TRANSFUSION

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State Blood Transfusion Council,
Maharashtra

Bank: Blood Bank.

Deposit- A Unit of Blood.

Tax Free Interest: Precious Human Life!

Blood Saves the Life!

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Message

The progressive state like Maharashtra has always remained in the forefront of health care delivery system.

The state has 263 registered blood banks, 71 of these blood banks have been modernised, while 8 have been equipped for fractionation. All the personnel has been imparted advanced training in transfusion medicine in reputed centres in and outside the country.

Last year we implemented a policy of single common donation card for the whole state, which will be

honoured for replacement by all the blood banks of the state for a period of two years. A Blood donor can avail blood for his kith and kin from any blood bank in the state.

Blood is precious to save the life, use it judiciously with due care.

This book gives all the practical guidelines. I am sure the crystal clear concepts will help in the best practices of transfusion. 1

I appeal to all the clinicians to promote voluntary blood donation and use the blood judiciously with proper indications and care. 1

--Shri. Digvijay Khanvilkar
Hon. Minister,
Public Health and Medical. Education.
Govt, of Maharashtra

Foreword

Blood Saves Life!
It is as precious as the human life!
Safe Blood starts with me!

In 2002, Govt, of India adopted the National Blood Policy which aims at ensuring easy accessibility and adequate supply of safe Blood. The action plan of Blood Safety brings about a paradigm shift in the management of Blood Transfusion Services.

An authorized Blood Bank may be set up only after obtaining a license from the competent

authority, and the license should be renewed as per the rule.

Various amendments to the Drugs and Cosmetics Act, make mandatory the universal screening of blood units for five transmissible infections, i. e., hepatitis B hepatitis C, HIV, syphilis and malaria.

In medical practice, blood transfusion is used in several emergency and non-emergency conditions. Therefore, all doctors involved in management of such situations must be kept updated of safe transfusion practices. I sincerely feel, this need will be fulfilled by this book.

Simple language, precise writing and a concise approach have made this book extremely readable. I recommend it for every doctor.

--Dr. Subhash Salunke,
Director General of Health Services,
Maharashtra State.

Preface

Transfusion Medicine has emerged as a subspeciality ofMedicine.

The understanding of the molecular basis of disease, potential of transfusion transmissible infections, transfusion related complications coupled with the short supply of blood has led to the employment of stringent safety measures and prompted the judicious use of blood and blood components.

Blood Banking is one aspect of transfusion medicine. Blood Bankers need to continuously update

themselves with the rapid strides made in this ever growing field.

The second important aspect of transfusion medicine is the clinical domain. The clinicians play the crucial role in transfusion practices. They are responsible for prescription of blood and blood components. The clinicians transfuse the patient and also monitor the patient for transfusion reactions/ complications. Therefore it is imperative that the clinicians understand the paradigm shift in transfusion practices. This handbook is intended to be helpful in day-to-day clinical practice of transfusion.

I am thankful to all my colleagues for their academic contributions. Without the financial support from the State Blood Transfusion Council Maharashtra, it would not have been possible to publish this book.

I express my gratitude to Hon. Shri Digvijayji Khanvilkar for his encouragement and Dr. Subhash Salunke, DGHS for the guidance and financial support.

-Prof. Alaka K. Deshpande

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National Blood Policy

Policy Document of National AIDS Control Organization (NACO)

INTRODUCTION:
A well organised Blood Transfusion Service (BTS) is a vital component of any health care delivery system. An integrated strategy for Blood Safety is required for elimination of transfusion transmitted infections and for provision of safe and adequate blood transfusion services to the people. The main component of an integrated strategy include collection of blood only from voluntary, non-remunerated blood donors, screening for all transfusion transmitted infections and reduction of unnecessary transfusion.

The Blood Transfusion Service in the country is highly decentralised and lacks many vital resources like manpower, adequate infrastructure and financial base. The main issue, which plagues blood banking system in the country, is fragmented management. The standards vary. from State to

State, cities to cities and centre to centre in the same city. In spite of hospital based system, many large hospitals and nursing homes do not have their own blood banks and this has led to proliferation of stand-alone private blood banks.

The blood component production/availability and utilisation is extremely limited. There is shortage of trained health-care professionals in the field of transfusion medicine. For quality, safety and efficacy of blood and blood products, well-equipped blood centres with adequate infrastructure and trained manpower is an essential requirement. For effective clinical use of blood, it is necessary to train clinical staff. To attain maximum safety, the requirements of good manufacturing practices and implementation of quality system moving towards total quality management, have posed a challenge to the organisation and management of blood transfusion service.

Thus, a need for modification and change in the blood transfusion service has necessitated formulation of a National Blood Policy and development of a National Blood Programme which will also ensure implementation of the directives of Supreme Court of India - 1996.

MISSION STATEMENT:

The policy aims to ensure easily accessible and adequate supply of safe and quality blood and blood components collected / procured from a voluntary non-remunerated regular blood donor in well equipped premises, which is free from transfusion transmitted infections, and is stored and transported under optimum conditions. Transfusion under supervision of trained

personnel for all who need it irrespective of their economic or social status through comprehensive, efficient and a total quality management approach will be ensured under the policy.

OBJECTIVES OF THE POLICY:

To achieve the above aim, the following objectives are drawn:

1. To reiterate firmly the Govt, commitment to provide safe and adequate quantity of blood, blood components and blood products.

2. To make available adequate resources to develop and reorganise the blood transfusion services in the entire country.

3. To make latest technology available for operating the blood transfusion services and ensure its functioning in an updated manner.

4. To launch extensive awareness programmes for donor information, education, motivation, recruitment and retention in order to ensure adequate availability of safe blood.

5. To encourage appropriate clinical use of blood and blood products.

6. To strengthen the manpower through human resource development.

7. To encourage Research & Development in the field of Transfusion Medicine and related technology.

8. To take adequate regulatory and legislative steps for monitoring and evaluation of blood transfusion services and to take steps to eliminate profiteering in blood banks.

OBJECTIVE-1:

To reiterate firmly the Govt. commitment to provide sate and adequate quantity of blood, blood components and blood products.

1.1 A national blood transfusion Programme shall be developed to ensure establishment of non-profit integrated National and State Blood Transfusion Services in the country.

1.1.1 National Blood Transfusion Council (NBTC) shall be the policy formulating apex body in relation to all matters pertaining to operation of blood centres. National AIDS Control Organisation (NACO) shall allocate a budget to NBTC for strengthening Blood Transfusion Service.

1.1.2 State/UT Blood Transfusion Councils shall be responsible for implementation of the Blood Programme at State/UT level, as per the recommendations of the National Blood Transfusion Council.

1.1.3 Mechanisms for better co-ordination between NBTC and SBTCs shall be developed by the NBTC.

1.1.4 Mechanisms shall be developed to monitor and periodically evaluate the implementation of the National Blood Programme in the country.

1.1.5 The enforcement of the blood and blood products standards shall be the responsibility of Drugs Controller General India as per Drugs and Cosmetics Act/Rules, with assistance from identified experts.

1.1.6 NBTC shall ensure involvement of other Ministries and other health programmes for various activities related to Blood transfusion services.

1.2 Trading in blood i.e. Sale & purchase of blood shall be prohibited.

1.2.1 The practice of replacement donors shall be gradually phased out in a time bound programme to achieve 100% voluntary non-remunerated blood donation programme.

1.2.1.1 State/UT Blood Transfusion Councils shall develop an action plan to ensure phasing out of replacement donors.

1.3 The following chain of Transfusion Services shall be promoted for making available of safe blood to the people.

1.3.1 State Blood Transfusion Councils shall organise the blood transfusion service through the network of Regional Blood Centres and Satellite Centres and other Government, Indian Red Cross Society & NGO run blood centres and; monitor their functioning. All Regional Centres shall be assigned an area around in which the other blood banks and hospitals which are linked to the regional centre will be assisted for any requirement and shall be audited by the Regional Centre. It will also help the State Blood Transfusion Council in collecting the data from this region.

1.3.2 The Regional Centres shall be autonomous for their day to day functioning and shall be guided by recommendations of the State/UT Blood Transfusion Councils. The Regional Centre shall act as a referral centre for the region assigned to it.

1.3.3 NBTC shall develop the guidelines to define NGO run blood centres so as to avoid profiteering in blood banking.

1.4 Due to the special requirement of Armed Forces in remote border areas, necessary amendments shall be made in the Drugs & Cosmetics Act/Rules to provide special licences

to small garrison units. These units shall also be responsible for the civilian blood needs of the region.

OBJECTIVE-2:

To make available adequate resources to develop and reorganise the blood transfusion service in the entire country.

2.1 National & State/UT Blood Transfusion Councils shall be supported/ strengthened financially by pooling resources from various existing programmes and if possible by raising funds from international] / bilateral agencies.

