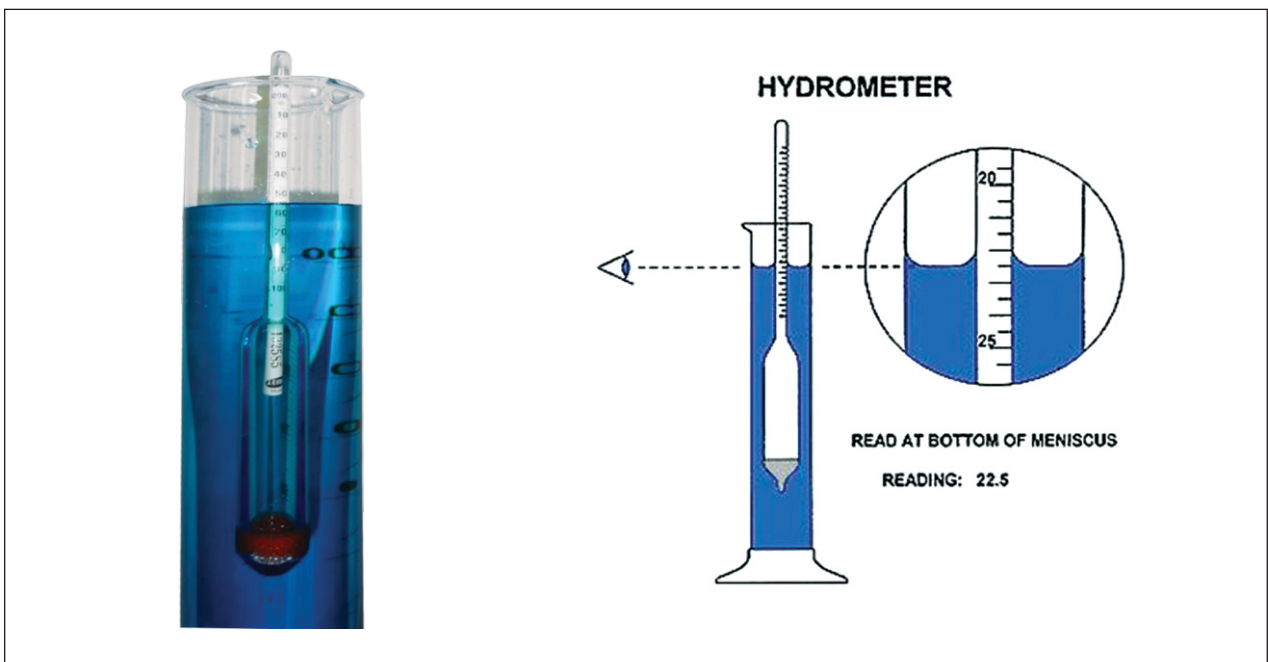


Figure 1: Copper Sulphate Solution

Figure 2: Copper Sulphate solution - Specific gravity measurement

(ii). Hemoglobin estimation by portable digital Haemoglobinometer

This is a quantitative test.

Principle: Azide methemoglobin method to measure Hb in undiluted blood.

Microcuvettes used for Hb estimation has;

Sodium desoxycholate that dissolves and disperses the cell membrane of the red blood corpuscles thereby releasing the hemoglobin formerly contained in the erythrocytes.

Sodium nitrite it oxidises the bivalent iron of the oxyhemoglobin and the deoxyhemoglobin to trivalent iron, in methemoglobin.

Sodium azide existing and formed methemoglobin and azide ions from sodium azide NaN_3 form a coloured complex which exhibits maximal absorption at 540 and 575 nm and hence it can be quantitatively determined photo metrically.

Microcuvettes can be stored for a period of two years from the date of manufacture but once opened they are stable only for three months.

Method

- i. The ring finger tip is cleaned thoroughly with spirit swab and allowed to dry.
- ii. The finger is then punctured firmly near the tip with sterile disposable lancet. A good free flow of blood is ensured; the finger is not to be squeezed repeatedly since it may dilute the blood drop with excess tissue fluid and give false low results.
- iii. The first drop of blood is wiped and the next drop of blood is allowed to fill the cuvette completely in one continuous process.
- iv. Wipe off the excess blood on the outside of cuvette. Make sure that no blood is withdrawn out of the cuvette during this procedure.
- v. Place the filled cuvette into the cuvette holder immediately and push it in a measuring position.
- vi. Results are displayed in 15-45 seconds in g/dL.
- vii. Dispose the cuvettes and lancets in 1% sodium hypochlorite solution in a puncture proof container.

Interpretation

1. Donors with hemoglobin more than or equal to 12.5gm/dL are accepted for blood donation.
2. However, if the hemoglobin level is less than 12.5gm/dL the donor is deferred. Refer the donor to a physician for advice.

4. Donor selection for whole blood donation (as per Drugs and Cosmetics Act, 1940)

Donor selection is critical to the supply of safe blood and its products.

The purpose of donor selection is to identify any factors that might make an individual unsuitable as a donor, either temporarily or permanently. The following guidelines should be observed in selection of donors.

Donor selection is done by a qualified medical officer and is based on medical history, limited physical examination and simple laboratory tests. It should be done very carefully to avoid any untoward effect on the donor or the recipient. The prospective donor should appear to be in good health

1. General: No person shall donate blood and no blood bank shall draw blood from a person, more than once in three months. The donor shall be in good health, mentally alert and physically fit and shall not be inmate of jail, persons having multiple sex partners and drug-addicts. The donors shall fulfil the following requirements, namely:

- a) The donor shall be in the age group of 18 to 65 years;
- b) The donor shall not be less than 45 kilograms;
- c) Temperature and pulse of the donor shall be normal;
- d) The systolic and diastolic blood pressures are within normal limits without medication;
- e) Hemoglobin which shall not be less than 12.5 grams;
- f) The donor shall be free from acute respiratory diseases;
- g) The donor shall be free from any skin diseases at the site of phlebotomy;
- h) The donor shall be free from any disease transmissible by blood transfusion, insofar as can be determined by history and examination indicated above;
- i) The arms and forearms of the donor shall be free from skin punctures or scars indicative of professional blood donors or addiction of self-injected narcotics.

2. Additional qualifications of a donor: No person shall donate blood, and no blood bank shall draw blood from a donor, in the conditions mentioned in column (1) of the Table given below before the expiry of the period of deferment mentioned in the column (2) of the said Table

Table 1.3: Deferment of blood donation

CONDITIONS (1)	PERIOD OF DEFERMENT (2)
(a) Abortions	6 months
(b) History of Blood transfusion	6 months
(c) Surgery	12 months
(d) Typhoid	12 months
(e) History of malaria and duly treated	3 months (endemic) 3 years (non-endemic area)
(f) Tattoo	6 months
(g) Breast feeding	12 months after delivery
(h) Immunization (Cholera Typhoid, Diphtheria, Tetanus, Plague, Gammaglobulin)	15 days
(I) Rabies vaccination	1 year after vaccination
(j) History of Hepatitis in family or close contact	12 months
(k) Immunoglobulin	12 months

3. No person shall donate blood and no blood bank shall draw blood from a person, suffering from any of the diseases mentioned below, namely:-

- (a) Cancer
- (b) Heart disease
- (c) Abnormal bleeding tendencies
- (d) Unexplained weight loss
- (e) Diabetes controlled on insulin
- (f) Hepatitis infection
- (g) Chronic nephritis
- (h) Signs and symptoms suggestive of AIDS
- (I) Liver disease
- (j) Tuberculosis
- (k) Polycythaemia Vera
- (l) Asthma
- (m) Epilepsy
- (n) Leprosy
- (o) Schizophrenia
- (p) Endocrine disorders

(For details refer WHO guidelines: www.who.int/bloodsafety/publications/bts_guideline_donor_suitability/en)

Guidelines on Assessing Donor suitability for blood donation

Physical Examination

- A prospective donor should be in good health.
- Donors weighing more than 45 kg (for 350ml) and more than 50 kg (for 450ml) are acceptable (8-9 ml/kg body weight).
- Blood pressure should be within acceptable range for a particular age group with or without medication. Diastolic BP: 60 to 90mm of Hg; Systolic BP: 100 to 160 mm of Hg.
- Hemoglobin should not be less than 12.5g/dL
- Pulse of the donor should be observed for one minute and should be between 60 to 100. Any irregularity in the pulse or pulse deficit more than 10 should be considered for deferral
- Phlebotomy site is examined for any infective lesions and scar of needle pricks indicative of intravenous drug abuse or frequent blood donations.
- Systemic examination of heart, lungs and abdomen should be normal.
- There should be no generalized lymphadenopathy or epitrochlear nodes.

5. Donor registration

It is the information form / card to be filled by the donor with all demographic details in order to trace the donor in case of any requirement.

The following information must be included

1. Date of donation
2. Name of the donor
3. Father's/husband's name
4. Age (date of birth)
5. Gender
6. Occupation
7. Address and telephone no. of residence/place of work
8. Blood group, if known
9. Date of last donation
10. Previous donor reaction, if any
11. Consent for Inclusion in emergency panel
12. Previous deferral from donation (and its reasons)

(i) Donor consent

Consent of the donor should be taken for phlebotomy and screening tests for various transfusion transmitted diseases. Consent should also be taken for revealing the results of screening tests.

Understand that:

- (a) Blood donation is a totally voluntary act and no inducement or remuneration has been offered

- (b) Donation of blood/components is a medical procedure and that by donating Voluntarily, I accept the risk associated with this procedure.
- (c) My donated blood, blood and plasma recovered from my donated blood may be sent for plasma fractionation for preparation of plasma derived medicinal products, all of which may be used for larger patient population and not just this blood bank.
- (d) My blood will be tested for Hepatitis B, Hepatitis C, Malaria parasite, HIV/AIDS and syphilis in addition to any other screening tests required ensuring blood safety.
- (e) I would like to be informed about any abnormal test results done on my donated blood: Yes/No

(ii) Directed donation

The donors for directed donation are also selected as above and are informed, that his/her donation may be used in the general pool if not transfused to the designated recipient. Consent is taken for the same in the register / form provided.

Donors are to be selected as above and directed donor is informed, that his/her donation may be used in general pool if not transfused to the designated recipient. Consent is taken for the same in the register provided. Directed donation from family members is discouraged and if necessary, the blood should be irradiated before transfusion to the family member for prevention of Transfusion-Associated Graft vs. Host Disease. (TA-GVHD)

(iii) Pre-deposit Autologous donation (Ref: DGHS Technical Manual)

The donors for Pre-deposit Autologous donation are accepted after receiving a written request from the treating/concerned doctor that the donor can withstand the stress of donation. Donor selection criteria can be relaxed in case of autologous donors. Blood bank physician may still refuse to accept the donor if he/she doesn't find the donor fit for donation. Autologous Blood donation unit is not taken into general inventory as relaxation in donation selection criteria may deem it unfit for other patients. However mandatory testing for infectious disease markers is carried out and any unit found reactive is discarded after notifying the concerned physician.

For Autologous Donation : Minimum hemoglobin level should be 11 g/dL or hematocrit \geq 34%

There is no upper and lower age limit and no weight restrictions. However, the volume should not exceed 9ml/kg body weight

(iv) Plateletpheresis (Ref: DGHS Technical Manual)

General screening procedure and the prerequisites are the same as for routine whole blood donation along with following special requirements for serial apheresis program.

- a. Donor should meet all the acceptable criteria.
- b. Age of the donor should be between 18 to 50 years.
- c. The weight of the donor should be more than 60kg.
- d. The results of the TTI screening test of the donor should be non-reactive for all the TTIs.
- e. The pre-procedure platelet count should be more than 150,000 / μL . Donor with less than 1,50,000 / μL pre procedure count is deferred irrespective of fulfilling other criteria
- f. Donor should not have taken aspirin or any other platelet inhibitor in last 72 hours.
- g. The donor should not be fasting prior to the procedure, however should refrain from oily/spicy food, also citrus fruits or juices.
- h. Donor should have a prominent and easily accessible antecubital vein in at least one of the arms.

Note: If the donor is on other antiplatelet drug which has a longer platelet inhibitory effect, he/she should be deferred for longer periods accordingly.

(v) Donation interval

- The minimum time gap between two blood donations should be **12 weeks/3 months**.
- Whole blood donation must be deferred for at least **72 hours** after plateletpheresis. In case of re-infusion failure, donor should not donate whole blood for **12 weeks**

(vi) Private Interview

A detailed sexual history should be taken. Positive history should be recorded in a confidential notebook. It is important to ask donors if they have been engaged in any high risky behaviour. Allow sufficient time for discussion in the private cubicle. Try and identify result-seeking donors and refer them to ICTC (Integrated Counseling and Testing Centre) Reassure the donor that strict confidentiality is maintained.

- **Pre donation counseling:** Donor should be given information on blood donation process and the procedures to identify their suitability as donors. They should be encouraged to self-exclude or self-defer.
- **Donor self-exclusion:** The decision by a donor, not to give blood because they have engaged in risk behaviour or because of the state of their own health.
- **Self-deferral:** The decision by the donor to wait until an unsuitable condition resolves. Privacy and confidentiality of the donor should be maintained during donor selection.

(vii) Donor acceptance / rejection

- Depending on the criteria of donor selection, the donors are accepted or deferred.
- When donors are deferred either temporarily or permanently, the reasons for deferral should be explained and appropriate documentation should be done. Temporarily deferred donors should be encouraged to come for donation once the deferral period is over.

6. Blood Collection Procedure

(i). Materials required in the blood collection area

• Demethylated spirit	• Oxygen cylinder with accessories
• Betadine	• Rubber gloves
• Isopropyl swab	• First aid tray
• Cotton/Gauze swabs	• Tube stripper
• Pilot Tubes: Plain and EDTA	• Electronic tube sealer
• Puncture proof container	• Needle destroyer
• Artery forceps, Scissors	• Blood collecting bags
• Bp Apparatus (non-mercury) / Tourniquet	• Discard Jar with 1% Sodium Hypochlorite
• Blood bag mixer / Comfortable donor couch or chair	• Adhesive plaster

(ii) Selection of Blood Bag for blood collection

There are variations in the volume of blood to be collected and the type of anticoagulant-preservative solution to be used. Different types of blood bags in use:

- Single
- Double
- Triple (with or without additive solution)
- Quadruple (with additive solution)
- Penta bags

The approved anticoagulant-preservatives solutions used in the blood bag with the shelf life of whole blood/PRBC

- Acid-citrate-dextrose solution (ACD) : 21 days
- Citrate-phosphate-dextrose solution (CPD) : 28 days
- Citrate-phosphate-dextrose-dextrose solution (CP2D) : 21 days
- Citrate-phosphate-dextrose-adenine solution (CPDA-1). : 35 days

Whole blood is obtained from human blood donors by venesection. During donation, blood is collected into a sterile, disposable, plastic pack which contains an anticoagulant-preservative solution. This solution usually contains citrate, phosphate, dextrose and often adenine (CPDA). Their individual functions are.

Solutions	Functions
C Sodium Citrate	Binds with calcium ions in blood in exchange for the sodium salt so that the blood does not clot
P Phosphate	Supports metabolism of the red cells during storage to ensure they release oxygen readily at tissue level
D Dextrose	Maintains the red cell membrane to increase storage life
A Adenine	Provides energy source

During storage, metabolism continues in the red cells and platelets, while some plasma proteins lose their biological activity.

The biochemical and metabolic effects of storage on whole blood are

- Reduction in the pH (blood becomes more acidic)
- Rise in plasma potassium concentration (extracellular K⁺)
- Progressive reduction in the red cell content of 2,3 diphosphoglycerate (2,3 DPG) may reduce the release of oxygen at tissue level until it is restored
- Loss of all platelet function in whole blood within 48 hours of donation
- Reduction in Factor VIII to 10–20% of normal within 48 hours of donation. Coagulation factors such as VII and IX are relatively stable in storage

Additive solutions (AS) : Used to enhance the shelf life of RBC to 42 days. Most commonly used additive solution is SAGM which contains Saline, Adenine, Glucose and Mannitol. A donation of 450 ml of whole blood requires 100 ml of AS for extending the shelf life to 42 days.