2.2 Efforts shall be directed to make the blood transfusion service viable through non-profit recovery system.

2.2.1. National Blood Transfusion Council shall provide guidelines for ensuring non-profit cost recovery as well as subsidised system.

2.2.2. Efforts shall be made to raise funds for the blood transfusion service for making it self-sufficient.

2.2.3. The mechanism shall be introduced in government sector to route the amounts received through cost recovery of blood/blood components to the blood banks for improving their services.

OBJECTIVE-3:

To make latest technology available for operating the blood transfusion services and ensure its functioning in an updated manner.

3.1 Minimum standards for testing, processing and storage shall be set and ensured.

3.1.1. Standards, Drugs & Cosmetics Act/Rules and Indian Pharmacopoeia shall be updated as and when necessary.

3.1.2. All mandatory tests as laid down under provisions of Drugs & Cosmetics Act/Rules shall be enforced.

3.1.3. Inspectorate of Drugs Controller of India and State FDA shall be strengthened to ensure effective monitoring.

3.1.4. A vigilance cell shall be created under Central/State Licensing Authorities.

3.2 A Quality System Scheme shall be introduced in all blood centres.

3.2.1. Quality Assurance Manager shall be designated at each Regional Blood Centre/any blood centre collecting more than 15, 000 units per year to ensure quality control of Blood & its components in the region assigned. He shall be exclusively responsible for quality assurance only.

3.2.2. Every blood centre shall introduce an internal audit system to be followed by corrective actions to reduce variations in Standard Operating Procedures (SOPs) as a part of continuous improvement programme.

3.2.3. Regular workshops on the subject of quality assurance shall be conducted to update the personnel working in blood centres.

3.2.4. Regular proficiency testing of personnel shall be introduced in all the blood centres.

3.3 An External Quality Assessment Scheme (EQAS) through the referral laboratories approved by the National Blood Transfusion Council shall be introduced to assist participating centres in achieving higher standards and uniformity.

3.3.1. Reference centres shall be identified in each State/UT for implementation of EQAS. All blood centres shall be linked to these reference centres for EQAS.

3.3.2. NBTC shall identify a centre of national repute for quality control of indigenous as well as imported consumables, reagents and plasma products.

3.4. Efforts shall be made towards indigenisation of kits, equipment and consumables used in blood banks.

3.5. 3. 5. Use of automation shall be encouraged to manage higher workload with increased efficiency.

3.6. A mechanism for transfer of technology shall be developed to ensure the availability of state-of-the-art technology from out side India.

3.7. Each blood centre shall develop its own Standard Operating Procedures on various aspects of Blood Banking.

3.7.1. Generic Standard Operating Procedures shall be developed by the National Blood Transfusion Council as guidelines for the blood centres.

3.8. All blood centres shall adhere to bio-safety guidelines as provided in the Ministry of Health & Family Welfare manual "Hospital-acquired Infections: Guidelines for Control" and disposal of bio-hazardous waste as per the provisions of the existing Biomedical Wastes (Management & Handling) Rules-1996 under the Environmental Protection Act - 1986.

OBJECTIVE-4:

To launch extensive awareness programmes for blood banking services including donor motivation, so as to ensure adequate availability of safe blood.

4.1 Efforts shall be directed towards recruitment and retention of voluntary, non-remunerated blood donors through education and awareness programmes.

4.1.1 There shall not be any coercion in enrolling replacement blood donors.

4.1.2 The replacement donors shall be encouraged to become regular voluntary blood donors.

4.1.3 Activities of NGOs shall be encouraged to increase awareness about blood donation amongst masses.

4.1.4 All blood banks shall have donor recruitment officer/donor organiser.

4.1.5 Each blood centre shall create and update a blood donor's directory which shall be kept confidential.

4.1.6 In order to increase the donor base specific IEC campaigns shall be launched to involve youth in blood donation activities.

4.2 Enrolment of safe donors shall be ensured.

4.2.1 Rigid adherence to donor screening guidelines shall be enforced.

4.2.2 At blood donation camps, appropriate attention shall be paid on donor enrolment and screening in accordance with national standards instead of number of units collected.

4.2.3 A Counselor in each blood centre shall be appointed for pre and post donation counseling.

4.2.4 Result seeking donors shall be referred to a Blood Testing Centre (BTC) for post donation information and counseling.

4.3 State/UT Blood Transfusion Councils shall recognise the services of regular voluntary non-remunerated blood donors

and donor organisers appropriately.

4.4 National/State/UT Blood Transfusion Councils shall develop and launch an IEC campaign using all channels of communication including mass-media for promotion of voluntary blood donation and generation of awareness regarding dangers of blood from paid donors and procurement of blood from unauthorised blood banks/ laboratories.

4.5 National / State / UT blood transfusion councils shall involve other departments / sectors for promoting voluntary blood donations.

OBJECTIVE-5:

To encourage appropriate clinical use of blood and blood products.

5.1 Blood shall be used only when necessary. Blood and blood products shall be transfused only to treat conditions leading to significant morbidity and mortality that cannot be prevented or treated effectively by other means.

5.2 National Guidelines on **"Clinical use of Blood"** shall be made available and updated as required from time to time.

5.3 Effective and efficient clinical use of blood shall be promoted in accordance with guidelines.

5.3.1 State/UT Governments shall ensure that the Hospital Transfusion Committees are established in all hospitals to guide, monitor and audit clinical use of blood.

5.3.2 Wherever appropriate, use of plasma expanders shall be promoted to minimise the use of blood.

5.3.3 Alternative strategies to minimise the need for transfusion shall be promoted.

5.4 Education and training in effective clinical use of blood shall be organised.

5.4.1 Medical Council of India shall be requested to take following initiatives:

5.4.1.1 To introduce Transfusion Medicine as a subject at undergraduate and all post graduate medical courses.

5.4.1.2 To introduce posting for at least 15 days in the department of transfusion medicine during internship.

5.5 To include Transfusion Medicine as one of the subjects in calculating credit hours for the renewal of medical registration by Medical Council of India, if it is introduced. 5. 4. 2 CME and workshops shall be organised by State Blood Transfusion Councils in collaboration with professional bodies at regular intervals for all clinicians working in private as well public sector in their States.

5.5 Blood and its components shall be prescribed only by a medical practitioner registered as per the provisions of Medical Council Act - 1956.

5.6 Availability of blood components shall be ensured through the network of regional centres, satellite centres and other blood centres by creating adequate number of blood component separation units.

5.7 Appropriate steps shall be taken to increase the availability of plasma fractions as per the need of the country through expanding the capacity of existing centre and establishing new centres in the country.

5.8 Adequate facilities for transporting blood and blood products

including proper cold-chain maintenance shall be made available to ensure appropriate management of blood supply.

5.9 Guidelines for management of blood supply during natural and man made disasters shall be made available.

OBJECTIVE - 6:

To strengthen the manpower through Human Resource Development.

6.1 Transfusion Medicine shall be treated as a speciality.

6.1.1 A separate Department of Transfusion Medicine shall be established in Medical Colleges.

6.1.2 Medical Colleges/Universities in all States shall be encouraged to start PG degree (MD in transfusion medicine) and diploma courses in Transfusion Medicine.

6.1.3 PG courses for technical training in transfusion medicine (PhD / MSc) shall also be encouraged.

6.2 In all the existing courses for nurses, technicians and pharmacists, Transfusion Medicine shall be incorporated as one of the subjects.

6.3 In-service training programmes shall be organised for all categories of personnel working in blood centres as well as drug inspectors and other officers from regulatory agencies.

6.4 Appropriate modules for training of Donor Organisers/Donor Recruitment Officers shall be developed to facilitate regular and uniform training programmes to be conducted in all States

6.4.1 Persons appointed as Donor Organisers/Donor Recruitment Officers shall undergo training for Donor

Motivation and Recruitment organised by State Blood Transfusion Councils.

6.5 Short orientation training cum advocacy programmes on donor motivation and recruitment shall be organised for Community Based Organisations (CBOs)/NGOs who wish to participate in Voluntary Blood Donor Recruitment Programme.

6.6 Inter-country and intra-country exchange for training and experience of personnel associated with blood centres shall be encouraged to improve quality of Blood Transfusion Service.

6.7 States/UTs shall create a separate cadre and opportunities for promotions for suitably trained medical and para medical personnel working in blood transfusion services.

OBJECTIVE - 7:

To encourage Research & Development in tin
Transfusion Medicine and related technology.

7.1 A corpus of funds shall be made available to NBTC/SBTCs to facilitate research in transfusion medicine and technology related to blood banking.

7.2 A technical resource core group at national level shall be created to co-ordinate research and development in the country. This group shall be responsible for recommending implementation of new technologies and procedures in coordination with DC(1).

7.3 Multi-centric research initiatives on issues related to Blood Transfusion shall be encouraged.

7.4 To take appropriate decisions and/or introduction of policy initiatives on the basis of factual information, operational research on various aspects such as various aspects of Transfusion Transmissible Diseases, Knowledge, Attitude and Practices (KAP) among donors, clinical use of blood, need assessment etc shall be promoted.

7.5 Computer based information and management systems shall.be developed which can be used by all the centres regularly to facilitate networking.

OBJECTIVE - 8:

To take adequate legislative and educational steps to eliminate profiteering in blood banks.

8.1 For grant/renewal of blood bank licenses including plan of a blood bank, a committee, comprising of members from State/UT Blood Transfusion Councils including Trans-fusion Medicine expert, Central & State/UT FDAs shall be constituted which will scrutinise all applications as per the guidelines provided by Drugs Controller General India.

8.3 Fresh licenses to stand-alone blood banks in private sector shall not be granted. Renewal of such blood banks shall be subjected to thorough scrutiny and shall not be renewed in case of non-compliance of any condition of licence.

8.3 All State/UT Blood Transfusion Councils shall develop a State Action Plan for the State/UT Blood Transfusion Service where in Regional Blood Transfusion Centres shall be identified. These centres shall be from Government, Indian Red Cross Society or other NGO run blood banks of repute. Approved regional blood centres/government

blood centres/Indian red cross blood centres shall be permitted to supply blood and blood products to satellite centres which are approved by the committee as described in para 8. 1. The Regional Centre shall be responsible for transportation, storage, cross-matching and distribution of blood and blood products through satellite centres.

8.4 A separate blood bank cell shall be created under a senior officer not below the rank of DDC(1) in the office of the DC(1) at the headquarter. State/UT Drugs Control Department shall create such similar cells with the trained officers including inspectors for proper inspection and enforcement.

8.5 As a deterrent to paid blood donors who operate in the disguise of replacement donors, institutions who prescribe blood for transfusion shall be made responsible for procurement of blood for their patients through their affiliation with licensed blood centres.

8.6 States/UTs shall enact rules for registration of nursing homes wherein provisions for affiliation with a licensed blood bank for procurement of blood for their patients shall be incorporated.

8.7 The existing provisions of drugs & Cosmetics Rules will be periodically reviewed to introduce stringent penalties for unauthorised/irregular practices in blood banking system.

History of Blood Transfusion

N. B. Jaju

1616- William Harvey discovered that blood has a flow inside the animal body.

1665 Richard Lower succeeded in saving life of a dog by transfusing another "dog's" blood in it.

1667- The first recorded blood transfusion into vein or artery took place in France in 1667 and was unsuccessful. A cupful of lamb's blood was transfused into a man via a silver tube. The man survived two transfusions and then died.

1668- The Pope banned any kind of experiment on blood,

1818- Dr. James Blunded was successful in saving a man's life by direct transfusion from another man.

1874- William Highmore first suggested autologous transfusion.

1875- Karl Landsteiner was first to notice that just any man's blood cannot be transfused to another.

1900-01- Karl Landsteiner's experiment revealed A, B and O group in human blood. This opened the floodgate for the development of science of "Transfusion Medicine". Rightly, Karl Landsteiner was awarded **"Nobel Prize**" for his grand discovery.

1914- Dr. Hustin's use. of sodium citrate removed the problems in coagulation of blood.

1914-18- Blood transfusion was used during the first world war, when blood was transported to the battlefront in modified, clean, sterilized milk bottles.

1930- The first mobile blood bank was set up in the 1930s during the Spanish civil war.

1937- World's first hospital blood bank was established on March 15, in Cook County Hospital of Chicago, U.S.A.

1939- India's first blood bank was set up in the School of Tropical Medicine, Kolkatta (Calcutta) by Sir Upendranath Brahmachari, the then Chairman of Bengal Red Cross Society.

1940- Rhesus Factor of Blood was discovered by Landsteiner and Weighner.

1941- Blood collecting bottles and also the collection quantity per unit was specified.

1957- Dr. Gibson found out the process of storing blood upto

28 days in a temperature of 4 - 6°C by mixing it up with a solution of ACD and sodium dihydrogen phosphate.

1964-- Infection of jaundice through blood transfusion was confirmed.

1981- Use of polythene bags for collection, storage and transfusion of blood was legalised.

1986- First AIDS patient due to blood transfusion in Mumbai was reported.

1996- Supreme Court's judgment on blood transfusion and blood banking in India; as a result of which National Blood Transfusion Council and State Blood Transfusion Councils are established for improvement of Blood Banking services in the country.

2000- World Health Day on 7th April 2000 was celebrated with, "**Safe blood starts with me"** as the slogan of the year.

2001- Every year, over 100 million blood units are collected from blood donors throughout the world. 6. 5 million blood units are collected, every year, in India.

Some Mathematics in Blood Banking

- Human body contains 4-5 liters of Blood, or about 8% of Body Weight.
- 40-45% of Blood is made up of red blood cells which carry

oxygen. The remaining 55-60% is plasma with a small proportion of white blood cells for defending the body, clotting factors and platelets preventing the blood leak.

- The average person has 25 billion red blood cells.

- If every capillary, vein and artery in person's body were lined up end to end, they would cover a distance of 150, 000 kilometers. Heart, by its powerful pumping action circulates blood throughout the body through this closed channel.

- All the iron in an average person's blood could make a 2" nail (gross), still iron deficiency anemia is rampant in India.

- Lifespan of red blood cells is about 120 days and white blood cells normally last 3-9 days. New blood cells are constantly generated in the body.

- After each donation of blood it takes 36 hours for the body to reconstitute the blood volume and 21 days for the blood count to return to a normal level.

- Every year, over 100 million blood units are collected from blood donors throughout the world.

- Upto 7% HIV Infection in India is due to transfusion of blood and blood products. Transmission of HIV infection by infected blood transfusion is almost 100% effective in each case.

- One can donate blood 168 times in his lifetime, which measures to whopping 58 litres of blood i. e. 12 times the total blood volume of the body. This is the amazing potential of blood donor.

Blood grouping & Cross Matching

Prof. Alaka Deshpande
Mrinal Patnaik

Karl Landsteiner was awarded Nobel prize in medicine for his path breaking achievements in the field of Transfusion Medicine. Prior to the discovery of blood groups by this great scientist, blood transfusion was considered extremely hazardous, being associated with a high mortality and morbidity.

Blood groups are protein antigens present on the RBCs. These antigens are unique to the human species. Every human being has a blood group, which is delineated by the type of antigen he or she carries. These antigens are of three types; 'A', 'B' & 'AB' It was also found that a large number of people do not have any of these proteins and hence were labeled as blood group 'O' If a person has a particular blood group, any other blood group protein will be recognized as being foreign by the body and the body will mount an immune response against the

antigen, which almost always is catastrophic. Karl Landsteiner in 1901, 1 year after he entailed A, B and O groups, discovered the AB antigen. These patients had both the 'A' and 'B' antigens and hence could receive blood from any human being. This subset of people was termed as the *'universal recipients'*. The people who lacked the antigens i. e. the O group could in turn donate that blood to any one and were termed as *'universal donors'*..

Despite the detailed description of the A, B, O blood group systems Karl Landsteiner noticed that there were number of reactions occurring in compliant transfusions. He also noticed a large number of fetal deaths due to intravascular hemolysis termed as Erythroblastosis Foetalis or hemolytic disease of the newborn. He found that this was due to some other antigen present in the population. In 1940 he identified it as the Rh or Rhesus factor. The mother of the children with Hemolytic Disease of the newborn was Rh negative while the father was Rh positive. The first pregnancy was generally uneventful, but during parturition the Rh +ve fetal blood was found to enter the mother's circulation. This is recognized as a foreign antigen and the immune system of the mother is stimulated to produce anti Rh antibodies. During the next pregnancy, if the fetus is again Rh +ve, the anti Rh antibodies from mother's blood cross the placenta, destroy Rh +ve RBCs of the foetus producing haemolysis.

Karl Landsteiner died at the age of 75 years at the Rockfeller Institution in USA holding a pipette in his hand. His pioneering revolutionary work is an important milestone of the history of

medicine. Subsequently a number of scientists and physicians had begun research in transfusion medicine resulting in the discovery of a large number of Red cell antigens each having there own significance. These antigens are also called minor antigens, as the reactions observed with them are minor.