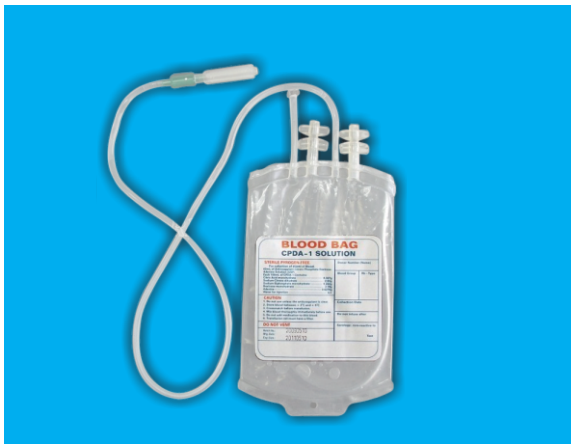


Figure 3: Single Blood Bag



Figure 4: Double Blood Bag



Figure 5: Triple Blood Bag System



Figure 6: Quadruple Blood Bag System



Figure 7: Penta Blood Bag System

(Photos/images source 3-7: Transfusion Medicine Centre, NIMHANS, Bangalore)

Table 1.4: Recommended blood bags for various components

DONOR		COMPONENTS	BAGS	
Weight	Aspirin intake	Prepared	Type	Qty. (ml) of Blood
>50kg	No	PRBC+FFP+PC	Triple or Quadruple	450ml
>50kg	Yes	PRBC+FFP	Double	350/450ml
45-50kg	No	Whole blood/ PRBC+FFP	Single/ Double	350ml
45-50kg	Yes	Whole blood/PRBC+ FFP	Single/ Double	350ml

PRBC: Packed Red Blood Cells

FFP: Fresh Frozen Plasma

PC: Platelet Concentrate

- Before use, Check the expiry date of the bag and look for any puncture or discoloration of the bag visually. If so reject the bag and do not use.
- Use single bag when:
 1. Components are not to be separated from that unit.
 2. When autologous blood is collected for patients e.g., elective surgery.
 3. Therapeutic phlebotomy is being performed on a patient.

(iii) Collection of Blood

- Receive donor cordially in the blood collection area as he/she should feel that staff is caring, concerned and committed.
- After a thorough screening, the donor is asked to lie down on the donor couch in a well-lit and air-conditioned environment.
- Identification of donor must be re-checked by asking him/her to tell their name and tally it with card, blood bag and sample tubes (pilot tubes) and registration number.

Preparation of phlebotomy site

- Select prominent vein (preferably central) in the ante-cubital area, apply BP cuff, and inflate till 40 to 60 mm Hg. Alternately tourniquet can be used. Lower margins of the tourniquet should be one and half inch above the ante-cubital area to avoid contamination.

- The area should be disinfected with two disinfectants – Iodine based and methylated spirit or isopropyl alcohol or 2% chlorhexidine is used to prepare the site for phlebotomy.



Figure 8: Cleaning Phlebotomy site with Povidone Iodine

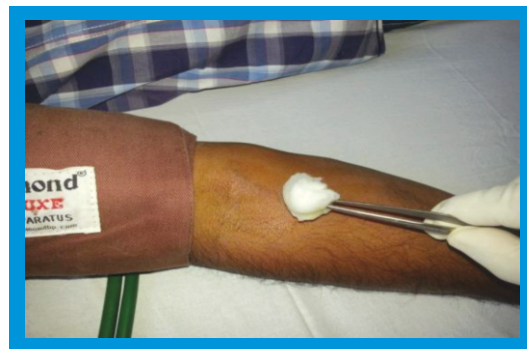


Figure 9: Cleaning Phlebotomy site with Isopropyl Alcohol

(Picture source: Trans fusion medicine centre, NIMHANS, Bangalore)

- Position donor's arm in naturally extended position and provide handgrip and request the donor to squeeze firmly.
- Do not use betadine if donor is allergic to iodine.
- Start disinfection of the skin of about an area of 5 cm of diameter from the centre outwards in the circular motion.
- Allow this solution to dry for 30 seconds.
- If the phlebotomy site is touched after cleaning, repeat the skin disinfection procedure.
- Set the blood collection monitor for desired volume and place the bag on it.
- Clamp the bleed line of the blood bag using plastic clamp to ensure that no air enters the tubing or the bag once the needle cover is removed.
- Keep the bevel of the needle upwards and the shaft at an angle of 15 degree with the arm, insert the needle in the vein 1 to 1.5 cm by a bold single sharp prick.
- Monitor filling of blood bag and assure proper mixing with anticoagulant.
- Sign the donor record card after checking the number on the bag, card and tubes and indicate the arm used for phlebotomy.
- Interact with donor to prevent reaction. Allow collection to continue until desired quantity of blood is collected and NEVER leave the donor alone.
- Discontinue collection if donor feels uncomfortable or collection time is more than 10 minutes. or donor develops haematoma at venipuncture site.

Note: If the collection is not completed it should be considered as a donated unit and after due testing, should be discarded as under collected.

- In case of venipuncture failure, second venipuncture may be performed if the donor gives consent to do so. NEVER use same arm or bag for a second venipuncture.

- Seal tubing by tube sealer and cut it 8 to 10 inches away from venipuncture end and take samples in pilot tubes.
- Before separating collected unit of whole blood from donor's couch re-inspect the blood bag for any defects and recheck donor's registration number and name on blood bag, processing tubes, donor records and donor slip that is to be issued in case of Relative Donor / Directed Donor / Autologous Donor.
- Remove sphygmomanometer cuff/tourniquet.
- Apply pressure by folding the arm at phlebotomy site so that swab may not fall. Affix adhesive tape after verifying that there is no ooze at the venipuncture site and a stable clot has formed.
- Rest and refreshment is to be given to donor and observe the donor for at least 15-20 minutes post donation. If he/she feels well, then he/she may be allowed to leave. The first time donor, obese donor or female donor should be given extra rest and may be escorted to refreshment area.

Observation of donor:

- To prevent adverse reactions like giddiness, ask the donor not to get up from the chair for 8-10 minutes even if he/she feels perfectly all right.
- Observe for another 10 minutes in the refreshment area while the donor has refreshment (a packet of biscuit and a tetra pack fruit drink).
- Inspect the venipuncture site before the donor leaves the donor room. Apply an adhesive tape only after oozing stops. If there is persistent oozing at the site of venipuncture, apply pressure with a dry, sterile cotton swab. If there is haematoma apply Thrombophob ointment gently over the area after 5 minutes. Inform the donor about the expected change in skin colour. If the pain persists, ask him/her to apply ice and the donor must contact the blood bank personnel.
- Issue the donor replacement/voluntary donor card and ensure that the donor puts his/her signature on the donor record register.
- Thank the donor and encourage him/her to become a regular voluntary blood donor.
- Ask the donor to write his/her comments/suggestions in the donor refreshment register.

7. Post Donation Care

Instruct the donors regarding the following:-

- Take more fluids for next 4 hours
- Do not smoke or drive for next half an hour
- Do not drink alcohol for next 6 hours
- If bleeding occurs from phlebotomy site raise the arm and apply pressure on the venipuncture site

- If the donor is feeling dizzy, make him/her lie down with legs slightly raised above the head level and if symptoms still persist consult nearest doctor, blood bank doctor or clinician
- Remove the adhesive band after 5-6 hours
- Do not apply any medication on venipuncture site on your own.
- Avoid lifting heavy weight or strenuous exercise to prevent bruising or bleeding from venipuncture site.
- No extra/special diet is needed. However, iron rich foods may be advised like green leafy vegetables, jaggery, dates, meat (for non-vegetarians), etc.
- Rest and refreshment should be given to all.
- Thank the donor for their valuable contribution and ask them to repeat the same for a noble cause. A thank you card goes a long way for the donor to come back as a repeat donor.

8. Donor reaction and its prevention

Definition: Untoward feeling by blood donor before, during or after blood donation is known as a donor reaction.

Table 1.5 Classification of Donor Adverse Reactions

LOCAL REACTIONS RELATED TO NEEDLE INSERTION	
Category	
Vessel Injuries	Haematoma, Arterial puncture, Thrombophlebitis
Nerve Injuries	Injury of a nerve, Injury of a nerve by a haematoma
Other Complications (related to needle insertion)	Tendon injury, Allergic reaction (local), Infection (local)
RARE, IMPORTANT COMPLICATIONS	
Related to Vessel Injury	Brachial artery pseudoaneurysm, Arteriovenous fistula, Compartment syndrome, Axillary vein thrombosis
Accidents	Accidents related to Vasovagal syncope, Other kinds of accidents
Cardiovascular Reactions	Angina pectoris, Myocardial infarct, Acute neurological condition (TIA, stroke)
Related to apheresis procedures	Diffuse allergic reaction, Anaphylaxis, Haemolysis, Air Embolus
Death	
Other	

1. Types of Vasovagal reactions

- a) Mild Vasovagal Reaction
- b) Moderate Vasovagal reaction
- c) Severe Vasovagal reaction

a) Mild Vasovagal reaction

Incidence 1-2%

Symptoms : Pallor, perspiration specially on palms, forehead which may be generalized, sighing or yawning, hyperventilation, feeling of warmth or air hunger, dizziness, light headedness, nausea with or without vomiting.

Management:

- Discontinue donation
- Immediate sealing of venipuncture site
- Application of wet towels to donor's forehead and ask donor to cough
- Loosen any tight clothing and ensure that the donor has clear airway
- Raise the knees with feet flat on the bed/couch
- Talk to donor to assure that it is nothing serious and he/she will be perfectly alright
- The donor should NEVER be left alone
- Allow a sufficient period of rest before he leaves the room.


b) Moderate Vasovagal reaction

Symptoms: There is progression of all the symptoms of mild reaction and additional symptoms of bradycardia, shallow respiration, hypotension (systolic as low as 60mm Hg), quiet anxiety may be present. There is prolonged recovery. Donor must be protected from injury if unconsciousness occurs.

Management: In addition to treatment of mild reaction administration of 95% O₂ and 5% CO₂ may be helpful in case of fainting with hyperventilation. If possible remove the donor from the general donor area to another room or use a screen to prevent sympathetic fainting. In case facility for monitored administration of 95% O₂ and 5% CO₂ is not available, rebreathing into a paperbag is helpful.

c) Severe Vasovagal reaction

Symptoms: All symptoms of mild or moderate reaction with any or all of the following: incontinence of urine or faeces (it's very rare), convulsions focal or generalized.



Management: Must prevent injury to donor, padded tongue blade needs to be placed between teeth if convulsions are prolonged.

Do not give anything by mouth during reaction. If there is no improvement within 30 minutes, shift the donor to emergency medical ward and administer 300-500 ml normal saline with or without dextrose.

After recovery post donation instruction must be given to the donor and some additional instructions depending upon the severity of the reaction. Documentation of such reactions must be made on the donor card/donor register and should be explained to donor and called the next morning or evening for follow up and for reassurance.

Observation is very essential. Keep donor under observation in rest room. If need be, assistance should be provided to accompany the donor to his place to avoid any injury or accident.

2. **Tetany / Muscular spasm / Twitching:** These are usually due to hyperventilation in an apprehensive donor. Ask the donor to breathe in a paper bag to counteract the effect of hyperventilation by increasing amount of carbon dioxide, which provides prompt relief. Do not give oxygen. Give Inj calcium Gluconate slowly over a period of 10 minutes if tetany persists
3. **Haematoma:** Release the tourniquet/pressure cuff immediately. Apply pressure on the venepuncture site and withdraw the needle from the vein. Raise the arm above the head for a few minutes. Apply Thrombophob ointment gently around the phlebotomy site after about 5 minutes. Advise the donor to apply ice if there is pain and inform about the expected change in skin colour.
4. **Convulsions:** Keep the head tilted to the side; prevent the tongue bite; keep the airway patent by inserting a tongue blade or gauze between the teeth
5. **Eczematous reactions of the skin around venepuncture site:** Apply steroid ointment.
6. **Delayed syncope:** These may occur as late as 30 minutes to 1 hour after donation, usually after the donor has left the blood bank. Permanently defer any donor who gives history of such attacks more than twice.
7. **Accidental puncture of Artery :** This is uncommon but you should be able to recognise as a very fast flow of bright red blood. You should discontinue the donation and apply hard pressure after withdrawal of the needle for at least 15 minutes Apply a pressure bandage to be kept for 4-6 hrs Reassure the donor and explain for unsuccessful venepuncture and apologise.
8. **Problems with blood flow :** Occasionally venepuncture is unsuccessful or vein may develop spasm after venepuncture so that blood flow is not maintained. If so do not fiddle with the needle as it can cause haematoma. Remove the needle and discard the unit as it will be contaminated. Reassure the donor and explain for unsuccessful venepuncture and apologise. Record the information.

Table: 1.6. Materials required during an emergency in the post donation period

i. Oral medication

- ▶ Analgesic tablets(Paracetamol), Calcium and Vitamin C tablets

ii. Injection

- ▶ Inj. Adrenaline
- ▶ Inj. Atropine
- ▶ Inj. Avil
- ▶ Inj. Dexamethasone
- ▶ Inj. Hydrocortisone
- ▶ Inj. Phenargan
- ▶ Inj. Furosemide (Lasix)
- ▶ Inj. Dilantin
- ▶ Inj. Perinorm
- ▶ Inj. Deriphylline
- ▶ Inj. Soda-bi-carbonate
- ▶ Inj. KCL
- ▶ Inj. Calcium Gluconate
- ▶ Inj. Dopamine
- ▶ Inj. Rantac
- ▶ Inj. Diazepam
- ▶ Dextrose 25% 100 ml
- ▶ Normal Saline 500 ml
- ▶ Inj. Noradranaline
- ▶ Inj. Mefetine
- ▶ Inj. Diclofenac
- ▶ Inj. Vitamin K
- ▶ Inj. Tramadol
- ▶ Inj. Lignocaine 2%
- ▶ Inj. Midazolam

iii. Antiseptics

- ▶ Betadin, Tincture Benzoine

iv. Miscellaneous

- ▶ Laryngoscope
- ▶ Laryngoscope Blade
- ▶ Ambu Bag with Mask
- ▶ Reusable oxygen reservoir
- ▶ Torch
- ▶ Airway
- ▶ BT – Set
- ▶ IV – Set
- ▶ Syringe
- ▶ E.T. 7.5mm, 7.0mm
- ▶ Three-way stop cock
- ▶ Ventimask
- ▶ Veinflow – 18 G, 20 G
- ▶ Stilette
- ▶ Oxygen cylinder with key
- ▶ Artery forceps
- ▶ Kidney tray (Plastic)
- ▶ Emesis basin
- ▶ Scissors
- ▶ Adhesive Plaster
- ▶ Anti Histaminic Cream
- ▶ Heparin and Benzyl
- ▶ Nicotinate ointment
- ▶ Smelling Salt-Spirit of Ammonia
- ▶ Tongue Depressor
- ▶ Oxygen Cylinder
- ▶ Infusion Set
- ▶ Paper Bag