1. ABO System:

This is based on the presence or absence of the A & B antigens. They are the most important red cell antigens present. Recognizing their presence on RBCs, persons are said to have blood groups A, B, AB and O. The genes present on chromosome number 9 regulate the expression of these red cell antigens. The protein that is formed is then attached to the red cell surface glycoprotein molecules called as glycophorins. From this location these antigens can be secreted into the plasma and other body fluids. Persons who are capable of doing so are termed as secretors. Interestingly, it has been found that the non-secretors are more predisposed in developing infections by capsulated organism like Streptococcus pneumoniae, Meningococci, Hemophilus influenzae and Candida species. The precursor protein from which the blood group proteins are formed from is termed as the H substance. This is biochemically produced by the combination of Fucose to the surface glycoproteins, the process being catalyzed by Fucosyl transferase.

If N-actetyl galactosamine binds to the H substance it forms the blood group A, whereas if galactose binds to it, it forms the group B. Absence of any binding substance produces the O blood group.

A rare genotype of people has been identified in Mumbai, India in whom it was found that the deficiency of the enzyme fucosyl transferase resulted in the absence of the H substance. Hence these people neither had an A, AB, B or O group. This rare phenotype was labeled as the **Bombay Blood Group.**

Isoagglutinins are omnipresent antibodies seen in all people with the ABO blood grouping system. In patients with a blood group A there will be preformed antibodies against blood group B and vice versa. Those with the blood group O have antibodies preformed against both A and B antigens. The people having the AB blood group do not contain any isoagglutins and are hence termed as the universal recipients.

2. Rh System:

The Rh (Rhesus) system was described in 1940 by Karl Landsteiner. The Rh proteins are controlled by chromosome number 1. There are 6 antigenic subtypes cde/CDE, out of which the D substance is the most important. The presence or absence of the D substance (antigen) will determine if a person will be Rh positive or negative. About 85% of the world population is Rh + ve.

The significance of this blood group arises in pregnancies in which the moter is Rh-ve and father is Rh +ve. The fetus due to the father's genotype is Rh +ve. There is sensitization of the mother and in the next pregnancy catastrophic hemolysis takes place, termed as Erythroblastosis Foetalis. Immunizing the mother with anti D immunoglobulin at first pregnancy or first delivery can prevent this fatal condition.

3. Kell System:

This system contains the third most antigenic blood group antigens after ABO and Rh system respectively. The Kell system can result in minor hemolytic transfusional reactions.

Interestingly the absence of the Kell group is observed with a typical phenotype termed as the McLeod's phenotype characterized by

- Acanthocytes
- Reduced RBC survival
- Progressive muscular dystrophy
- Cardiomyopathy

4. Lewis System:

This system contains unique blood group antigens that are not present on the RBC surface from the beginning but are subsequently absorbed from the plasma. This antigen however is one of the most common causes of alloimmunisation mediated minor hemolytic transfusional reactions.

5. P System:

This antigen is implicated in a rare form of a hemolytic anemia termed as the paroxysmal cold hemoglobinuria seen with syphilis and other viral infections. Here the antibody evolved is a biphasic antibody called as the Donnath Landsteiner antibody that binds to the P antigen at cold temperature and activates the complement of the RBC membrane causing hemolysis.

6. I and i

These are antigens involved in cold antibody mediated autoimmune hemolytic anemias. The antibodies are produced secondary to infections with mycoplasma pneumoniae, EBV and with lymphomas.

7. MNSSU

8. Kidd

9. Duff

This antigen assumes importance in areas where malaria is endemic. It has been observed that 70% of the population here is negative for the Duff antigen. This is believed to be due to the result of Darwinian selection resulting in the survival of the fittest. The Duffy antigen acts as a receptor for the entry of the protozoan parasite plasmodium vivax, which then causes malaria. The absence of Duff antigen thus blocks the entry of P. vivax and offers protection against malaria.

Cross Matching

Cross matching is a procedure that is carried out in all blood banks to check for the Transfusional compatibility of donors blood with that of the intended recipient .Compatibility testing is performed for whole blood and packed red cell transfusions, but not for fresh frozen plasma, cryoprecipitate or platelet transfusions. However it is important to note that Fresh Frozen Plasma platelets should be ABO compatible with the recipients

RBC. Granulocyte concentrates contain RBC and require compatibility testing.

Tests performed:

The ABO and Rh type is determined on both the patients blood sample and the donor unit. The patient's serum should be tested for the presence of unexpected RBC alloantibodies as a part of the compatibility test. This is called as the antibody screen. It is important to carry out this test because if it is not done it can result in a hemolytic blood transfusion reaction.

In a cross match procedure the compatibility is tested between the donor RBC and the recipients serum. If the recipients serum contains antibodies then there will be agglutination on the cross match reaction. Once the cross match is done the unit of the blood can be then issued for the patient.

If blood is needed urgently in an acute emergency; type O, Rh negative blood may be provided prior to doing a cross matching reaction.

Type specific RBC may be provided after the patients ABO and Rh type are determined.

Safe Blood Transfusion ■ Paradigm Shift!

Prof. Alaka K. Deshpande
(Based on the Oration by Dr. M. B. Agarwal)

Transfusion medicine has emerged as a distinct subspecialty of clinical medicine.

The whole story of modern blood transfusion has evolved over a century. The days when blood groups were not known, when blood was not fractionated into its components, the transfusion meant a single unit of blood obtained from a donor and given to a single individual.

Till about 20 years ago when an epidemic of HIV broke out and when it was realized that transfusion was one of the modes of transmission of HIV, all clinical disciplines viz. Medicine, Surgery, Anesthesia insisted on one concept that hemoglobin of an individual must be brought upto 10 gms. % before he is subjected to surgery. It was not uncommon that Anesthetist in the preoperative check up would write down that "couple of units of blood should be transfused, Hb should be brought to

10 gms. % before the patient is taken up for surgery. " Obviously with the onset of HIV epidemic, the same clinicians insisting on 10 gms. % of Hb before surgery, brought down this figure to 7 gms. % as it would curtail down the risk of transfusion related HTV transmission tremendously.

How can the concepts of Medicine change?

The "minimum requirement" of yesterday was no more recommended and reason was obviously that this figure of 10 gms. was not based on any scientific principles. The transmission of HIV for which no diagnostic kits were available in early 80's, then became the bigger fear than to give anesthesia at Hb of 7 gms. % and operate upon a patient. In fact, today a patient, ,, depending upon his age, cause of anemia, the onset of anemia, the condition of heart and lung, can be operated not only at 7 gms. % but even lower levels of Hb viz. 5-6 gms % under general anesthesia without undue risk.

The onset of HIV epidemic, identification of many blood borne infections, the better understanding of scientific principles of hemodynamics with advanced technology, brought down this figure of 10 gms of minimum requirement of pre-op Hb to 7 gms%.

Couple of decades ago, blood was used as a volume expander. It was not unusual to give blood as a "tonic" because somebody's wound was not healing and surgical sutures could not be removed. Blood transfusion probably had a placebo effect on a Patient, Surgeon and Anesthetist.

Nutritional anemias due to iron or vitamin deficiencies are the

simplest hematological disorders for therapy, but instead of nutritional supplements, blood was used as a "hematinic". Unfortunately, even today, this practice continues. It is not only wastage of blood but it also results into administration of various unsafe antigens. Even today the practice of single unit transfusion continues.

One must remember that blood is not a permanent solution but only a temporary support except in case of a stem cell transplant A couple of bags of platelets given to a case of ITP with low platelet count does not help, as in ITP the bone marrow is functioning 20 times more than normal. It is producing and releasing millions of platelets in circulation every day, therefore a transfusion of 8, 10, 12 bags of platelets is just like adding a drop in the ocean.

If one counts the platelets before and half an hour after the platelet transfusion, the counts will be identical. This kind of a temporary support must serve some purpose and therefore must be based on scientific principles.

A clinician therefore must ask a few questions to himself before prescribing blood or its components for transfusion. After administering the blood one should evaluate the achievements in the form of patient's health.

We have always been against fixed drug combinations. We do not have three cardiac drugs in one capsule or injection, or three antibiotics in a combination for obvious reasons. But we forget that the blood is a readymade mixture of large number therapeutic agents in a natural fluid. Efforts have to be made to separate these agents. These efforts are worthwhile and help

in-judicious use of blood, its components as per the requirement of the case. It also saves the recipient from the avoidable risks of transfusion.

When one considers the benefits of transfusion, he should not forget the risks involved. It is therefore imperative to weigh the benefits against risks before prescribing blood.

Today, the unit of blood has become very expensive. The old glass bottles have been replaced by triple plastic bags. An expensive set up of the blood bank, sophisticated cross matching, testing of blood for 4-5 infectious diseases, the cost of fractionation, etc all escalate the cost of the unit of blood.

Considering the risks involved, it has become necessary to inform the recipients about advantages as well as risks involved. **A written informed consent of the recipient is the first and most important step before transfusion is given.**

Informed consent — as per the GCP (Good Clinical Practices) guidelines every Doctor must fully realize the meaning and implications of informed consent. All the information regarding transfusion must be given to the recipient. He must be told about the indications and benefits of the transfusion. He also must be informed about the risks involved. The transfusion is to be given only after informed written consent.

In view of the blood borne pathogens and various antigens, today, probably the safest transfusion is the autologus transfusion, nothing can be better than one's own blood, but still the acceptance of the same particularly on the part of surgical fraternity is poor.

1. Autologus Blood Transfusion:

Lot of misery can be prevented and sorted out if one believes in autologus blood transfusion. One of the most popular methods by which autologus transfusion ever came up was the shortage of blood, which compelled a surgeon to use the patient's own blood during surgery. A surgeon handling a young woman with ruptured ectopic pregnancy lost a couple of liters of blood in peritoneal cavity. There was no blood to replace the loss. The young woman was dying of hypoxia. The surgeon collected the blood from the peritoneal cavity and used it in an attempt to save a life! This was the genesis of autologus transfusion. But this kind of an autologus transfusion brought a bad name to it because, in this procedure one inadvertently also administered many other factors including platelets, fibrin thrombi, and various components that were present in the peritoneal cavity, which were not required.

Today, the technology has advanced, methods have improved and use of autologus transfusion is increasing all around the world.

Today there are sophisticated methods of practicing intra-operative blood salvage. There are cell-washers and there are cell-savers. These sophisticated machines are expensive, the recurring cost per blood cell from the cavity is also high as a result, very few institutions have these blood savers and very few really use them optimally. This suffices to say that autologus blood transfusion in the form of intra-op. blood salvage can certainly be scientifically practiced, but the cost is prohibitive.

With the availability of blood and blood components the demand has been less and there is not much incentive to invest in this kind of blood savers. As a result, either one would not be practicing this or one would be practicing dangerously by collecting the blood and giving it oneself.

The present autologus blood transfusion is of a different type and it must become the routine preoperative practice.

Most popular method is **pre-operative deposit of blood.** If a patient is undergoing a complex, elective surgery, the surgeon knows that he will require 2 or 3 units of blood. These units are taken out from the patient's body in the preceding month, stored in the blood bank and given to the patient at the time of surgery after the blood loss occurs.

The rules and regulations for pre-op deposits are quite different. A small kid, a pregnant woman and a 80 year old man can be bled for his own blood to be re-administered at the time of surgery. A person who has undergone a myocardial infarction and triple bypass surgery can also donate blood for himself provided his physician agrees that so much amount of blood can be taken out from his body at a time.

One must realize the two major risks of allogenic blood transfusion in the patient (1) the unknown infectious agents and (2) the immunological reactions that the body can be exposed to. One fears of these reactions the most, and the same can be prevented by these pre-op deposits. Even the Hb level of the donor which one has in the allogenic blood transfusion has been lowered for the purpose of autologus blood

transfusion. The main purpose is that overall advantages should surpass the disadvantages.

There is another interesting method of autologus blood transfusion and that is the perioperative haemodilution. Here the blood bank officer is not involved. It is totally between the surgeon and the anaesthetist. A person scheduled for the surgery is taken to the operation theatre. Before the surgery, two units of blood are removed from his body by the anaesthetist and equivalent amount of colloids are administered so as to restore the circulating volume. The surgery is then performed. The intraoperative blood loss, which occurs, will be of diluted blood. At the end of achieving hemostasis, these two units which have never left the operation theatre are re-administered. Once again age, sex are no bars. This kind of perioperative haemodilution is not as much cost effective and safe as pre-op deposits and so has not become popular.

Twenty years ago only 10% of the U. S. hospitals provided services in the form of autologus blood transfusion. Ten years ago all regional centers in the U. S. offered this service and 3 years ago one third of the surgical blood replacement was totally autologus.

2. ADVERSE EFFECTS OF BLOOD TRANSFUSION:

If the blood was free of adverse effects then probably there would not have been a need of discussion on transfusion safety. Some of the blood transfusion reactions which are less talked about are:

a. GvHD (Graft Versus Host Disease)

Besides Bone Marrow Transplantation (BMT) and Stem Cell Transplantation (SCT) blood transfusion itself can lead to graft versus host disease (GvHD). The mortality from GvHD is high in the setting of BMT and stem cell transplant but is less than 100%, as against the GvHD due to transfusion results into 100% mortality.

In case of BMT, the transplanted stem cells take over the function. Lymphocytes from transplanted Bone Marrow act against the recipient's body. Hence, although there is mortality, it is not 100%.

In the case of transfusion recipient, his own bone marrow is functional. But the viable lymphocytes from the transfused blood knock down the stem cells leading to bone marrow aplasia resulting into unsalvageable state with 100% mortality.

b. TRALI (Transfusion Related Acute Lung Injury)

The Transfusion Related Acute Lung Injury is a peculiar reaction. Although rare, whenever it occurs, the mortality is about 40%.

It is not related to the amount of transfused blood. Neither can it be prevented by any type of filter. It occurs because of the leukocytes of the recipient react with the preformed antibodies present in the transfused blood. This Ag + Ab reaction takes place at the pulmonary alveolar bed. This acute lung injury leads to massive pulmonary edema with 40% mortality.

Clinically, it manifests within few minutes of starting the transfusion and can be diagnosed within a short time. The

transfusion recipient needs assisted mechanical ventilation and supportive steroid therapy. Despite these measures the mortality is high. The reaction cannot be predicted or prevented. It occurs with a frequency of one in three thousand transfusion cases. If one witnesses this reaction in life time one would be deadly scared of blood transfusion and will confirm that SAFE BLOOD TRANSFUSION IS NO BLOOD TRANSFUSION.

c. Immune suppression

Blood is an immunosuppressant. In precyclosporine era the nephrologist and urologist used to transfuse donor specific 3-4 units of blood before kidney transplant. It improved **the** kidney salvage rate because the prior transfusion acted as a good immune suppressant. The advent of cyclosporine changed this practice of pretransplant transfusion.

A patient of Ca colon if operated with blood transfusion he had much higher risk of metastasis than a case operated without transfusion, again suggesting the role of transfusion as immune suppressant. Post-op septicemia with metastatic infection is higher in cases who underwent surgery with blood transfusion than those who did not receive transfusion.

d. Fever

Majority of the fever developing after transfusions is taken very lightly and rightly so because these are pyrogen reactions and may be related to various kinds of fluids present in the ACD (Acid Citrate Dextrose) bag or CPD (Citrate Phosphate Dextrose) bag or they may be related to the plastic to which the fluid has been exposed to and so on. One can easily handle

them with the help of paracetamol, anti-histaminics and corticosteriods. But little does one realize that this kind of pyrogen reaction may be something beyond the pyrogen.

The septic blood mortality is 80%. The fatal haemolytic transfusion reactions are related to it. In between comes the leucocyte mediated fever. This is opposite of acute lung injury. In acute lung injury there is a reaction between the various antibodies in the blood and the leukocytes of the. person who receives the blood. Febrile non-haemolytic reactions are due to leucocyte in the donor blood and the antibodies present in the recipient. These can be prevented or can be reduced specially if the person has repeated transfusions as in the cases of Thalassemia or Aplastic Anaemia or in any condition with frequent blood transfusion. This can also be prevented either by removing the leukocytes during the transfusion or in the blood bank itself.

Some of these reactions may not be directly due to leukocytes at the time of transfusion, but due to the various cytokines liberated in the blood during the storage. As a result of which, even if one uses an inline leukocyte filter, these cytokines may still be getting into the body and producing various kinds of catastrophes. Then the best practice is to remove the leukocytes from the unit of blood or platelet in the blood bank itself even before storage. This technology has just arrived in this country but the cost deters majority of blood banks from using it. Sooner or later one would have leukocytes removal in the pre-storage fashion and all these types of febrile reactions due to leukocytes will become a rarity.

Many of us wonder that so much is written about transfusion reactions but we don't see them! Many of them are not noticed. For various reasons, this kind of estimate is grossly an underestimate of what one does. Many of them occur under anaesthesia because large amount of blood is used in the operation theatres. Many of them may be clinically occult and the person who gives transfusion would never realize it. For e. g. Hepatitis C, which is still not mandatory today to test, would be recognized by a gastroenterologist after 15 years when a woman who received the first unit of blood at the age of 18 died of a variceal bleeding at the age of 3 8 years. Nobody would publish them, report them or talk about them. One is not going to be proud of a blood transfusion reaction. Thus there is poor reporting. Even familiarity with these kinds of reactions is low especially in smaller places, rural places, town places, and in major urban areas in a small nursing home setting. Our patients receiving transfusion are very docile. They don't talk about, they don't complain about what has happened because, the doctor is a God for them. The source of blood donor is still not the best that it should be; the expertise of the blood bank staff is still not probably the best and we still don't use blood components and autologus blood transfusions.