Blood Donor Selection

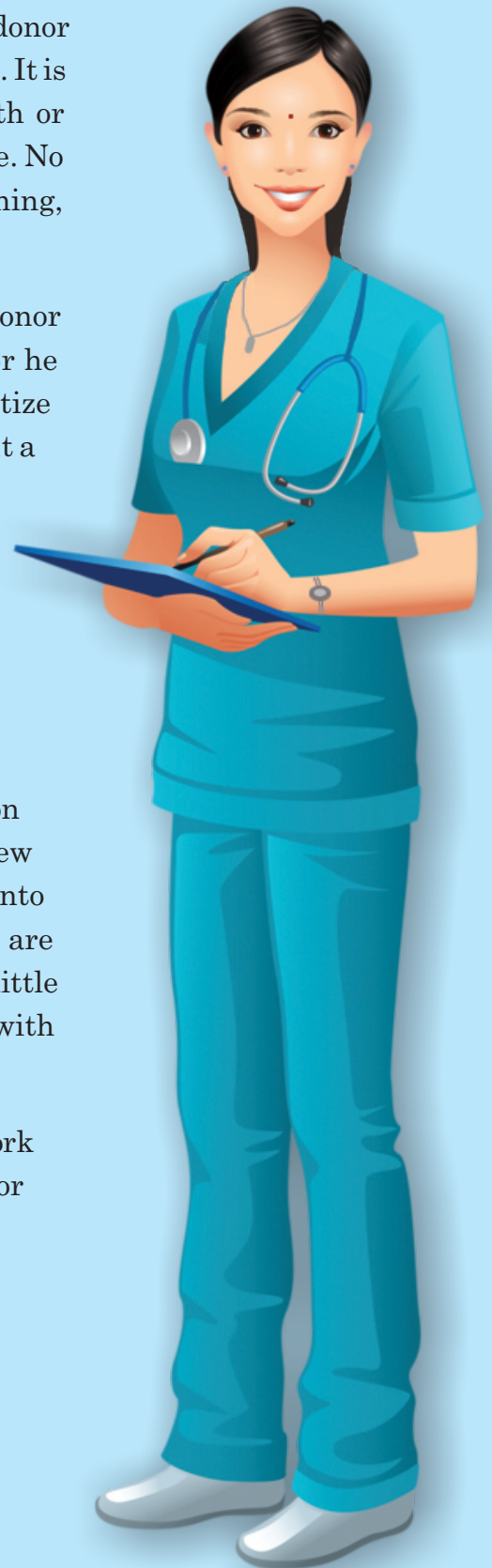


9. Roles and responsibilities of Nurses

- ◆ Nurses are responsible for providing daily leadership and supervision of blood transfusion services in the blood bank
- ◆ They will supervise the donor area and make the necessary arrangements to keep the donor area ready for blood collection
- ◆ Supervise staffing and daily activities to ensure the quality of work carried out
- ◆ Manages the blood inventory of the hospital
- ◆ Work as a team member along with the medical officer and technicians in donor selection
- ◆ Maintains the records of donor information
- ◆ Facilitates positive communications and interaction with the staff and the donor
- ◆ Helps in donor selection
- ◆ Carries out donor registration and obtains consent from the donor
- ◆ Provides health education to donors on blood donation
- ◆ Provides safe, pleasant and convenient environment for the donor
- ◆ Collects present medical and family history and past medical history of the donor
- ◆ Keeps all the materials required for blood collection ready at the bed side
- ◆ The medical officer collects the blood sample from the donor but the nurse should have knowledge and skill in performing grouping and measurement of hemoglobin
- ◆ Supports medical officer in carrying out physical examination of the donor
- ◆ Supports medical officer in carrying out phlebotomy for the donor
- ◆ Observes donor for any reactions. Monitors donor's parameters
- ◆ Observes for any reaction



- ◆ The nurse should remember that the focus of all donor selection is safety, both for the donor and the recipient. It is often necessary for donors to discuss intimate health or lifestyle related issues to ensure that they are suitable. No risks can be taken, so if the donor is unsure of anything, the blood bank will not take a donation.
- ◆ It is important to remember that an enthusiastic donor will, on occasion, find it difficult to accept that she or he cannot donate. It is the role of the nurse to sensitize donors and ensure that they are motivated to return at a later date if they can.
- ◆ If the volunteer is permanently deferred, it is important that the nurse clearly communicates the reason for the decision and shows appreciation for the effort that the person has made to help others.
- ◆ Changes are made regularly to the donor selection guidelines, hence nurses have to learn the new guidelines and ensure that essential policies are put into practice. It is important that the new changes are managed competently, accurately and with as little disruption to blood stocks and the relationship with donors as possible.
- ◆ Nurses should prepare protocols, ready reckoners, work flow charts, brochures, information posters etc. for ready reference.



1.3 Organization of Blood Donation Camps

Blood donation camp can be organized by

1. A licensed designated Regional Blood Transfusion Centre
2. A licensed Government blood bank
3. The Indian Red Cross Society
4. Licensed registered voluntary or Charitable Trust Organization recognized by State Blood Transfusion Council (SBTC).

Note:

- (i) "Designated Regional Blood Transfusion Centre" shall be a centre approved and designated by a Blood Transfusion Council constituted by a State Government to collect, process and distribute blood and its components to cater to the needs of the region and that centre has also been licensed and approved by the Licensing Authority and Central Licence Approving Authority for the purpose.
- (ii) The designated Regional Blood Transfusion Centre, Government blood bank and Indian Red Cross Society shall intimate within a period of seven days, the venue where blood camp was held and details of group wise blood units collected in the said camp to the Licensing Authority and Central Licence Approving Authority.
- (iii) *Definition of RBTC is under revision.*

1. Procedure for Organizing a Blood Donation Camp

The organizers or motivators are requested to furnish the following information in the confirmation letter:

- a. Exact venue of the camp
- b. Number of donors (approximately)
- c. Time of the camp
- d. Refreshment for donors i.e. whether it will be arranged by the organizers or department will reimburse for the same.

Name of organization: _____
Contact person: _____
Complete address with: _____
Tel./Fax/Mobile: _____
Phone no.: _____
Email: _____

Table 1.7 Required number of beds according to the expected number of donors

No. of Donors	No. of Couches/Beds
50-100 donors	6 to 8
100-200	8 to 10
200-300	10 to 14
Above 300 donors	14 to 16

Furniture

1. Big tables - as per number of donor beds (2 tent house tables will be required for one bed).
2. Folding donor couches for mobile camps.
3. Chairs with arms or sofa sets for donors in the refreshment area.

Apparatus and equipments required for blood donation camp

1. BP apparatus (non-mercury)
2. Stethoscope
3. Blood bags (Single - 350, Double-350/450, Triple-350/450, and Quadruple-350/450)
4. Donor questionnaire, Registration cards and other essential stationery
5. Weighing device for blood donors
6. Weighing device for blood bags
7. Blood collection monitor
8. Beaker, pipette and tips
9. Tourniquet
10. Bed sheets, draw sheets, blankets/mattress, pillows, Macintosh and arm rests
11. Lancet, blades
12. Footsteps, hand grip balls
13. Portable Hb meter with cuvettes /copper sulphate working solution
14. Glass tube/ Vacuum tube for pilot sample collection
15. Big racks for test tubes
16. Rubber bands
17. Spirit, betadine, cotton roll
18. Medicated adhesive tape, micropore or leucoplast roll
19. Gel packs (coolants), anti-coagulant solution

20. Plastic waste basket and colour coded plastic bags for waste disposal
21. Donor thank you cards
22. Emergency medical kit
23. Insulated blood bag container's (Transport boxes) with provision for storage temperature between 2 to 10 degrees centigrade.
24. Certificates of appreciation and honour and donor badges
25. IEC materials, Banners and post donation standee
26. Documentation registers, other forms and formats
27. Soap dispensers

Space

It should be a well-lit and ventilated hall. This area can be further divided according to the instructions of the doctor in charge as;

- a) Waiting area for donors
- b) Donation area
- c) Post donation care area

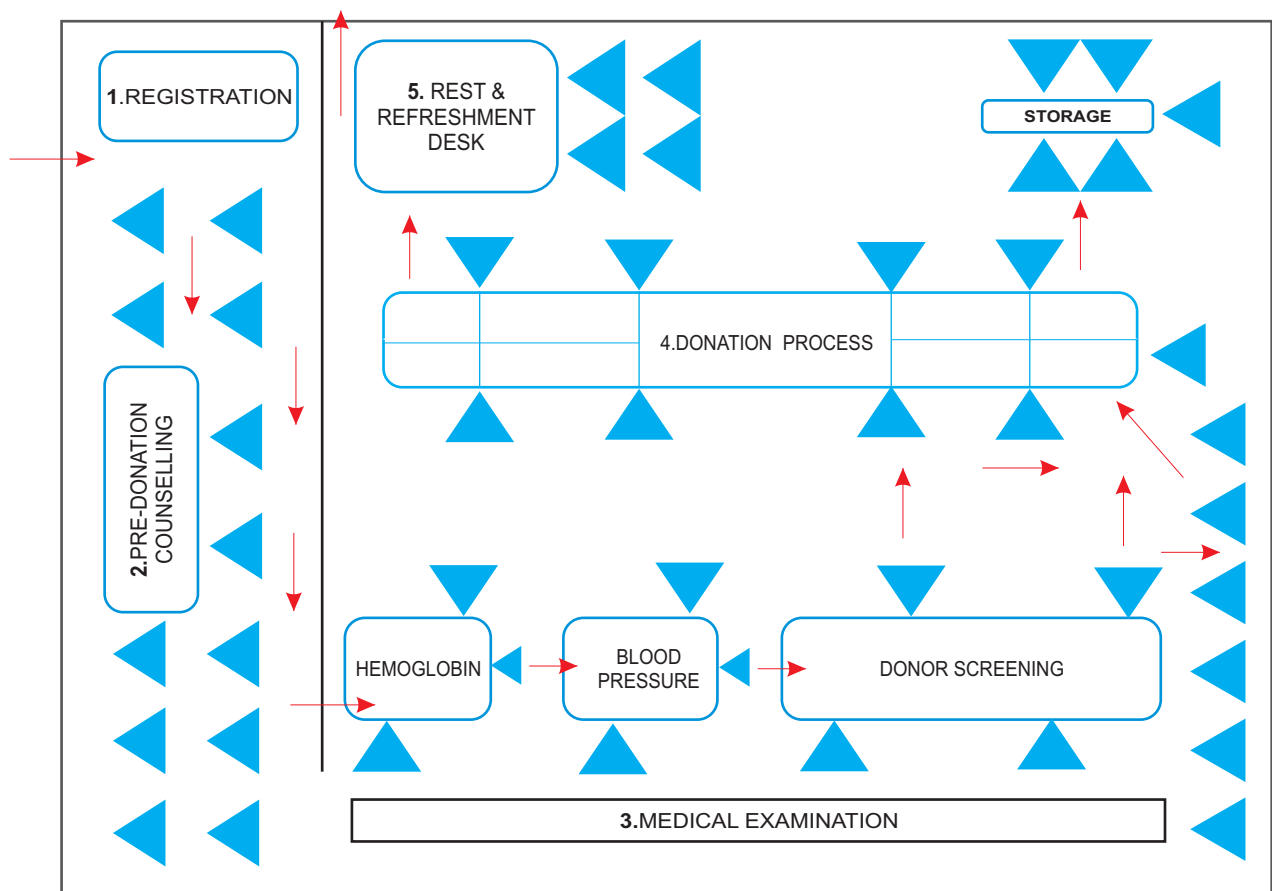


Figure No: 10 Sample layout of blood donation camp

Refreshment

Light snacks and fluids depending upon geographical preferences.

Post–donation care

Post-donation care and refreshment is the same as mentioned in donor room procedures.

Blood Mobile

The blood mobile is one of the modern methods of mobile blood collection facility funded through the third phase of National AIDS Control Programme (NACP) and the National Blood Transfusion Council (NBTC) of India. The concept was to reach the blood donor with the blood collection facility in order to minimise the time spent on travel to the nearest blood donation centre or outdoor blood donation camp/drive. The blood mobile was designed with the concept of stationing it for blood collection at prominent public places and rotate the schedule in a manner that regular repeat voluntary blood donors know that the blood mobile will be stationed for collection near his/her workplace/housing, and could thus plan his/her blood donation in advance.



Figure: 11 Internal panoramic view of blood mobile

2. Storage

The collected blood units are stored in transport boxes during the camp and transportation from the venue of camps back to the blood bank.

3. Records concerning Blood Donation Camp

1. Registration cards/forms
2. Statement of Expenditure
3. Report proforma of staff
 - Donor deferrals register
 - Donor reactions register
 - Hemoglobin registers
 - Other forms and formats mandated by SBTC
 - Register for remarks, suggestions to blood bank by organizers or donors

(ix) Roles And Responsibilities Of Nurses: Organizing Blood Donation Camps

- ◆ Know the procedure for organizing a blood donation camp
- ◆ Organize for the blood donation camps
- ◆ Inform the hospital authority and make sure donors are informed about the blood donation camp
- ◆ Learn the care to be provided before, during donation phase and post donation phase
- ◆ Check the facility for storage of blood collected during the camp
- ◆ Check for apparatus and equipment required for the mobile blood collection
- ◆ Make sure arrangements are made, like furniture, mobile vans, refreshments, forms, equipment, blood bags and transport boxes
- ◆ Maintain records of blood donation camps



Choose the Best Option:

- Age of a blood donor should be between:
 - 18 to 65 years
 - 18 to 58 years
 - 16 to 60 years
 - 16 to 58 years
- The minimum weight of a blood donor should be:
 - 40 kg
 - 45 kg
 - 50 kg
 - 55 kg
- A donor is NOT permanently deferred if he suffers from which of the following disease:
 - Hepatitis B
 - Hepatitis A
 - Cancer
 - Heart Disease
- Hemoglobin of a blood donor should be more than:
 - 11.5 gm/dL
 - 12 gm/dL
 - 12.5 gm/dL
 - 13 gm/dL
- Which type of donor is not accepted:
 - Voluntary donor
 - Professional donor
 - Replacement donor
 - Directed donor
- If a donor is taking aspirin, the blood is collected for preparation of following components:
 - PRBC + FFP
 - PRBC + PRP
 - PRBC + FFP + PC
 - Any of the above
- The donor phlebotomy site should be inspected for :
 - Scar mark
 - Tattoo
 - Any active lesion
 - All of the above
- The temperature at which blood is stored is:
 - 2° to 6°C
 - 2° to 24°C
 - 2° to 8°
 - Below -30°C
- In the copper sulphate method for hemoglobin estimation, which of the following inference is correct:
 - If the drop of blood sinks, the Hb is > 12.5 gm/dL
 - If the drop of blood floats the, Hb is < 12.5 gm/dL
 - Both of above
 - None of the above
- The specific gravity of copper sulphate working solution for estimation of Hb should be:
 - 1.053
 - 1.050
 - 1.052
 - Not sure

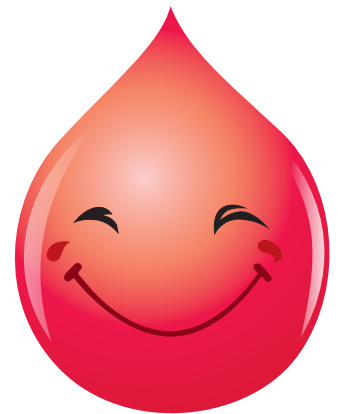
NOTES:

IMMUNOHAEMATOLOGY

Learning Objectives

When you have completed this chapter you should be able to:

- Describe the basic red cell serology
- Describe ABO grouping and compatibility testing
- Describe about the serological discrepancy and its resolution



2.1 Basics of Red Cell Serology

Blood Group Antigens

Proteins or carbohydrates that cover the red blood cells make up a person's blood group. These are called blood group antigens.

ABO blood group system

Karl Landsteiner first discovered the ABO blood group system in 1900. He was able to divide blood into 3 groups; A, B and O. In 1902 the fourth group (AB) was discovered by two of his pupils (De Castelle and Sturli)

In addition to these A and B antigens there is another substance on red blood cells called Rh antigens. Rh D antigen is the commonest and the most immunogenic antigen of the Rh system. People who have Rh D antigen on their red blood cells are Rh positive. People who do not have Rh antigens on their red cells are Rh negative.