There are alternatives for blood transfusion for e. g. In ITP we use Corticosteriods, IVIG and they work. Renal anemia responds to Erythropoietin, which has virtually made blood an obsolete thing provided one can afford it. Yet we do not have synthetic blood or recombinant blood and blood products but soon synthetic blood may be a reality. Whenever possible, if one can do without blood/blood products, one should do so.

3. BLOOD COMPONENTS:

Blood Components are now well known to institutions and health care providers.

The practice of component transfusion is still lagging behind. Many a times the whole blood is used when one does not have to use it. One must realize that component therapy has become the reality of today if one understands the following factors:

1. Blood is a limited resource today.
2. The Kinetic consideration for the half-life of human blood components is different in vivo and in vitro.

Life span of:

RBC	110-120 days in healthy subjects
WBC	7. 5 hours
Platelets	7-10 days

The plasma and its components can be stored for 1 year or more. The platelets are viable only for 3 days in the stored blood. The RBCs can be stored for 20, 30, 45 days depending upon the reagents used. Consideration has to be given to the different in vivo and invitro kinetics of the various components of the blood. The storage conditions for each component are also different.

If it is for red cells, the blood has to be stored at 4^0C. The platelets have to be stored at 22°C. The plasma is to be stored at minus temperature.

When one understands the kinetics and the storage conditions, one is convinced that unless one breaks the unit of blood into its components, he cannot use it scientifically.

When one talks about adverse effects, some are due to the components. Getting rid of that particular unwanted component would obviously reduce the adverse effect. Centrifugation is the simplest way of separating the blood into at-least 3 or 4 components and can be easily done in any blood bank.

Platelet transfusion:

For platelet transfusion, more than one type of products are available.

a. Platelet Rich Plasma (PRP):

Whenever components in the past were prepared on demand, one of the requirements in the patients of DIC was plasma and platelets. In such an event, the red cells were removed by centrifugation and the remaining upper component consisted of a combination of platelets and plasma termed as PRP. This contained about 750-1000 ml. of plasma with platelets.

However, with differing storage requirements of plasma (- temp.) and platelets (22 °C), the PRP could not be stored and used effectively. Therefore this preparation has not been very popular and can never become popular. Instead, as per requirement, platelets and the fresh frozen plasma can be transfused separetly.

b. Platelet Concentrates:

The platelets are separated from each bag of blood collected in the blood bank and the platelet concentrate is prepared by pooling the platelets from 8-10 **random donors.** The platelets are suspended in about 50-80 ml of plasma. This fulfills the requirement of acute platelet transfusion at a lesser cost. However, if these concentrates are transfused repeatedly, they

result in sensitization (alloimmunisation) with a progressive reduction in the 'correceted count increment' of platelets.

In conditions like bone marrow or stem cell transplant, or even aplastic anemia, where the requirements are very high, over a longer duration of time, it is desirable to provide single donor apharesis.

C. Plateletpheresis:

6-8 units of platelets can be procured from a **single donor** by this method. The platelets are selectively separated from the whole blood of a single donor and retained in a collection bag while the remaining components like RBCs, WBCs and plasma are reinfused in the donor.

A single unit contains 3-5 x 10^{11} platelets to build a platelet count of 5, 000 cells/mm^3 at an optimum transfusion dose of 0. 07 x 10^{11} platelets/kg.

There are specific indications where one would like to have these kind of platelets, e. g.: Immunology of the patients could be a problem, allosensitisation may be there, one may require an HLA matched platelet transfusion and the requirement to increase the platelet may be large.

4. MASSIVE BLOOD TRANSFUSION:

Massive blood transfusion is defined as replacement of total blood volume within a period of 24 hours. In clinical terms it means more than 12 units of old blood to an adult individual or more than 20 units of packed red cells or in a general way, replacement of 50% of circulating blood volume in less than 3 hours. The common clinical situations are-

1. Road vehicular accidents with poly-trauma,
2. Massive GI bleed,
3. Cardiovascular surgery,
4. Hepatic transplant and cancer surgery,
5. Other complex surgeries.

One can realize that the requirement of blood in these conditions is very large. Such large amount of blood cannot be accessible as a fresh blood; therefore one ends up giving large amount of stored blood. As a result of massive transfusion of stored blood:

1. The red cells show the storage lesions, the 2-3 DPG in the stored red cells is reduced. Therefore although the Hb increases, the oxygen delivery to the tissue may not be optimum.
2. There is large amount of citrate being administered which results into citrate toxicity leading to hypocalcemia.
3. Due to CPD and ACD delivered to the body, there can be acid-base derangement.
4. There can be risk of hyperkalemia as the cells liberate potassium.
5. The hemolytic/non-hemolytic reactions will be higher as one has virtually replaced the whole blood volume.
6. There is a higher risk because of the basic disease as well as the stored blood transfusion leading to DIC and coagulopathies and overt clinical bleeding. Like red cells the platelets may not be functioning, the coagulation factors may not be in the adequate quantity.
7. **Large number of deaths can occur due to hypothermia.**

Hypothermia is a very important cause of mortality in Massive

Blood Transfusion. Unfortunately one fails to recognise it. One tends to attribute the mortality to basic disease like poly-trauma/DIC etc. without realizing that the death is due to the lowering of body core temperature. The lowering of core tem perature itself leads to **coagulopathy.** The entire coagulation cascade is temperature based. All the invitro tests are done at 37°C because these enzymes don't work at lower temperatures. Effects of hypothermia are many. It adds to ischaemia of tissues, lowers the tissue 2, 3 DPG, adds to alkalosis, impairs the platelet function, impairs coagulation cascade, aggravates the hypocalcemia and ultimately leads to fatal arrhythmias. Hypothermia is a consequence of the delivery system hence one recommends the use of inline warmers. Patients undergoing open heart surgery or abdominal surgery, patients in shock, patients at extremes of age and patients who are debilitated are at the risk of hypothermia. Therefore before giving massive blood transfusion, one must remember to warm the blood.

Many teachers teach formulae i. e. after so many units of blood transfusion, you must give so many FFPs, so many platelets, so much calcium, so much sodabicarb. There are no such for-mulae to calculate. All this has to be judged at the bedside. No Lab will be able to tell because the time is an important factor. One has to only realize, i. e. to bring up the BP with crystalloids and colloids. Next important thing is to get rid of hypoxia to red cells. Third most important thing is to take care of body core temperature. If one has taken care of all these three, probably very few would die because one has given Massive Blood Transfusion. It is also important to push the platelets beyond 50, 000 or so in this particular setting. Very rarely should one bother about calcium, bicarbonate and plasma.

Transfusion Transmissible Agents

Sanjaykumar Jadhav

Summary:

Blood Transfusion has gained paramount importance in the light of its efficiency to transmit infectious agents. Practice of stringent donor recruitment and mandatory screening of blood for high risk microbes has ensured transfusion safety to greater extent.. However, transfusion of blood continues to be at risk due to the typical characteristics of microbes and present scientific limitations in the screening techniques. The adoption of strategy to collect blood from voluntary, non-remunerated, healthy blood donors with emphasis on use of specific blood components and plasma expanders, autologous blood transfusion would be the ideal recommendation.

Introduction:

It is only over the last 15 years that the true significance of the

potential of blood transfusion as a vehicle for the transmission of infectious agents has been widely recognized. The identification of HIV and HCV that opened many eyes not only to the potential of transfusion as a route of infection, but also to its startling efficiency in the transmission of whole range of infectious agents[2].

A meticulous donor screening, mandatory testing of blood units for high-risk infections and viral inactivation of plasma derivatives; together has resulted in substantial decline in transfusion-transmitted infection[3]. The developed world takes expensive measures that increase blood safety even marginally.

But more than 2/3 of world's nations do not have adequate policies to ensure a safe blood supply. An estimated 13 million blood donations globally are not tested for HIV, HBV and HCV, primarily in developing countries.

Transfusion Transmitted Agents:

Transfusion transmissible agents share following characteristics:

1. Prolonged persistence in the blood stream of a donor-giving rise to a carrier or latent state.

2. Causation of diseases with long incubation periods.

3. The ability to cause asymptomatic infections.

4. Stability in the stored blood and in plasma fraction.

Table-1 (see the next page) is a comprehensive list of transfusion transmitted agents[5].