Table 2.1: Blood Type, Blood Group Antigen and Blood Group Antibodies

Blood Type	Antigens Present	Antibodies in Serum
A Positive	A,H and Rh D antigens	Anti B
B Positive	B,H and Rh D antigens	Anti A
AB Positive	AB, H and Rh D antigens	None
O Positive	H and Rh D antigens, no A or B antigens	Anti A, Anti-B
A Negative	A,H antigens, no Rh D antigens	Anti B, Rh D
B Negative	B,H antigens, no Rh D antigens	Anti A, Rh D
AB Negative	A,H antigens, no Rh D antigen	Rh D
O Negative	Only H antigen, no A,B, or Rh D antigen	Anti A and Anti-B, Rh D








BLOOD GROUP	ANTIGEN + ANTIBODY PRESENT	AS DONOR, IS	AS RECIPIENT, IS
A	 ANTIGEN-A  MAKES ANTI-B	COMPATIBLE WITH: A AND AB	COMPATIBLE WITH: A AND O
B	 ANTIGEN-B  MAKES ANTI-A	COMPATIBLE WITH: B AND AB	COMPATIBLE WITH: B AND O
AB	 ANTIGENS A & B MAKES NEITHER ANTI-A NOR ANTI-B	COMPATIBLE WITH: AB ONLY	COMPATIBLE WITH ALL GROUPS UNIVERSAL RECIPIENT
O	 NEITHER A OR B ANTIGEN  MAKES BOTH ANTI-A AND ANTI-B	COMPATIBLE WITH: ALL GROUPS UNIVERSAL DONOR	COMPATIBLE WITH: O ONLY

Figure 12: ABO Blood Group System

Blood Group Antibodies

In addition to red cell antigens present on red cells there are blood group antibodies present in a person's plasma. These are Anti-A antibodies and Anti-B antibodies.

1. Group A person has A antigens on their red cells and Anti-B antibodies in their plasma.
2. Group B person has B antigens on their red cells and Anti-A antibodies in their plasma.
3. Group O person has neither A antigens nor B antigens on their red cells but they have both Anti-A and Anti-B antibodies in their plasma.
4. Group AB person has both A and B antigens on their red blood cells. They do not have either Anti-A or Anti-B antibodies in their plasma.

Table 2.2: ABO and Rh blood group percentage distribution in India

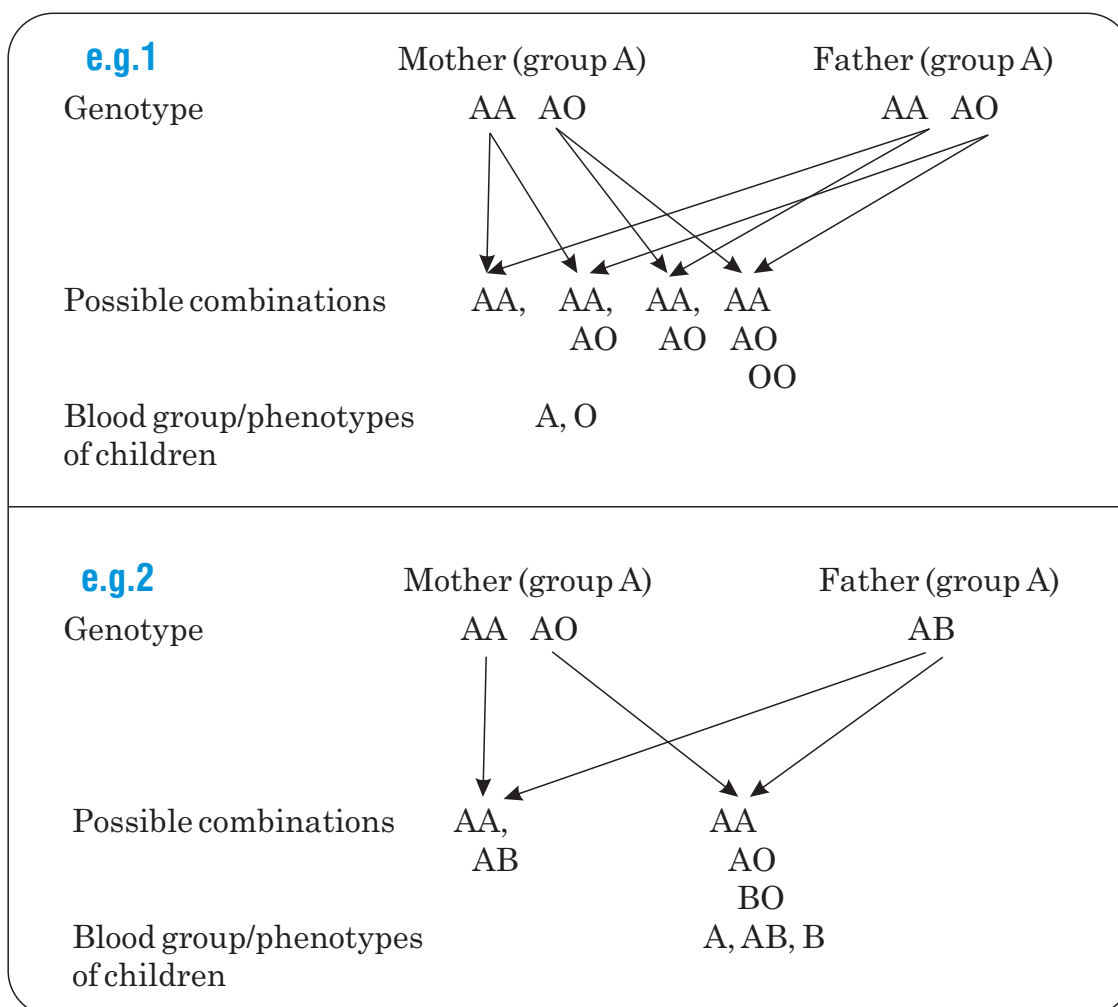
Blood group	Percentage (%)
O	30-43
B	27-35
A	21-25
AB	06-11

Approximately 5-8% of Indian population is Rh negative.

Genotype and Phenotype

The genes on the chromosomes determine the antigen present on the red cell. Three genes can be inherited in the ABO system. They are A, B and O genes. Out of these three genes O gene is an amorphic gene. Each person has two genes that come from mother and father; the following combinations of genes or genotypes are possible.

Possible genotypes: AA, AO, BB, BO, AB, OO



There are number of other blood group systems, but out of all, ABO and Rh systems have major clinical importance. Some of these other blood group systems are Kell, Kidd, Duffy, MNSs and Lewis.

Bombay group

Another important blood group is Bombay blood group. Main features of this blood group is absence of A,B and H antigens on red cells and plasma of these persons have antibodies anti-A, anti-B and anti-H. The phenotype of this group is O_h .

This can be observed in vitro by lack of reaction of Bombay type red cells with anti sera A, B, AB and H, whereas the serum of a person with O group does not react with anti-A,-B,-AB but reacts very strongly with anti-H antiserum and this indicates clear differentiation between O and O_h individuals. Bombay (O_h) group individuals can be transfused only O_h blood.

2.2 ABO And Rh Grouping

Standard tube technique is used for cell and serum grouping. Refer to SOP in your blood bank for the procedure.

Table 2.3: Agglutination pattern of different blood groups

Cell grouping				Serum grouping			Interpretation
Anti A	Anti B	Anti AB	Anti D	A cells	B cells	O cells	Blood group
+	-	+	+	-	+	-	A Rh positive
+	-	+	-	-	+	-	A Rh negative
-	+	+	+	+	-	-	B Rh positive
-	+	+	-	+	-	-	B Rh negative
+	+	+	+	-	-	-	AB positive
+	+	+	-	-	-	-	AB negative
-	-	-	+	+	+	-	O positive
-	-	-	-	+	+	-	O negative
-	-	-	+	+	+	+	Oh positive
-	-	-	-	+	+	+	Oh negative

+ Indicates the presence of either agglutination or haemolysis

- Indicates the presence of neither agglutination nor haemolysis

Serum grouping is not reliable to determine the ABO blood group on:

- Cord blood
- Newborn babies up to 4 months.
- Rh D positive recipient can be transfused Rh D negative blood.
- Rh D negative recipients, either males or post-menopausal females can be transfused Rh D positive blood, if there are no Rh antibodies detected in their plasma.
- Rh D negative females in the child bearing age should be transfused only Rh D negative blood

2.3 Compatibility Testing (cross matching)

Compatibility tests are done to ensure that particular unit of blood may be safely transfused to a patient. Normally group specific blood, ABO and Rh (D), as that of the patient is selected. However in certain situation, because of the non-availability of group specific blood, group O blood (red cells) is selected for A or B patient and A or B blood for an AB patient as explained earlier.

RED BLOOD CELL COMPATIBILITY TABLE

Recipient	Donor							
	O-	O+	A-	A+	B-	B+	AB-	AB+
O-	✓	✗	✗	✗	✗	✗	✗	✗
O+	✓	✓	✗	✗	✗	✗	✗	✗
A-	✓	✗	✓	✗	✗	✗	✗	✗
A+	✓	✓	✓	✓	✗	✗	✗	✗
B-	✓	✗	✗	✗	✓	✗	✗	✗
B+	✓	✓	✗	✗	✓	✓	✗	✗
AB-	✓	✗	✓	✗	✓	✗	✓	✗
AB+	✓	✓	✓	✓	✓	✓	✓	✓

Figure 13: Selection of ABO compatible donor red blood cells

Compatibility testing (cross match) includes

a) Major cross match (Compatibility)

Recipient's serum is cross matched with donor's red cells for IgM and IgG antibodies compatibility.

b) Minor cross match (Compatibility)

Donor's serum is cross matched with recipient's red cells for IgM and IgG antibodies compatibility. If donor's serum has been screened for irregular antibodies and found negative, minor cross-match can be avoided.

If incompatibility is not detected in cross matching then, it is likely that the donor blood transfused into patient will survive normally.

Finding of incompatibility indicates that transfusion of such blood is potentially dangerous and further steps should be taken to identify the antibody.

Major Compatibility Tests

It is done both for IgM and IgG antibodies

Compatibility Test for IgM Antibody / Antibodies

Requirement

1. Recipient's serum.
2. Donor's red cells taken from the tube attached to the bag.

Saline technique

Saline technique is designed to detect compatibility of IgM antibody (ies) in patient's serum against antigens on donor's red cells.

Method

1. Label one tube for each donor sample to be tested.
2. Put two drops of patient's serum in labelled tube.
3. Add one drop of 2-4 % of saline suspended red cells of donor.
4. Mix and incubate for 5 – 10 min. (spin method) or incubate for 30-60 min (sedimentation method) at RT.
5. Centrifuge at 1000 rpm for 1 min. in spin method (after 5–10 minutes incubation), centrifugation is optional in sedimentation method.
6. Read the result, observe for hemolysis and agglutination.
7. Negative result should be confirmed under microscope.

Note: In emergency, spin technique is acceptable.

Saline technique is inadequate as a complete compatibility test because it is inadequate to detect clinically significant IgG antibodies.

Interpretation

Agglutination or hemolysis indicates a positive result (incompatible)

Compatibility Test for IgG Antibody/ Antibodies

Anti – Human Globulin Test (IAT)

Indirect anti human globulin test (IAT) is the most important and widely used serologically procedure in modern blood banking to test the IgG compatibility between recipient's serum and donor's cells. The majority of incomplete antibodies are IgG and are detected by AHG test.

Method:

1. Put two drops of patient's serum in a labelled tube.
2. Add one drop of 2-4% saline suspended red cells of donor.
3. Incubate for 30-60 min at 37°C
4. Centrifuge at 1000 rpm for 1 min, check for hemolysis / agglutination
5. If there is no hemolysis / agglutination, wash the cells three times with normal saline.

6. Perform IAT Test
 - Add two drops of polyspecific AHG serum to washed cells
 - Centrifuge at 1000 rpm for 1 minute
 - See for agglutination
7. Add IgG coated red cells to negative AHG test.
8. Centrifuge and check for agglutination – if there is no agglutination test is invalid.

Interpretation

Hemolysis or agglutination at any stage indicates incompatibility.

Note: Cross-match can be done by two tubes technique for IgM and IgG separately as described above or by one tubes in which donor' cell and the patient's serum after step 5 in saline technique is incubated at 37°C for 20-30 minutes and then do IAT.

In major – cross for IgG antibodies albumin or enzyme or LISS can be used with IAT to increase sensitivity. For techniques see chapter of Antiglobulin Test.

Minor-Cross Match

- If donor's serum has not been screened for irregular antibodies with OR, R1 and OR, R2 cells of screening panel, and found negative, it is advisable to do minor cross matching.
- In minor cross – match donor's serum is cross-matched with recipient's red cells for both IgM and IgG antibodies compatibility.

Method

Method is same as that of major cross-match except in minor cross-match donor's serum is tested against patient's cells both for IgM and IgG antibodies compatibility.

2.4 Compatibility test in special circumstances

Compatibility Testing in Emergencies

- On the request of the clinician blood can be issued in emergency after ABO and Rh (D) typing followed by cross match by immediate spin tube technique for IgM compatibility.
- In extreme cases, where there is no time to take sample and to test it, O, Rh (D) negative blood, preferably red cells, may be given on the request of the clinician.
- Donor's unit that has not been tested or partially tested for compatibility for IgM and IgG antibodies against patient's serum, should be clearly labelled 'Uncrossed-match Blood'.
- It is advisable to complete the routine cross-matching both for IgM and IgG compatibility, after issue of blood with incomplete or without compatibility test.

Massive Transfusion

- When massive transfusions are given, that is when the number of units transfused in a 24 hours period exceeds the recipient's blood volume, compatibility testing may be reduced to checking the ABO and Rh (D) types of the transfused units. If the patient has known allo-antibody reactive at 37°C, the blood should be negative for the relevant antigen, as much as possible.
- After the emergency has been dealt with, if antibodies are detected in pre-transfusion sample, and in case further transfusion is necessary compatible blood is selected.
- Donor's units that have not been tested or have been partially tested against the patient's serum, should be clearly labelled "uncross matched blood".

Pre – Transfusion Testing of Neonates

1. *Open-heart surgery*

- In open-heart cases, all the procedures are the same as given above in compatibility testing. In addition, make a pool of donor cells [i.e. 5 or 6 in number] in separate tube and from these pooled cells, take 1 drop of 3-5% cell suspension and add 2 drops of the patient's serum (ratio 1:2) in four different tubes. These tubes are kept at various temperatures, viz: 4°C, RT, and 37°C.
- Wash these incubated cells three times with normal saline; after centrifugation decant the supernatant saline and then add polyspecific Coombs sera (AHG). Centrifuge and see for agglutination. If there is no agglutination, 'the blood units are compatible.'
- Blood unit taken for compatibility testing should be as fresh as possible (within 5-7 days of storage). In case of rare blood groups (e.g. Rh-negative patients), 7-10 day old blood may be issued with appropriate component (PC and FFP) supplementation

2. *Multiple Myeloma*

In cases of multiple myeloma, wash the patient's cells 6-8 times in normal saline and perform cell grouping from these washed cells and for reverse grouping, serum is diluted with normal saline in the ratio of 1:4.

Compatibility test: The procedure is same as given in routine compatibility testing, but patient's cells washed 6-8 times and diluted serum are taken to perform Major Crossmatch, Minor crossmatch and AHG phase compatibility testing.

3. *Severe anemia*

In case of severe anemia (Hemoglobin < 7 gm/dL), always ask for EDTA sample along with clotted sample. Perform cell grouping from EDTA sample. Rest of the procedure is the same as given in routine cross match testing.

4. Cancer cases

- Always perform cell grouping from washed cells in known cases of cancer patients.
- Compatibility test for cancer cases is same as given in routine compatibility test.

In case of packed red blood cells, supplementation with components (PC, FFP) may be required.

2.5 Compatibility test in new-borns

Pre – Transfusion Testing of Neonates (In less than 4 months old infant)

Procedure:

- Group ABO and Rh (D) group of infant cells should be determined by cell grouping only.
- Direct AHG test on baby's cells is performed.
- Maternal serum should be screened for any irregular antibody, if mother's blood sample is available.
- If the antibody screening and DAT is negative in mother's blood, and no evidence of HDN, cross – matched blood of the same ABO and Rh (D) type as that of the infant using mother's serum (if ABO compatible and sample is available) or baby's serum. This is to exclude the possibility that incomplete antibody from the mother may be in baby's serum in the absence of the antigen on the baby's red cells to that antibody.
- If the antibody screening is positive, the direct AHG is positive or HDN is present, the donor's blood must be cross – matched against maternal serum. The neonate's serum can also be used (if mother's blood sample is not available).
- When group O blood needs to be given to an infant who is group A and / or B, then red cell concentrates of units with low titre anti – A or anti – B should be used. It is a good practice to use packed cells re-suspended in one third volume of AB plasma (or A plasma or B plasma as appropriate).

Double Volume Exchange Transfusion (DVET) in newborns

- Cases of neonatal jaundice for DVET require both new-born and mother's blood sample.
- For transfusion purpose, all the paediatric patients are considered as neonates for the first three to four months of their life, as they do not have any naturally occurring antibodies (i.e., Anti - A or Anti - B) in their serum/plasma. Therefore for compatibility testing, the mother's sample should accompany the neonatal sample to look for any irregular antibodies transferred from mother to baby.

Rule of Thumb:

Give ABO and Rh compatible blood to baby i.e. which must be compatible with both baby and mother

- Mother's sample is very essential besides the baby's sample. Perform the ABO and Rh grouping of baby as well as of mother and do reverse grouping of only the mother's sample.

Choice of blood for Double Volume Exchange Transfusion:

1. ABO group of the baby and Rh type of mother
2. Blood group compatible to both baby and mother.

Table 2.4: Choice of blood for DVET

Baby's Blood Group	Mother's Blood Group	1 st Choice	2 nd Choice
O	O	O	-
O	A	O	-
O	B	O	-
O	AB	O	-
A	O	O	-
A	A	A	O
A	B	O	-
A	AB	A	O
B	O	O	-
B	A	O	-
B	B	B	O
B	AB	B	O
AB	O	O	-
AB	A	A	O
AB	B	B	O
AB	AB	AB	A,B,O
Rh Positive	Rh Negative	Rh Negative	-
Rh Negative	Rh Positive	Rh Negative	-

1. Blood should be cross matched against mother's serum by Indirect Coombs Test (IAT/ICT) i.e. AHG phase testing
2. If mother's blood is not available, or group is not known, give O Rh negative Packed RBCs only.
3. Blood used should not be more than 5 to 7 days old.
4. Compatible plasma or AB plasma should be issued for reconstitution.

Table 2.5: Choice of Blood / Blood Components

For Packed Red Blood Cells(PRBCs)						
Donor						
Recipient	A	B	O	AB	Rh Positive	Rh Negative
A	Option-1		Option -2			
B		Option-1	Option -2			
O			Option-1 (the only option)			
AB	Option-2	Option -3	Option -4	Option-1		Option -2
Rh Positive					Option-1	
Rh Negative						Option-1 *


Immuno - Haematology And Roles And Responsibilities Of Nurses:

- ◆ The nurse should have knowledge of basic red cell serology which includes information on blood group antigen, ABO blood group system, blood group antibodies, genotype and phenotype, Bombay group etc.
- ◆ Compatibility test is the most important procedure in a blood bank and nurses have a major role. Nurses should have knowledge on how to do the compatibility test, samples required and sample collection procedure.
- ◆ Nurses should have knowledge on tests done for blood grouping and antibody testing during pregnancy and pre - transfusion testing of babies who are < 4 months old
- ◆ Participates in regular and refresher training on blood bank
- ◆ Maintains records on continuing nursing education and training programs



Choose the Best Option:

1. For ABO blood grouping, which of the following statement is true:
 - a. Only forward grouping is required
 - b. Only reverse grouping is required
 - c. Both forward and reverse grouping are required
 - d. Not sure of the answer
2. which is true regarding the IgM antibodies:
 - a. Can be detected at room temperature
 - b. Cannot fix complement
 - c. Best reactivity is at 37°C
 - d. All of the above
3. Donor typed as O+ve on forward/ cell grouping will show which of the following results:
 - a. Anti-A - 4+, Anti-B - 4+, Anti D - 4+
 - b. Anti-A - Neg, Anti-B - 4 +, Anti D - 4 Neg
 - c. Anti-A - Neg, Anti-B - Neg, Anti D - 4 +
 - d. Anti-A - 4+, Anti-B - Neg , Anti D – Neg
4. For Rh (D) typing on donor units, including weak D typing which anti- D antisera is required:
 - a. IgM monoclonal anti- D
 - b. IgG monoclonal anti D
 - c. IgM + IgG monoclonal anti- D
 - d. d. Not sure of the answer
5. Immediate spin cross match technique detects the following EXCEPT:
 - a. IgM antibodies
 - b. IgG antibodies
 - c. ABO incompatibility
 - d. Saline reacting antibodies
6. During daily quality control check of anti-A antisera, which of the following statements is true:
 - a. A₁ Cells -4+, B Cells - Neg, O Cells - Neg
 - b. A₁ Cells - Neg , B Cells - 4+, O Cell - Neg
 - c. A₁ Cells - 1+, B Cell - Neg , O Cells - Neg
 - d. A₁ Cells - 4+, B Cell - Neg , O Cells - 4+

- 
7. The desired titre of monoclonal Anti-A antisera as quality control criteria is:
- 1:128
 - 1:256
 - 1:64
 - 1:32
8. Which of the following statement is false about strength of agglutination:
- 4+ - A Single large clump
 - 3+ - Multiple large size clumps with turbid background
 - 2+ - Medium Size clumps with clear background
 - 1+ - Small size clumps with turbid background
9. If A+ve blood is not available in the stock which of the following options are correct:
- A → B → AB → O whole blood
 - A → AB → O → B packed red cells
 - A → O whole blood
 - A → O packed red cells
 - Not sure of the answer

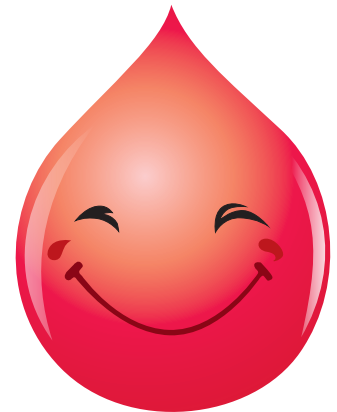
NOTES:

TRANSFUSION TRANSMISSIBLE INFECTIONS

Learning Objectives

When you have completed this chapter you should be able to:

- Recognize the transfusion- transmissible infections (TTIs)
- Know the characteristics of TTIs



Introduction

Screening of donated blood for TTIs represents an important strategy for blood safety and availability. The first line of defense in providing a safe blood supply and minimizing the risk of transfusion-transmissible infections are to collect blood from well-selected, repeat voluntary non-remunerated blood donors, in whom the infections are generally much lower than replacement donors. A lower prevalence of TTIs in the donor population reduces the rate of discarded blood and hence results in improved efficiency and use of resources.

Transfusion-transmissible infections

The microbial agents of importance to blood transfusion services are those organisms that are transmissible by blood and can cause morbidity and mortality in recipients. In order to be transmissible by blood, the infectious agent or infection usually has the following characteristics:

3.1. Characteristics Of Transfusion Transmissible Pathogens

1. Cause mild or asymptomatic infections such that the infected potential donor would be accepted for donation.
2. If symptomatic, would have a long incubation period or window period eg. Months (HBV, HCV) or even years (HIV) prior to development of symptoms.
3. Might cause a “carrier state” of infection (HIV, HBV, HCV)
4. Might cause a “latent state” of infection in host cells by incorporating their own genome in the host’s genome (HIV, HTLV, CMV)
5. Would be stable under the storage conditions at which blood and components are stored.
6. Would be present in blood components either in plasma or as a DNA copy in leukocytes (HIV)

Following tables show various organisms that can be transmitted by blood transfusion and their characteristics, respectively.

Following tables show various organisms that can be transmitted by blood transfusion and their characteristics, respectively.

Table 3.1 Transfusion Transmitted Agents

Sr. No	Microbial Agent Type	Name
1	Virus (Enveloped)	HIV-1, HIV-2, HTLV – 1, HTLV-2, HHV-6, HHV – 8, EBV, HBV, HCV, HEV, GBV-C , CMV, West Nile Virus
2	Virus(Non- Enveloped)	HAV, Parvovirus B 19, TTV, enteroviruses
3	Bacteria (Endogenous)	<i>Treponema pallidum</i> (Syphilis), <i>Borrelia burgdorferi</i> (Lyme disease), <i>Brucella melitensis</i> (Brucellosis), <i>Yersinia enterocolitica</i> .
4	Bacteria (Exogenous- environmental/ skin commensals)	<i>Staphylococcus sp.</i> , <i>Pseudomonas fluorescens</i> , <i>Salmonella enteritidis</i> , <i>Citrobacter freundii</i> , <i>Serratia marcescens</i> , <i>Enterobacter cloacae</i> , <i>Flavobacterium sp.</i> , <i>Serratia sp.</i> , <i>Coxiella burnetti</i> , <i>Rickettsia rickettsii</i> .
5	Protozoa	Plasmodium sp., <i>Babesia microti</i> , <i>B. divergens</i> , <i>Trypanosoma cruzi</i> , <i>Leishmania sp.</i> , <i>Toxoplasma gondii</i> ,
6	Prions	Variant Creutzfeldt – Jakob disease (vCJD)

New infections are called **‘incident’ infections**. The term incidence describes the frequency of new infections in a defined population within a defined period of time. The incidence tells us what is happening now.

The term **prevalence** describes the proportion of a population who, at a given time, has evidence of the infection. The prevalence of an infectious agent, such as HIV antibody, can tell us what has already happened.

The term **window period** describes the period when there is viraemia but no detectable evidence of antibodies. Blood taken in this period is usually infectious, but the virus cannot be detected by current screening tests as ELISA for detection of antibody to HIV

Some infections such as HIV, hepatitis B and hepatitis C remain present in the blood; this is often called a **‘chronic carrier state’**. The blood of individuals who are chronic carriers will transmit the infection to others.

As per the Drugs and Cosmetics Act, 1940 of India, current mandatory tests for screening of blood donation in India include

- Anti-HIV -1 and 2 antibodies
- Anti-HCV antibodies
- Hepatitis B Surface Antigen (HBsAg)
- Serological test for syphilis
- Malaria parasite

(i) Human Immunodeficiency Virus

HIV is a retrovirus, an enveloped RNA virus, which is transmissible by the parenteral route. It is found in blood and other body fluids. Once in the bloodstream, the virus primarily infects and replicates in lymphocytes. The viral nucleic acid persists by integrating into the host cell DNA. A number of different groups and subtypes have been identified with some significant antigenic differences. HIV-1 group M is responsible for more than 99% of the infections worldwide. The prevalence of HIV-2 is mainly restricted to countries in West Africa. The appearance of antibody marks the onset and persistence of infection, but not immunity.

As HIV can be present in the bloodstream in high concentrations and is stable at the temperatures at which blood and components are stored, the virus may be present in any donated blood from an HIV-infected individual. Infectivity estimates for the transfusion of infected blood products are much higher (around 95%) than for other modes of HIV transmission owing to the much larger viral dose per exposure than for other routes.

HIV is transmitted through sexual contact, sharing of HIV contaminated needles and/or syringes, transfusion of blood/ components, and nosocomial exposure to HIV contaminated blood or bodily fluids. It can also be passed vertically from a mother to her infant.

Screening

The methods used to identify the presence of HIV employ the following screening targets:

- Serological markers:
 - ♦ Anti-HIV-1 & anti-HIV-2
 - ♦ HIV p24 antigen (p24 Ag)
- Viral nucleic acid: HIV RNA.

Using the present anti-HIV ELISA tests, antibody to HIV becomes detectable approximately 21 days after exposure to infection.

Newer technologies such as HIV-1 p24 antigen test and HIV nucleic acid amplification testing (HIV NAT) can significantly reduce the window period.

The test selected for donated blood should be a combined HIV-1/HIV-2 assay, which is highly sensitive and specific. All serum/plasma should be tested with one ELISA or simple/rapid assay. Units of blood yielding reactive or indeterminate test results must be considered as probably infected with HIV and should be discarded using universal safety precautions. The non-reactive units may be taken on blood inventory for use.

(ii) Hepatitis 'B' Virus

Hepatitis B virus (HBV) is a member of the hepadnavirus group and is an enveloped DNA virus. HBV is transmissible by the parenteral route and may be found in blood and other body fluids. Once in the bloodstream, the virus travels to the liver where it replicates in hepatocytes. HBV is highly prevalent in certain parts of the world such as the Far East and Africa (Ref: AABB Technical Manual).

In recently infected individuals, viral DNA is normally present, although not always at high levels. Chronically infected individuals may either be infectious (viral DNA present) or non-infectious with HBV, but does not in itself distinguish between recent and chronic infections. The distinction between acute and chronic infection is not relevant to blood screening. All HBsAg positive donations should be considered to be at high risk of transmitting HBV and should not be released for transfusion.

The serology of HBV is complex. A number of different serological markers develop during the course of infection, including hepatitis B surface antigen (HBsAg) and hepatitis B core antibody (anti-HBc). In addition, HBV DNA can be detected in the majority of cases, although in HBsAg negative phases of infection, the DNA levels are generally relatively low and the viraemia may be transient. Hepatitis B surface antigen is the prime marker used in blood screening programs. It normally appears within three weeks after the first appearance of HBV DNA and their levels rise rapidly. The presence of HBsAg may indicate current or chronic infection and thus potential infectivity. Most blood transfusion services screen donated blood for HBsAg using sensitive immunoassays.

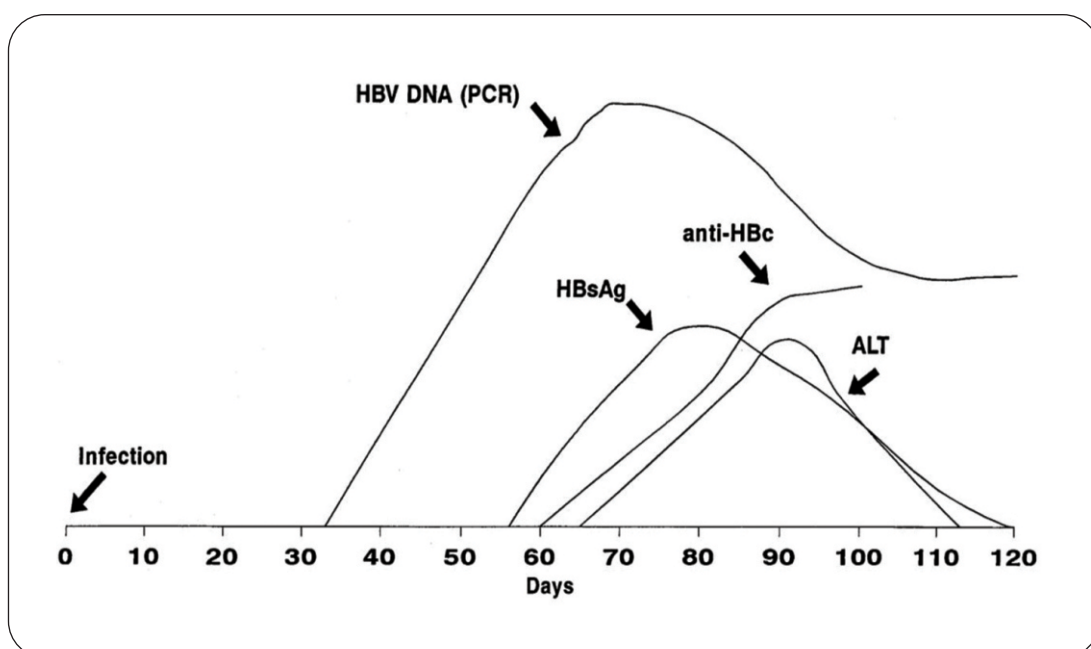


Figure 14: Appearance of serological markers in HBV infection

Screening

The methods used to identify the presence of HBV employ the following screening targets:

- Serological markers:
 - Hepatitis B surface antigen
 - Hepatitis B core antibody, in some situations
- Viral nucleic acid: HBV DNA.