Table-1: Transfusion Transmitted Agents

Sr No	Microbial Agent Type	Name
1.	Viruses (Enveloped)	HIV-l, HIV-2, HTLV-1, HTLV-2, CMV, HHV-6, HHV-8, EBV, HBV, HCV, HGV, HEV[19]
	Viruses (Non-Enveloped)	HAV, Parvo virus B19, TTV, enteroviruses[6]
2.	Bacteria (Gram +ve)	Staphylococcus epidermis Staphylococcus aureus Coagulase negative staphylococci Streptococcus viridans Enterococcal species Bacillus cereus Clostridium perfringes[7]
	Bacteria (Gram -ve)	Yersinia enterocolitica Pseudomonas fluorescens Salmonella enteritidis Citrobacter Freundii Serratia marcescens Enterobacter cloacae Coliform bacteria Flavobacterium species Serratia
	Others	Treponema pallidum
3.	Protozoa	Plasmodium vivax Plasmodium Falciparum Plasmodium malariae Plasmodium ovale Babesia microti/divergens Trypanosoma cruci

The TTA's could be exogenous or endogenous associated with blood cells or cell free plasma or both.

Most of the countries screen blood for syphilis, HBV, HBC, HIV-1 & 2. In addition tests are also carried out for alanine transferase and anti HBC. Japan, USA, France and some Carribean countries screen the blood for HTLV antibodies too. Central and south American countries screen for T. Cruzi antibodies. In Austria, blood is screened for neopterin as a non-specific marker of inflammation (Honlinger et al 1988) and in some S. American countries such as Columbia, blood is screened for brucellosis. In many countries, it is also tested for CMV. The carrier state of the donor is mainly dependent on the prevalent infectious diseases in different population.

Some infectious agents e. g. CMV, HTLV, T. pallidum are transmitted more easily by fresh or relatively fresh blood components but the other agents such as HBV, HIV are very stable in stored and even frozen blood or plasma.

The molecular characteristics of viruses are:

1. Size which enables them to pass ultrafine filters that hold back bacteria,
2. Ability to move from one cell to another,
3. Presence of nucleic acids,
4. Typical replication (only phage DNA and not the phage protein, enters the host cell) and
5. Ability to lyse the infected cell.

Viruses

Hepatitis B Virus (HBV): Blumberg first recognised an

antigen in the serum of an Australian aborigine in 1928. The provisional name given was Australia antigen. It appeared to have an association with acute leukemia. However, it was not long before the association with hepatitis was realized (Blumberg et al. 1968). Recognizing the viral structure of HBV, Australia antigen is now called as HBsAg - the surface antigen of HBV. HBsAg is shed into the plasma in large quantities in the form of spheres and sometimes rods. (diam. 18 to 22 nm) It can readily be detected by immunoassay.

The prevalence of HbsAg varies considerably in different parts of the world and exceeds 15% in some populations in Africa, China, Latin America. It has been estimated that carriers clear their HbsAg at a rate of about 1. 7% per annum. (Sampliner et al 1979, Barbara 1983); when HbsAg is eventually lost. It is also known that a donor can transmit HBV after having had a positive test for HbsAg for as long as 19 years. (Zuchkerman & Taylor 1969).

The HBV is transmitted by sexual route as well as parenterally by infected blood and infected Hospital equipment. Acute HBV infection is followed by:

a. clearance and immunity.
b. or chronic infection with persistence of virus replication for extended periods, maybe lifelong.
c. or Chronic infection may resolve spontaneously and deve lop immunity or reactivate with resulting acute episode[2].

As little as 0. 1 to 0. 25 ng HbsAg/ml can be detected in blood by immunoassay. However, carriers with even subminimal levels can transmit HBV by blood transfusion. Serum from

patients which was negative for all HBV seromarker but positive for HB V-DNA by PCR, transmitted Hepatitis B. Cases of fulminant HBV hepatitis have been reported in recipients of HbsAg negative blood units. Analysis showed that point mutations in the pre-core region resulted in the inability to synthesize HbsAg although high levels of HbcAg were elicited in the infectious donors.

Hence the paradigm shift to autologous transfusion!

Hepatitis C Virus (HCV): It is an enveloped RNA virus. At least six distinct genotypes of HCV are found and two more are under investigations'[3].

Following infection; there is an incubation period of about 11 to 61 days prior to the appearance of HCV RNA and HCV antigen, and further 68 days before the development of anti-HCV antibody.

HCV infection can result into either acute infection followed by resolution or chronic persistent infection. Persistence develops in approx. 80% of acutely infected individual. Humans develop strain specific antibodies but are incapable of preventing the emergence of viral variants that can maintain the infection [l3].

In developed countries like USA, UK, in addition to the Anti-HCV, RNA-HCV screening of blood is mandatory. However cases of posttransfusion hepatitis C have been reported, where donations were screened for RNA-HCV. Anti HCV screening of donated blood is introduced in India since last about 5 years.

Hepatitis Delta Virus (HDV) requires co-infection with HBV and screening for HbsAg prevents HDV transmission. Similarly the newly discovered TTV (DNA) virus has high prevalence rate with association of HBV infection[16]. However its transmission is not exclusively parenteral, the significance to blood transfusion is unclear[2-5].

Hepatitis A Virus (HAV): HAV is mainly responsible for epidemic hepatitis, it is transmitted by faeco-oral route. It causes a transient viremia and does not cause a carrier state.

Transmission of HAV leading to post-transfusion hepatitis (PTH) due to HAV occurs in special circumstances when the blood donor is in the early stages of incubation period with transient viremia of HAV infection at the time of donation.

Hepatitis G Virus (HGV): HGV, a flavivirus, has high prevalence worldwide (4. 3 % detection rate in Chinese and 1. 1 % in Canadian blood donors). Its role in hepatic disease is under doubt. It is similar to HCV except in that it lacks core gene.

Cases of post transfusion **hepatitis** E **virus**[19] and enterovirus[6] are reported.

Human Immunodeficiency Virus(HIV) is the causative agent of AIDS. It is a RNA virus, specific to human species, was identified in 1983-84. There are two subtypes HIV-1& HIV-2. The routes of transmission are unprotected sex with an infected partner, transfusion of blood from infected donor and vertical transmission from infected mother to her foetus.

The acquisition of HIV infection leads to Acute Primary HIV Infection (PHI) characterised by acute viremia with 'flu' like illness. Anti-HIV antibodies develop within 6-12 weeks (seroconversion). The virus causes gradual depletion of cell mediated immunity over many years, ultimately the patient succumbs to fatal opportunistic infections.

An infected person remains infectious till the end. Hence, the blood units are screened for HIV-1 and 2 for detection of anti-HIV antibodies. However, antibody detection before seroconversion i. e. during window period is not possible. The other tests for detection of HIV during window period are very expensive and cannot be used for routine screening.

The best method to minimise the chances of donation from a donor in the window period is counselling and self-deferral with the help of questionnaire.

HTLV, (Type I and II) is a retrovirus, associated with cell, infecting CD4+ lymphocytes and is not found in plasma. It is oncogenic virus causing adult **T-cell leukaemia and lymphoma.** Most infections are asymptomatic and disease may develop at any time up to 40 years after infection. Incubation period of 30 - 90 days is seen before seroconversion. Antibodies to HTLV persist for life [2].

CMV- Human cytomegalovirus is a clinically important herpes virus. It is classified as HHV-5 virus and is highly prevalent (40 to 100% in adults) Primary infection with CMV is invariably followed by life long viral persistence.

Parvovirus B 19 is the smallest DNA virus, very stable, non-enveloped and resistant to many chemical and physical inactivation techniques. Viraemia usually appears within the first week of infection and persists for 1-2 weeks. Antibodies are formed soon. The association of parvovirus b 19 with aplastic anemia is well recognised. B 19 is found to be resistant to several of the viral inactivation procedures used for plasma products.

EBV which causes infectious mononucleosis and is associated with Burkitt's lymphoma has its latency site in B Cells and is globally wide spread. Donor screening has limited value due to its symptomatic infectious nature [5].

HHV-8 or Kaposi's sarcoma associated herpes virus has other routes of transmission than blood but its transmission through organ transplants do suggest caution[2].

Creutzfeld - Jacob Disease (C JD) has never been transmitted to humans by blood transfusion. Transmission to mice by intracerebral inoculation of a crushed blood clot obtained at necropsy from a patient with C JD has been reported.

But the current criteria for selection of blood donors ensure that **demented subjects as well as people who have received growth hormone derived from pituitary extracts are excluded from blood donations** (WHO 1989).

Bacterial contamination of Blood:

Bacterial contamination is a long established and well-recognized complication of blood transfusion. It may occur

due to donor bacteraemia or skin, packs and environmental contamination. Sometimes allogenic **RBC** transfusion may act as an independent risk factor for development of postoperative bacterial infection °.

Bacterial contamination of blood components in Europe exceeds the risk of **HIV, HCV** and **HBV** [5].