(iii) Hepatitis 'C' Virus

Hepatitis C virus (HCV) is a member of the flavivirus group and is an enveloped RNA virus. It is transmissible by the parenteral route and may be found in blood and other body fluids. Once in the bloodstream, the virus travels to the liver where it replicates in hepatocytes, resulting in a similar picture to that seen with HBV infection.

In recently infected individuals, virus is normally present. Screening for both HCV antigen and antibody does not in itself distinguish between recent and chronic infection. All HCV antigen-antibody reactive donations should be considered to be at high risk of transmission of HCV and should not be used for clinical use.

Screening


The methods used to identify the presence of HCV employ the following screening targets:

- Serological markers:
 - HCV antibody
 - HCV antigen
- Viral nucleic acid: HCV RNA.

HCV antibody becomes detectable approximately 30 to 60 days after infection. Viral antigen normally appears between 0 and 20 days after viral RNA first appears. Antibody is generated and can be detected between 10 and 40 days after antigen is first detected. Until recently, anti-HCV has been the prime serological marker for blood screening programs. However, HCV antigen can be detected in the peripheral blood earlier than antibody in the course of early infection. HCV antigen assays, both antigen only and combined antigen-antibody, have been commercially available for a number of years. These have been introduced in some countries to improve the overall effectiveness of serological HCV screening.

(iv) Syphilis

Syphilis is caused by the Spirochete *Treponema pallidum subsp. pallidum*. It is transmissible by the parenteral route and may be found in blood and other body fluids. Once in the bloodstream, the bacteria spread throughout the body. A primary lesion, chancre, usually occurs about three weeks after exposure, although the duration may be shorter in cases of transfusion-transmitted infection where the organism enters the bloodstream directly. Syphilis is endemic in many parts of the world.



The treponemes are relatively fragile, in particular being heat-sensitive, storage below +20°C for more than 72 hours results in irreparable damage to the organism such that it is no longer infectious. Thus, although clearly potentially infectious, the risk of transmission through blood and blood components stored below +20°C is very low. Blood components stored at higher temperatures (above +20°C), such as platelet concentrates, present a significantly higher risk of transmitting syphilis.

Screening

The methods used to identify the presence of syphilis employ the following screening targets:

- Non-specific, non-treponemal markers: antibody to lipoidal antigen (reagin)
- Specific treponemal antibodies.

Specific assays commonly used for blood screening are Treponema Pallidum Haemagglutination Assays (TPHA) and enzyme immunoassays (EIAs). These detect specific treponemal antibodies and thus identify donations from anyone who has ever been infected with syphilis.

Non-specific assays such as Venereal Disease Research Laboratory (VDRL) and rapid plasma reagin (RPR) tests identify those individuals who may have been more recently infected. They detect antibodies to cardiolipin or lipoidal antigen (reagin); the plasma levels of these antibodies rise significantly in active infection due to the cellular damage. The sensitivity of these assays is lower than specific assays and the test results may not always be positive, even when the infection is recent.

(v) Malaria

Malaria is caused by parasites of the Plasmodium species. There are four main types that infect humans: *P. falciparum*, *P. vivax*, *P. malaria* and *P. ovale*. Malaria is primarily transmitted to humans through the bite of the female anopheles mosquito. Although primarily transmitted by mosquitoes, malaria is readily transmitted by blood transfusion through donations collected from asymptomatic, parasitaemic donors. The parasite is released into the bloodstream during its lifecycle and will therefore be present in blood donated by infected individuals. The parasites are stable in plasma and whole blood for at least 14 days when stored at +4°C.

Screening

There are a number of potential targets for malaria screening and the selection of screening method may depend on whether it is endemic in the country or not. The methods used to identify the presence of malaria employ the following screening targets:

- Direct detection of parasite by thick film



Detection of Malaria

Diagnosis of malaria can be done either microscopically or macroscopically.

a) Microscopic Examination: It includes examination of thin and thick blood films. However, microscopic examination of blood film is not suitable for screening large number of blood donations as it is difficult to find parasites in blood films in short time especially if density of parasites is less than 100 per microliter of blood. However, the demonstration of parasites within the red cell is considered the gold standard for diagnosis in suspected cases.

b) Macroscopic methods include:

1. tests for malaria antibody
2. tests for malaria antigen
3. parasitic metabolic products e.g. pLDH.

Detection of malaria antigen remains the method of choice for detection of malaria in blood donors. It is based on the chromatographic immunoassay principle.

The malaria antigen test contains a membrane strip, which is pre-coated with two monoclonal antibodies as two separate lines across a test strip. The sample is added into the sample well after which assay buffer is added. The test results are read after 20 minutes. Presence of only the control band indicates negative result. Absence of control band indicates an invalid test. Interpretation of the strip for identification of different species of *Plasmodium*, must be done as per the manufacturer's instructions.

No blood or blood product should be released for transfusion until all required tests are shown to be non reactive or negative.

3.2

Preventive Strategies of Transfusion Transmissible Infections

A variety of strategies have evolved in recent years in an attempt to decrease the morbidity and mortality associated with TTI. These strategies are summarized in the following Box

- I) Careful donor selection.
 - a. Repeat voluntary blood donors
 - b. Education counselling and retention of these donors
 - c. Improvement in the blood donor screening criteria

- II) Reduce the risk of product contamination
 - a. Improved venipuncture site disinfection
 - b. Removal of first aliquot of the donor blood by using bags with diversion pouch.

- III) Improved blood component processing and storage.
 - a. Optimizing storage temperature
 - b. Universal leukocyte reduction

- IV.) Improved pre- transfusion blood testing
 - a. Sensitive and specific serological testing
 - b. NAT test
 - c. Visual inspection of component before use

- V.) Reducing recipient exposure to blood donor
 - a. Optimizing transfusion indications
 - b. Increased use of single donor products

- VI.) Pathogen inactivation

Transfusion Reactions and Roles and Responsibilities of Nurses

- Avoid unnecessary blood transfusion
- Follow all precautions to AVOID transfusion reactions

♦ *Before blood/blood products transfusion:*

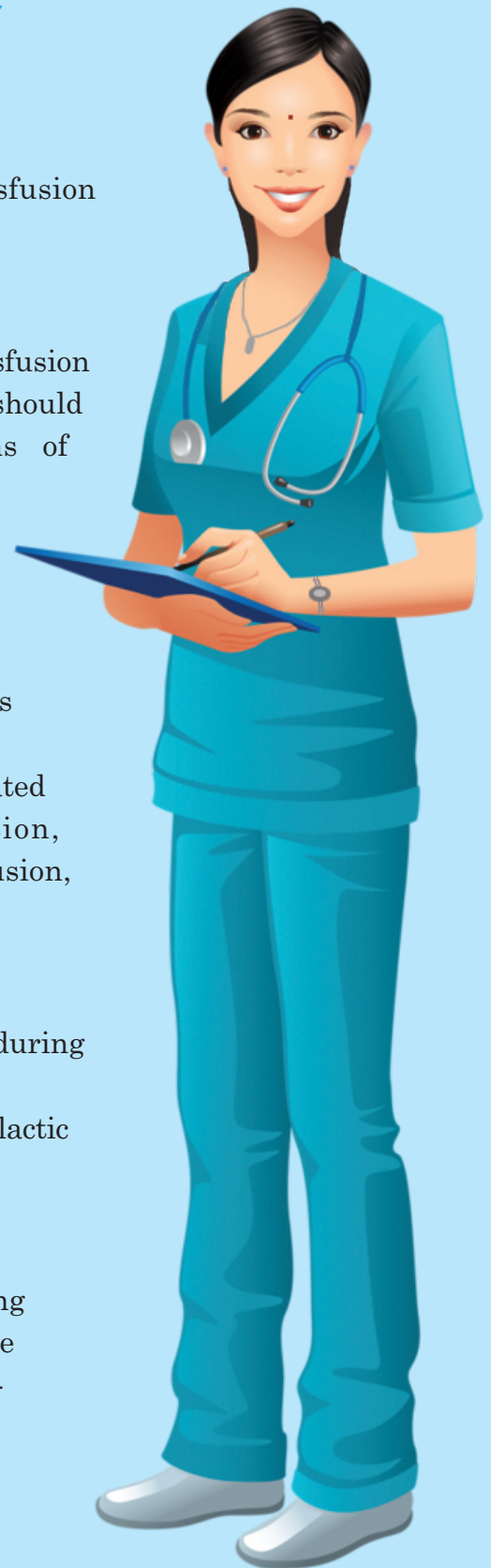
- Nurses should have knowledge on blood transfusion related reactions, classification of reactions, should be able to identify signs and symptoms of transfusion reactions.
- Avoid clerical errors like incorrect labelling, improper identification of patients etc.
- Avoid technical errors related to transfusion e.g., error in blood grouping of recipient or donor, incompatibility not detected in cross matching etc.
- Make sure that there are no non-immune mediated haemolysis e.g., bacterial contamination, mechanical trauma associated with infusion, thermal trauma etc.

♦ *During blood/blood products transfusion:*

- Careful and close observation of the patient during transfusion
- Look for allergic transfusion reactions, anaphylactic and anaphylactoid reactions.

♦ *Post transfusion of blood/blood products:*

- Nurses should develop the skills in identifying or evaluating post transfusion reactions like post transfusion purpura, TRALI or Non-Cardiogenic pulmonary edema, transfusion associated GVHD.



Choose the Best Option:

1. Answer in true or false:

According to Drugs & Cosmetics Act 1940, Ministry of Health and Family Welfare, Govt. of India, all blood and blood components should be screened for various transfusion-transmitted infections such as:

- | | |
|-------------------------------------|-----|
| a. HIV p 24 antigen | T/F |
| b. Hepatitis B surface antigen | T/F |
| c. Anti-HBc antibody | T/F |
| d. Hepatitis B surface antibody | T/F |
| e. Anti- HIV I/II antibody | T/F |
| f. Anti- hepatitis C virus antibody | T/F |
| g. VDRL/RPR test | T/F |
| h. Malaria parasite | T/F |

2. ELISA test stands for

- Enzyme Linked Immuno Solution Assay
- Enzyme Linked Immuno Sorbent Assay
- Enzyme Linked Immuno Savlon Assay
- All of the above

3. Correct sequence of the adding sample and reagents in an ELISA test is;

- Sample → conjugate → substrate → stop solution
- Conjugate → sample → substrate → stop solution
- Sample → substrate → conjugate → stop solution
- Not sure of the sequence

4. Reactive sample on an ELISA test is:

- OD of the test is less than cut off value
- OD of the test is above the cut off value
- OD of the test is at and above the cut off value
- None of the above

5. Comb AIDS rapid test for HIV is based on

- Dot immunoassay
- Line Immunoassay
- Flow through technique
- Lateral flow technique

6. The end result of VDRL/RPR test for syphilis is:

- Agglutination
- Flocculation
- Precipitation
- All of the above

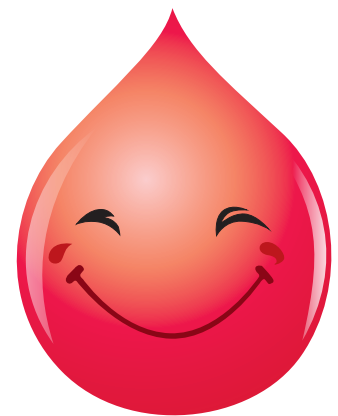
NOTES:

BIOSAFETY

Learning Objectives

When you have completed this chapter you should be able to:

- Define Bio-safety and occupational hazards
- Describe the modes of exposure to blood borne pathogens.
- Understand universal precaution methods



Definition

Biosafety is the use of laboratory practices, procedures and equipments for safety when working with potentially infectious microorganisms.

4.1 Risk to Health Care Workers (HCW)

Blood is the most important source of HIV, HBV and HCV infections. The risk depends upon the following factors.

- Prevalence of infected individuals in the population.
- Types of exposure, e.g. exposure of intact skin, breached skin, mucous membrane or needle stick injury.
- Quantity of blood to which HCWs are exposed e.g. more in case of hollow bore.
- The relative infectivity and concentration of the virus; HIV the risk is 0.05 to 0.3% (viral load 10 to 100 viral particles per ml plasma) HCV the risk is 3.0 to 10% (viral load is 10000 to 100000 viral particles per ml) HBV the risk is 10 to 30% (viral load is 10,000,000 viral particles per ml).
- Number of exposures.

Table 4.1: Modes of exposure to blood borne pathogens in the laboratory

Procedure	HCW at Risk	Source / Modes of Transmission
Collection of blood	Laboratory technical staff / phlebotomist	<ul style="list-style-type: none"> • Needle stick injury • Broken specimen container • Blood contamination of hand with skin lesion/breach
Transfer of Specimen	Laboratory Technician, phlebotomist and support staff and transport worker	<ul style="list-style-type: none"> • Contaminated exterior of the container / requisition slip • Broken container • Spill/splash of specimen
Processing of Specimen	Laboratory Technical Staff	<ul style="list-style-type: none"> • Puncture of skin • Contamination of skin/mucous membrane from contaminated work surface • Spills/splashes of specimen • Broken specimen container • Faulty techniques • Perforated gloves
Cleaning / Washing	Laboratory support staff	<ul style="list-style-type: none"> • Puncture of skin • Contamination of skin from contaminated glass ware • Spills/splashes • Contaminated work surface
Disposal of Waste specimen transport/ Mailing	Laboratory support staff, transport, postal staff	<ul style="list-style-type: none"> • Contact with infectious waste specially sharps, broken containers • Leaking container or packaging.

4.2 Good Laboratory Practices

As a general rule all samples should be treated as though they are potentially infectious

- Have a Biohazard sign displayed on the doors of the rooms where infectious agents are handled.
- Entry to laboratory working area should be only for laboratory person
- Doors to the laboratory should be kept closed.
- No smoking, eating, or drinking is allowed in laboratory area

Preparation of hypochlorite solution

Available chlorine concentration (labelled on bottle)	0.1% for general purpose and wiping working area	1% for spillage
Sodium hypochlorite (available chlorine 4%)	2.5 ml sodium hypochlorite + 97.5 ml water	25 ml sodium hypochlorite + 75 ml water
Sodium hypochlorite (available chlorine 5%)	2.0 ml sodium hypochlorite + 98 ml water	20 ml sodium hypochlorite + 80 ml water

(i) General Laboratory Hygiene

The work surfaces should be cleaned with a disinfectant before and after any procedures are performed. The equipments are cleaned with disinfectant at the end of each working day. 1% sodium hypochlorite and isopropyl alcohol are used as effective disinfectants.

The staff should avoid eating and drinking in the labs. There should be restricted access to the labs and only authorized staff should be present.

(ii) Universal Precautions

Universal (standard) precautions should be used consistently by all HCWs. These include barrier protection / personal protective equipment like gloves, lab coats, occlusive bandages on skin abrasions or cuts, plastic aprons for staff, clean reusable items and disposing waste. Gloves should be of good quality, well-fitting and disposable. One should avoid touching exposed body parts like face with gloved hands and take precaution not to touch the door handles and computers with gloved hands. If gloves get torn while working, they should be removed immediately and hands washed with soap and running water. The protective lab coats and aprons should be removed while leaving the laboratory.

(iii) Safe Handling of Specimens and Sharps

All samples should be collected in screw capped containers and capped securely to prevent spills and leaks. Disposable syringes and needles should be used for sample collection. Used needles must be disposed into a blue coloured “Puncture proof container”.

Used needles should not be recapped. A hub cutter to be used to cut the needle hub from syringe. Used syringes should be discarded into the Red coloured disposal bins. Samples (pilot tubes) from donors should be placed in racks in upright position and transported to labs in leak-proof plastic or rigid thermocol containers.

(iv) Management of Blood Spills

Blood spills should immediately be covered with absorbent paper sheets or gauze sponges to contain the spread of blood, gloves must be worn while handling blood spills. It should then be covered with 1% sodium hypochlorite for at least 30 minutes.

The paper towels / gauze should be disposed as biohazard waste. Any broken glass pieces should be swept with dustpan and brush and disposed as sharps. The spill should be immediately reported.

(v) Hepatitis B Vaccination for all Laboratory Staff

All blood bank staff must be vaccinated for Hepatitis B with three doses (0, 1 and 6 months). Revaccination should be considered for health care providers working in high risk environment once in 10 years .

Previously vaccinated health care providers need to check the Hepatitis B antibody titre and revaccinate if the titres are less than 10 IU.

(vi) Post Exposure Prophylaxis (PEP)

An exposure that may place a HCW at risk of contracting blood-borne infection includes a percutaneous injury which may be through mucous membrane contact, prolonged contact with intact skin or immediate contact with breached skin.

The exposure must be reported to the laboratory supervisor immediately and the staff Health services contacted and treated as an emergency. The exposed site should be washed immediately. Blood should be collected for testing after written informed consent.

i) PEP for HBV

Table 4.2: PEP for HBV

Recommendations for Hepatitis B prophylaxis following per cutaneous or per mucosal exposure.

Exposed Person	Treatment when source is found to be		
	HBsAg – positive	HBsAg–negative	Source not tested or unknown
Unvaccinated	HBIG x 1* and initiate HB vaccine	Initiate HB vaccine	Initiate HB vaccine
Previously vaccinated known responder	Test for anti-HBs titre 1. If adequate, no treatment 2. If inadequate, HB vaccine booster dose	No treatment	No treatment
Previously vaccinated known non-responder	HBIG x 2 or HBIG x 1 plus 1 dose of HB vaccine	No treatment	If known high-risk source, may treat as if source were HBsAg-positive
Response unknown	Test for anti-HBs 1. If inadequate HBIG x 1 plus HB vaccine booster dose 2. If adequate, no treatment	No treatment	Test for anti-HBs 1. If inadequate @, HB vaccine booster dose 2. If adequate, no treatment

* HBIG dose 0.06 ml/kg IM

@ Adequate anti-HBsAg is > 10 SRU by RIA or positive by EIA.

ii) PEP for HCV

There is no vaccination and no recommended chemoprophylaxis. Only follow-up testing for sero-conversion is recommended.

iii) PEP for HIV

Table 4.3: HIV Post-Exposure Prophylaxis Evaluation

Exposed	Status of Source (see below)			HIV status Negative
	HIV + and low Risk	HIV + and high Risk	HIV status unknown	
Mucous membrane / non-intact skin; small volume (drops)	Consider 2-drug PEP	2-drug PEP	Consider 2-drug PEP	No PEP is required if the source blood is confirmed HIV negative
Mucous membrane / non-intact skin; large volume (major blood splash)	2-drug PEP	3-drug PEP	Consider 2-drug PEP	
Percutaneous exposure: not severe solid needle, superficial	2-drug PEP	3-drug PEP	Consider 2-drug PEP	
Percutaneous exposure: severe large bore hollow needle, deep injury, visible blood in device, needle in patient artery/vein	3-drug PEP	3-drug PEP	Consider 2-drug PEP	

Low risk HIV exposure is said to occur when the exposure source is asymptomatic and has normal CD4 counts. High risk HIV exposure is said to occur when the source has advanced AIDS, high viral load or low CD4 counts.

Table 4.4: Post-Exposure Chemoprophylaxis

Basic regimen: 2 drugs (NRTIs) (4 weeks therapy)	Zidovudine (AZT/ZDV) – 300mg twice/day is used for all types of exposure + Lamivudine (3TC) – 150 mg twice a day is added to increase the effectiveness of ZDV and to prevent resistance to ZDV
Expanded Regimen: 3 drugs (2 NRTIs + PI) (4 weeks therapy)	Basic Regimen (AZT/ZDV + 3TC) + Nelfinavir 750 mg three times daily or any other boosted protease inhibitor. (for higher risk categories – consult expert)

In case the HIV source person is on antiretroviral therapy, the ART physician must be consulted to know if there is any drug resistance . (Refer updated PEP guidelines from NACO website)

Follow-up in case of PEP

As mentioned, the first blood sample is collected immediately after exposure. Subsequent blood samples are collected at 6 weeks, 12 weeks and 6 months to assess the seroconversion if any. During this period all standard precautions to avoid HIV dissemination should be observed.

4.3 Biomedical waste Management

Biomedical waste means any waste, which is generated during diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biological and including categories mentioned in Schedule I of the Biomedical Waste (Management and Handling) Rules, 1998, (Draft 2011) as published by the Ministry of Environment and Forests.

Table 4.5: Categories of Bio-Medical Waste

Option	Waste Category	Treatment and disposal
Category 1	Human anatomical waste	Incineration/deep burial
Category 2	Animal waste	Incineration/deep burial
Category 3	Microbiology and Biotechnology waste	Local autoclaving / microwaving / Incineration
Category 4	Waste sharps	Disinfection (autoclaving / microwaving and mutilation / shredding) Final disposal through authorized common BMW Treatment facility or secure landfill or concrete waste sharp pit.
Category 5	Discarded Medicines and Cytotoxic drugs	Incineration / destruction and drug disposal in secured and fills
Category 6	Soiled waste (items contaminated with blood and body fluids)	Incineration / autoclaving / microwaving
Category 7	Infectious Solid waste (Tubings, catheters, intravenous sets etc.)	Disinfection by chemical treatment autoclaving / microwaving and mutilation / shredding
Category 8	Chemical Waste	Disinfect chemically and discharge into drains

The Blood bank waste handling is an essential job which needs to be under supervision . Broad guidelines for waste segregation are to be followed.

Table: 4.6 Segregation and Disposal

Sl. No.	Area	Type of Waste generated	Segregation	Treatment of waste Disposal
1.	Donor Screening area	Swabs	Yellow Bags	Incineration
		Lancets	Puncture proof Container with Hypochlorite	Landfill/Safe pit
		Micro pipette tip	Red Bag	Shredder
		Gloves	Red Bag	Shredder
2.	Blood collection room	Swabs	Yellow Bag	Incineration
		Bag Needle	Needle destroyer (Puncture proof container)	Landfill/Safe pit
		Blood Bag tubing	Red Bag	Shredder
		Gloves	Red Bag	Shredder
		Wrappers(All Labs)	Black Bag	Municipal garbage
3.	Component lab	Blood bag tubing	Red Bag	Shredder
		Apheresis Kits	Red Bag	Shredder
		Gloves	Red Bag	Shredder
4.	TTI Lab	Sample tubes (Glass)	Hypochlorite solution	Recycle
		Sample tubes (Plastic)	Red Bag	Shredder
		Discarded plates	Red Bag	Shredder
		Washer waste	Hypochlorite solution	Drain in sewer line
		Chemicals reagents, kits Controls	Hypochlorite solution	Drain in sewer line
		Reactive Bags	Autoclave/Red Bag	Shredder
		Broken Sample tubes (Glass)	Hypochlorite solution	Land fill
		Gloves	Red bag	Shredder
5.	Serology Lab	Sample Vials (Glass)	Hypochlorite solution	Recycle/Land fill
		Blood Bag tubing	Red Bag	Shredder



Figure 15: Universal Bio Hazard Symbol



Figure 16: Colour Coded Bins



Figure 17: Red Bin with Infected Waste Discard



Figure 18: Black Bin with General Waste Discard

(Ref: Picture source: Transfusion Medicine centre, NIMHANS, Bangalore)


4.4 Disinfection

Disinfection is the reduction in the number of pathogenic microbes so that the material/object/surface becomes safe for handling. Sodium hypochlorite is the most frequently used general lab disinfectant. Its advantages are that it is affordable, easily available and has virucidal and bactericidal action. Its limitations are that the solution gradually loses its strength, hence requires daily preparation of fresh 1% solution from stock solution (generally available as 4%) and secondly it corrodes metals. Sodium hypochlorite should be poured in plastic jars or bins for use in labs.

Disinfection of glassware and plastic ware is achieved by immersing in 1% sodium hypochlorite for at least 30 minutes. Subsequently glassware can be placed in hot air oven at 160°C for 1 hour.

4.5 Autoclaving

In this process saturated steam under pressure is used to decontaminate the infectious material. The main factors influencing quality of steam disinfection are temperature, time and presence of saturated steam. A pressure of 15 psi at 121°C for 45 to 60 minutes is required for adequate microbial destruction. The quality of this procedure is checked with



strips or vials of *B. stearothermophilus*, at least once a month. Records of autoclaved blood units and quality control must be maintained.

Autoclave should be fitted with pressure and temperature indicator. Bio safety practices should be in accordance with the Biomedical Waste Management and Handling Rules, 1998 (Draft 2011).

4.6 Disposal of Blood and Laboratory Material

Nurses play an important role in disposal of blood and laboratory material. They should strictly follow all biomedical waste management rules and regulations in the disposal of blood and laboratory material. They can place ready reckoner for all other staff in following the standard protocols.

- Nurses should know the methods of disposal of blood bags. Method of disposal of blood bags should comply with the requirements of Biomedical Waste Rules of the Ministry of Environment and Forests and local pollution control board. Needles should be burnt using electric needle destroyers or soaked in hypochlorite solution or discarded in a puncture proof container of a non-chlorinated plastic. These should then be sent for deep burial or incineration.
- The spill on table tops/sinks should be covered with filter papers or plain cloth and soaked with 1% hypochlorite solution for at least 30 minutes and later swabbed and discarded into red bag.
- Hypochlorite – detergent solution 0.5-1.0 per cent solution of hypochlorite is the best general purpose disinfectant if contact is maintained for at least 30 minutes. (Except for metallic equipment which could be autoclaved or put in cidex). Disposal by Sterilisation: Autoclaving for 30 minutes at 121°C and 15p.s.i. (68.5 cm Hg) is the method of choice. Validation with use of biological indicator (*B. stearothermophilus*) should be done at least once a month.

4.7 Discarding TTI Reactive Blood Unit

All the blood units which are reactive or are in the gray zone reactivity in the first run; are discarded along with their components.

The units which are found to be reactive are kept in the quarantine box. The details of these units are checked by the technical supervisor. Record is made in the discard register. It is confirmed and signed by staff nurse, technical supervisor and the medical officer. The unit is autoclaved and is allowed to cool. After that is put in red bag and sent for disposal following the Biomedical Waste Management Rules.

Roles and Responsibilities of Nurses:

- ◆ Nurses should have knowledge of bio safety measures like modes of exposure to blood borne pathogens in the lab, essential steps of bio safety like good laboratory practices, laboratory cleanliness, universal precautions, safe handling of specimens and sharps, management of blood spills etc.
- ◆ Nurses should inform the medical officer/concerned authorities immediately if there are any incidental exposure to infected samples like bag breakage, splash and needle stick injury.
- ◆ All staff including nurses should receive preventive inoculation against Hepatitis-B infection after appropriate tests
- ◆ Make sure all the protective apparel for universal precaution are available and used by all the staff
- ◆ Wash hands before leaving the laboratory, and before eating or drinking. Wash hands immediately after they have been in contact with blood or blood products. Wear disposable gloves when handling all materials suspected of being infective or when opening samples of blood.
- ◆ Keep open wounds and cuts covered with an adhesive dressing or disposable gloves during working. Never invert a tube containing blood or a blood derivative by covering the mouth of the tube with a finger. Cover the mouth of the tube with parafilm or with a similar product.
- ◆ Always use a clean lab coat with buttons closed while working. If a laboratory coat becomes soiled with blood or serum, change to a clean one. The soiled coat should be soaked in hypochlorite or autoclaved before it is laundered. Do not wear lab coat when you proceed for lunch.
- ◆ Do not put fingers or objects such as pens, in the mouth. Do not use mouth pipetting. Eating, drinking, smoking is not permitted in any working area of the laboratory. No food or beverage should be stored in any laboratory refrigerator, freezer, hot air oven or incubator.
- ◆ Avoid needle stick injuries. Never recap or bend needles. Dispose all sharps in puncture proof containers. In case of a needle stick injury, inform medical officer and go for post exposure prophylaxis as per guidelines under State AIDS Control Programme.





Choose the Best Option:

1. The general rule regarding handling of blood and blood products is that:
 - a. All samples should be treated as potentially infectious
 - b. Reactive sample to be treated as potentially infectious
 - c. Samples from patients to be treated as potentially infectious
 - d. Sample for donors to be treated as potentially infectious

2. Yellow plastic bags are used for disposal of the following bio-medical waste in the blood bank:
 - a. Cotton swabs/tissue paper contaminated with blood/serum/plasma
 - b. Paper/general waste
 - c. Needles/lancets
 - d. All the above

3. Barrier protection does not includes:
 - a. Gloves
 - b. Hepatitis B vaccination
 - c. Masks
 - d. Occlusive bandages

4. To maintain general laboratory hygiene the following should be enforced:
 - a. Restricted entry to work areas
 - b. Avoid eating, drinking, smoking in the laboratory
 - c. Avoid mouth pipetting
 - d. All of the above

5. Which of the following is NOT an advantage of sodium hypochlorite:
 - a. Bactericidal
 - b. Virucidal
 - c. Affordable
 - d. Stable at room temperature

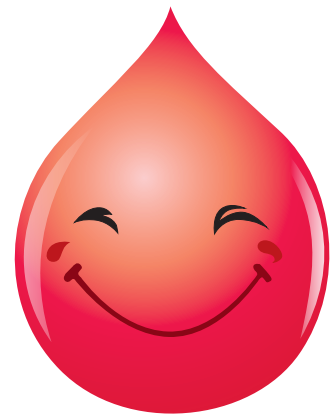
NOTES:

BLOOD COMPONENTS

Learning Objectives

When you have completed this chapter you should be able to:

- Describe constituents of blood and its components
- Carry out component preparation
- Carry out quality control of blood /blood components



5.1 Constituents of Blood

Blood is composed of plasma in which the following highly specialized cells are suspended

- Red blood cells (erythrocytes)
- White blood cells (leucocytes)
- Platelets

Plasma contains proteins, chemical substances, coagulation factors and numerous metabolic substances. It is capable of clotting.

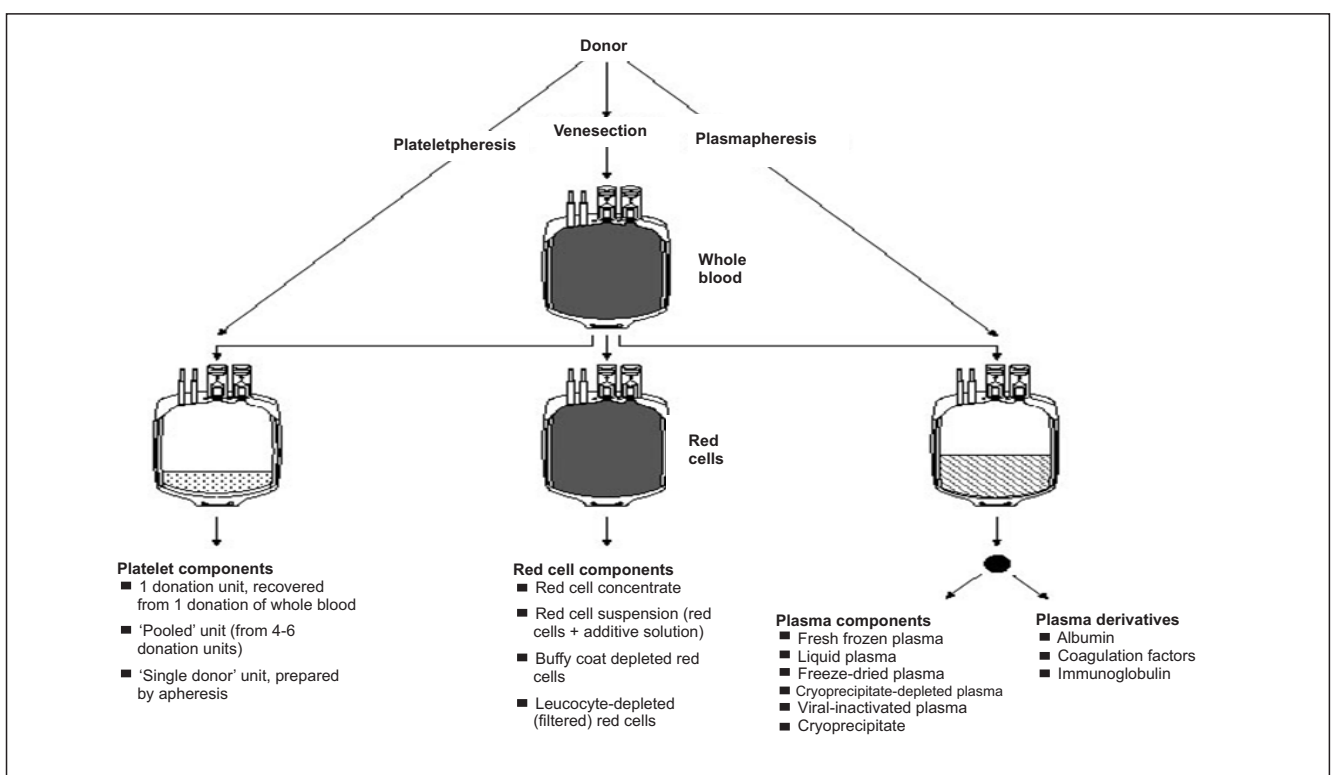


Figure 19: Constituents of Blood

The volume occupied by both cells and plasma in the vascular system is called the total blood volume.

- In an adult, this is approximately 7% of body weight or 70 ml/kg. For example, a 60 kg man would have a blood volume of 70 x 60, which is 4200 ml.
- As children have higher water content, the blood volume is calculated to be 8% of body weight or 80ml/kg.
- It is higher still in the neonate and is calculated to be 85 – 90 ml/kg



Red blood cells

Red blood cells (erythrocytes) are produced in the bone marrow under the controlling influence of the renal hormone erythropoietin. After entering the bloodstream, they have a life-span of approximately 120 days before being broken down in the reticuloendothelial system. The red cells contain the iron-containing pigment hemoglobin, whose primary function is to store and transport oxygen. Red cells are the most numerous of the cells in the blood and normally occupy about 45% of the total blood volume.

Hemoglobin is usually measured in grams per decilitre (g/dL) or grams per millilitre (g/100 ml) of blood. In adult males, a typical level would be approximately 14 g/dL and in adult females 13 g/dL.

White blood cells

White blood cells (leucocytes) are a family of cells consisting of:

- Granulocytes
- Lymphocytes
- Monocytes

They are produced in the bone marrow and lymphatic tissue. Their principal role in the blood is to identify, destroy and remove any foreign material that has entered the body. These cells are therefore important in fighting infection and in developing resistance to infection in response to natural exposure or immunization. White cells occupy less than 1% of the total blood volume.

Platelets

Platelets are small fragments of cells (megakaryocytes), which are produced in the bone marrow and contain enzymes and other biologically active substances. Their function is to respond to any vascular wall damage by gathering together at the site of injury to form an initial temporary platelet plug and releasing their contents into the blood.

The released contents of platelets are largely responsible for the subsequent coagulation process by activating the blood clotting mechanism that results in the permanent deposition of a fibrin clot at the site of the damage, preventing further bleeding.

Blood component preparation is an essential part of the blood transfusion services. Blood needs can only be met by separating it into various components. Thus component separation and administration helps in rationalizing use of blood.

Blood components are prepared using physical properties of blood for e.g., centrifugation, whereas blood derivatives are prepared by a chemical method, e.g. ethanol, in varying concentration and temperature for their separation. Primary goal of component therapy is to provide the right component to the right patient in the right quantity at the right time of the right quality.

5.2 Blood Component Separation

There are various methods to separate these components and the yield and quality of component depends upon the method applied. Various methods used are:-

- (a) Gravity separation
- (b) Low and high speed refrigerated centrifugation
- (c) Apheresis by cell separator

(a) Gravity separation:

This method is rarely used to separate plasma from whole blood and is used only in case of non-availability of equipments for centrifugation. It does not however result in optimal separation of plasma.

Steps

1. The blood is collected in a double or triple bag system.
2. Blood is kept hanging overnight at least for 12-16 hours for sedimentation of packed red cells.
3. The supernatant (clear) plasma is expressed into the satellite bag.

(b) Centrifugation:

Components are prepared by centrifugation where cells settle according to specific gravity.

$$Rcf (g) = 28.38 \times R \times (rpm/1000)^2$$

Or

$$rpm = 187.6 \times \sqrt{g/R}$$

R = radius of centrifuge in inches, rcf = relative centrifugal force, rpm = revolutions per minute

(c) Apheresis by cell separator:

Kindly refer BCSU handbook for more details.

The different components that can be separated are as below

Component	Common Abbreviation
• Packed Red Cells	PRBC
• Leuco-reduced Red Cells	LPRBC
• Platelet Concentrate	PC
• Fresh Frozen Plasma	FFP
• Cryo Poor Plasma/Cryo Deficient Plasma	CPP/CDP
• Cryoprecipitate	Cryoppt
• Buffy Coat Platelet Concentrate	BCPC

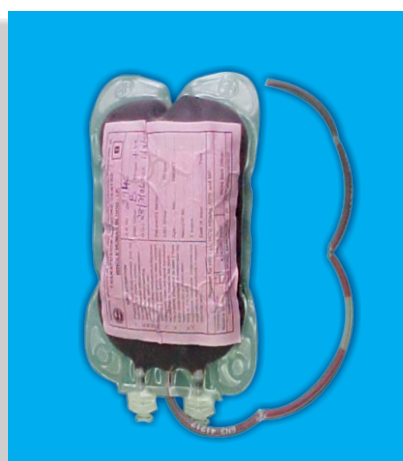


Figure 20: Whole Blood showing color coded label and segments



Figure 21: Red Cell Concentrate color coded label and segments



Figure 22: Fresh Frozen Plasma Unit

5.3 Steps of component separation

The basic procedures involved in component preparation are relatively simple and normally performed using closed, multiple blood bag systems.

(i) Special Precautions should be taken for blood collection for component preparation

1. Clean thoroughly to minimize bacterial contamination
2. Venipuncture should be smooth with good blood flow
3. Duration of venisection should not be more than 8min
4. Adequate mixing of Blood and Anticoagulant should be monitored
5. Appropriate volume of blood should be collected
6. Immediately strip and segment tubing
7. Appropriate storage is essential before processing

(ii) Apparatus and equipment for blood component preparation

1. Air-conditioned work place
2. Refrigerated centrifuge
3. Laminar air flow
4. Plasma expresser
5. Clipper and clips / dielectric sealer
6. Double pan weighing balance
7. Dry rubber balancing material
8. Artery forceps and scissors
9. Refrigerator with temperature range 2° - 6°C
10. Deep freezers, - 30°C to -40°C, - 40°C to -80°C
11. Refrigerated water bath
12. Insulated container for blood transportation

(iii) A standardized validated protocol is to be followed for preparation of blood components

5.4 Storage and shelf life of components

For calculating the expiry date the day of collection should be considered as day '0'. Blood should be collected in the blood bag before the date of expiry, which is mentioned on the manufacturer label of blood bag. The date of expiry of blood or component unit is calculated from the date of blood collection.


Table 5.1: Storage and Shelf Life of Components

Component	Storage temperature	Shelf life
Platelet concentrate	22 ± 2°C	5 days
Red cells	2° to 6°C	35 days
Red cells with additive solution	2° to 6°C	42 days
FFP	minus 30°C or below	1 year
Cryoprecipitate	minus 30°C or below	1 year
CPP	minus 30°C or below	5 years*

(*DGHS Technical Manual)

5.5 Storage of blood and blood components prior to transfusion

The 'Blood cold chain' is the system for storage and transportation of blood and blood components so that they are kept at the correct temperature at all times from collection from donor to administration to the patient. Any break in the blood cold chain increases the dangers for the recipients of blood components.



Clinical staff is responsible for ensuring that blood products issued by the BTS for transfusion are kept at the correct temperature until their transfusion into the patient.

Red Cells and Whole blood

Red cells and whole blood must always be stored at a temperature between +2° to +6°C. They must never be allowed to freeze. The upper limit of 6°C is essential to minimize the growth of any bacterial contamination in the unit of blood.

Below 2°C red cells become haemolysed. Haemolysed cells if transfused cause renal failure and fatal bleeding problems. Whole blood and red cells should be issued from the blood bank in the blood transport box or insulator carrier that will keep the temperature under 10°C.

Group specific red cells are issued after proper cross matching. Once issued red blood cells should be transfused within half an hour of release from the Blood bank or centre and if not required it should be sent back to BTS immediately.

Fresh Frozen Plasma (FFP)

Fresh Frozen Plasma is stored in BTS at -30°C or colder until it is thawed before transfusion. Most of the clotting factors are stable at refrigerator temperature except for factor V and VIII. The approximate volume is 150 - 175 ml/bag. It is thawed at 30°C to 37°C in a water bath and takes about 30 - 45 minutes. It is transported in a blood transport box in which the temperature is maintained between 2°C to 6°C. Once thawed it should be transfused within 30 minutes.

If not required for immediate use, it can be kept at 2°C to 6°C and transfused within 24 hours. Once thawed the FFP cannot be refrozen and has to be discarded. In order to not waste blood components, demand only when required essentially and in the requisite quantities. Group specific FFP has to be issued/ transfused. However, AB group plasma being neutral plasma (no antibodies) can be transfused to any group patient.

Platelet Concentrate (PC)

Platelets are stored at 20°C to 24°C in a platelet agitator to maintain platelet function. Volume of platelet concentrates is 30 - 50 ml and volume of PRP 150 - 170 ml. One unit of a single donor (Apheresis platelet) has a volume 150 - 300ml. Platelets are to be transported in a blood transport box that keeps the temperature at about 20°C to 24°C. Keep note: DO NOT REFRIGERATE platelets. Transfuse platelets as soon as possible. Whenever large quantities of platelets are required for special procedures inform the BTS at least 24 hours in advance. Platelet concentrate of any group can be transfused to any group patient, however group specificity /compatibility should be adhered to as much as possible.

Cryoprecipitate (Cryoppt)

It is stored at -30°C or lower. The volume of cryoppt is 25 - 30 ml. It is thawed at 30°C to 37°C in a water bath and takes about 15 - 30 minutes. Once thawed it should be transfused within 30 minutes. If not immediately transfused it is kept at 2°C to 4°C and can be transfused within 24 hours of thawing. It cannot be refrozen, so if not transfused, it has to be discarded.

Issuing blood and blood components

In order to avoid outdated, First in First out (FIFO) policy is implemented in blood bank. Issue forms are to be presented at the issue counter.

1. Ensure compatibility testing has been carried out.
2. Ensure that the compatible units are tested for TTI and found suitable for use
3. Remove the correct unit from blood bank refrigerator and label the unit with the blood issue label.
4. Keep it in the thermal box for transport
5. Make entries in the issue register
6. Instruct the individual to take the unit straight to OT/Ward for transfusion.

5.6 Criteria for Reissue of Received Back Blood Bags

Blood units are checked grossly, for physical changes, like clot formation, haemolysis or discolouration and are kept in quarantine for 24 hours. If supernatant plasma is clear, then these units are taken for further use in the general pool within the expiry date.

Objective criteria such as plasma hemoglobin in supernatant plasma would be helpful in reissue.

5.7 Procedure for Tracing a Unit of Blood

A unit of blood or blood component can be traced by its registration number with regard to donor particulars (donor register), patient particulars (patient and issue register) and screening test status (HIV, HBsAg, HCV, VDRL, Malaria) All records therefore must be meticulously maintained at the Blood Bank / Blood Centre.

Roles and Responsibilities of Nurses:

- ◆ Nurses should have knowledge of constituents of blood - like red blood cells, white blood cells and platelets
- ◆ Blood component -storage temperate and shelf life - Red cells is stored at + 2° to 6°C with shelf life of 35 days, Red cells with additive solution stored at + 2° to 6°C with shelf life of 42 days, FFP stored at - 30°C with shelf life of 1 year, CPP stored at - 30°C with shelf life of 5 years, Platelet concentrate stored at + 22°C with shelf life 5 days and Cryoprecipitate stored at - 30°C with shelf life of one year
- ◆ Knowledge on steps for component preparation, special precautions to be taken for blood collection for component preparation and apparatus and equipment required.
- ◆ Nurses should have knowledge on storage guidelines and shelf life of components, storage prior to transfusion and criteria for reissue of received back blood bags.
- ◆ Nurses should follow all the standard guidelines/protocols in the storage of blood and blood products
- ◆ Nurses should train all other subordinate staff on the above.



Choose the Best Option:

1. During storage, platelets require:
 - a. Flatbed storage surface only at 22°C
 - b. Gentle agitation on a flatbed surface at 4°C
 - c. Flatbed storage at 4°C
 - d. Gentle agitation on a flat bed surface at 22±2°C

2. The best product for a prospective bone marrow transplant patient who is thrombocytopenic is:
 - a. Platelet rich plasma (PRP)
 - b. Buffy coat reduced platelet concentrates (BC-PC)
 - c. Irradiated Random donor platelet concentrates (PC)
 - d. Irradiated Apheresis platelet concentrates (AP-PC)

3. Calibration/validation of a blood storage refrigerator temperature display is done by:
 - a. Keeping a hygrometer inside the refrigerator
 - b. Keeping a calibrated mercury thermometer inside the refrigerator
 - c. Keeping a calibrated mercury thermometer inside the refrigerator within a beaker filled with distilled water and glycerine
 - d. Not sure of the answer

4. Daily quality check parameters for a blood storage refrigerator are:
 - a. Functional temperature display unit showing temp between 1 - 6°C
 - b. An audio visual alarm, when temperature goes beyond the range
 - c. Audio visual alarm for the incompletely closed or open door
 - d. Thermograph tracing record of the last 24 hours
 - e. All of the above

5. The shelf life of platelet concentrate is :
 - a. 2 days
 - b. 7 days
 - c. 8 days
 - d. 5 days

6. The shelf life of SAGM –packed red blood cells is:
 - a. 37 days
 - b. 45 days
 - c. 21 days
 - d. 42 days

NOTES:

PRETRANSFUSION ISSUES AND BEDSIDE PRACTICES

Learning Objectives

When you have completed this chapter you should be able to:

- List down the essential prerequisites in arranging, requisition of blood and components from the BTS
- Discuss the bed side pre-transfusion checks and blood/component administration practices