There is higher incidence of contamination after platelet transfusion. This is mainly due to the storage temperature of 22° C, which supports bacterial survival or growth. In contrast, red cell is stored at **4**°C, a temperature which does not support the growth of the majority of bacteria[5] except typically Yersinia enterocolitica, Pseudomonas fluorescens, Citobacter freundii and Serratia marcescens[5] which proliferate at low temperatures.

Today, there is no longer a threat from Treponema pallidum. [21] It is generally considered that any spirochaetes present in the blood pack would be destroyed within 72 hours of storage at **4**°C[5].

Inspite of above known risks there is apparent infrequency of clinical events following transfusion of bacterial contaminated blood units. This may be due to non-pathogenic, insufficient number of bacteria; patients premedicated with antibiotics etc.

Protozoa: Parasitic diseases may also be transmitted by labile cellular blood products. Of great concern are post-transfusion malaria and particularly Chagas disease.

Malaria is a parasitic infection transmitted to humans through the bite of the Anopheles mosquito. There are four known

Species (Table 1). The incubation period ranges from 12 days for P. falciparum, 15 days for P. vivax and P. ovale and as long as 30 days for P. malariae. Only P. malariae persists for extended periods in humans (up to 30 years), whilst after 1-2 years Plasmodia of the other three types die. Individuals in endemic area are known to have immunity, but lose it on moving to non-endemic area [2]. In Plasmodium falciparum malaria, the parasites are sequestrated in tissue capillaries and may not always be present in the peripheral blood. Low parasitaemia needs considerable expertise and thus routine Giemsa staining might miss the malarial parasites.

Techniques such as QBC based on fluorescent stains have low specificity and methods such as PCR and Antigen detection (HRP-2, pLDH) [23] are expensive.

Chagas' disease: Trypanosoma cruzi causes Chagas disease. It is a major health problem in many Latin American countries. The acute phase is usually asymptomatic. Most of acute cases resolve over a period of 2-3 months into an asymptomatic chronic stage. The symptomatic chronic stage may not occur for years or even decades after initial infection.

Babesiosis: It is malaria like illness caused by tick borne protozoan parasite Babesia, B microti. A case has been reported in Canada where the individual infected with babesiosis remained asymptomatic but parasitemic for months to years Since the parasite remains infective under blood banking conditions, transfusion associated babesiosis is a risk of transfusion with blood and blood components[24]

Toxoplasma Gondii: One of the most wide spread vertebrate protozoan parasite, infects up to 95% adults in some countries. Organism replicate in variety of cells including reticuloendothelial system, leucocytes and CNS. Transmission by blood transfusion has occasionally been documented in immunosuppressed individual, including some fatalities, due to the presence of the organism in leucocytes. As such it is an opportunistic infection.

Leishmaniasis: It is caused by protozoa, leishmania app. Although potentially a threat to the blood supply in endemic areas, parasitemia is generally transient and at a low level and consequently there is low risk of transmission.

Future Microbial risks and threats:

Most emerging infections appear to be caused by microbial traffic. Many novel infections are seen crossing from their natural hosts into the human population, such as HIV Ancestry of HIV-1 is still uncertain, it appears to have had a zoonotic origin[25].

Strategy for Safe Blood Transfusion:

Strategy below will go a long way in ensuring blood safety.

100% Voluntary, nonremunerated blood donation.

Stringent donor recruitment with risk related questionnaire.

Self exclusion or self deferral.

- Rational use of blood and blood products.

Promoting use of plasma expanders as blood substitutes.

Leucodepletion of blood with buffy coat procedure an cylindrical bags.

- ❖ Screening of blood units mainly for HIV 1 -2, HB V, HCV, syphilis and Malaria, with inclusion of screening tests for infections prevalent in particular geographical region.
- ❖ Use of recombinant factor VIII, F-VII in bleeding disorders.
- ❖ Autologous blood Transfusion. [42]
- ❖ Directed blood transfusion.

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Administration of Blood

Mukesh Desai
Prof. Alaka Deshpande

Introduction:

"THE BEST BLOOD IS

THE ONE THAT YOU HAVE NOT

RECEIVED. "

Still blood is a life saviour in various critical conditions. Therefore each health care worker must know about the blood transfusion.

Transfusion deaths due to wrong identification still occur and largely occur due to human error. They can certainly be

prevented with proper and adequate knowledge of transfusion.

Deficiency in the transfusion process and ignorance amongst clinicians about administration of the blood result into transfusion deaths which are certainly preventable.

Clinicians must be aware of:

1. Indications for blood transfusion.
2. Alternatives to blood transfusion.
3. Informed consent for blood transfusion.
4. Administration of blood.
5. Transfusion reactions.
6. Component therapy.
7. Do's & Don'ts of blood transfusion.

Transfusion process:

Transfusion process begins once the decision for the transfusion is taken. Transfusionist can be a medical officer, a staff nurse or staff of a medical team. Transfusionist must be aware of **ALL** the steps in the transfusion process, i. e.:

1. Identification of intended recipient.
2. Informed written consent.
3. Transportation of blood and blood components.
4. Storage of blood and blood components.
5. Needle suitable for transfusion.
6. Initiation and monitoring of blood transfusion.
7. Duration of blood transfusion.
8. Use of blood filters, leucocyte filters whenever indicated.

9. Compatibility with other fluids.
10. Post completion record maintenance.
11. Addition of drugs and medication to the blood bag.
12. Handling of the adverse reaction to transfusion.
13. Paediatric transfusion practices.
14. Administration of blood components.
15. Use of mechanical devices.

A transfusionist is likely to be called upon to give transfusion in various clinical situations, he has to be knowledgeable about every aspect of blood transfusion.

"A TRANSFUSIONIST IS AT THE LAST STEP IN PREVENTING A WRONG BLOOD GOING TO THE WRONG PERSON AND AT THE FIRST STEP IN IDENTIFYING A TRANSFUSION REACTION "

BLOOD TRANSFUSION:

1. Ordering Blood:

a. Safe transfusion practice begins with correct identification of the intended recipient.
b. Blood samples of the recipient are to be collected, identified and labeled properly.
c. Blood samples are to be sent to the blood bank for grouping and cross-matching.
d. Blood transfusion request must provide all the relevant data in the requisition form.
e. Incomplete, inaccurate or illegible request will not be

accepted by transfusion services.

f. Inbuilt mechanism to identify person who drew blood sample is necessary.

g. 'Identifying information' is to be rechecked.

h. ABO Group, Rh type, crossmatching of recipients blood is to be carried out..

i. In case of any discrepancy a fresh blood sample is to be sent to the blood bank for grouping-crossmatching.

Steps to be taken in the blood bank at the time of the issue of blood:

A) Identification of intended recipient:

- ❖ Blood request form.
- ❖ Compatibility form.
- ❖ Transfusion form.

B) Compare ABO group and Rh type of the primary label and transfusion form.

C) Verify the label for sero negativity in relation to TTI *{Transfusion Transmissible Infections, e. g. HIVl &HIV2, HBV. HCV).*

D) Inspect the blood unit for the colour, expiry date and maintain the record. The blood bag with clots, pinkish discoloration of plasma, purple discoloration etc. should not be issued/accepted.

E) The issuing person must maintain a record of date, time and person to whom the unit is issued so that in case of an adverse reaction the person can be contacted to help to identify the cause of transfusion reaction.

Administration of the blood:

A. Receiving the blood from the bank.

a) Non-medical reasons for delay in starting blood transfusion can be avoided by proper planning and education of transfusionist.

b) Administer blood within half an hour of issue from the blood bank.

c) 1/2 hour time limit is empirical and is the time taken for blood bag to reach 10°C temp. There is no need to warm the blood except in cases of massive blood transfusion.

d) In case of delay in initiating blood transfusion, return the blood bag to blood bank **IMMEDIATELY** because no blood bank will accept the blood unit back if it has reached 10°C temp., in such circumstances the blood bag has to be discarded.

e) Don't store blood or blood component in unmonitored nursing station refrigerator as storage temperature of 0-4°C required for blood unit, cannot be assured and will give a false sense of safety. This is a common practice in small nursing homes, ICCUs and surgical theatres of most institutions.

f) Please note:

❖ Open system of blood e. g saline washed RBC should be used within 24 hr.

❖ Blood component like Cryoprecipitate & Fresh Frozen Plasma (FFP) to be used within 6 hrs of issue.

❖ Platelet bags should not be stored in a refrigerator. They should be maintained at 22-24 °C on a constant agitator.

B. Steps to be taken by the transfusionist at the time of transfusion:

Check all the identifying information,

Identity of the recipient on the transfusion form; compatibility label is a very important step prior to infusion.

Check ABO group, Rh type.

Check the sero negativity label against TTI.

Donor unit identification number is checked.

Expiry date is confirmed.

Check the compatibility label or tie tags.

Transfusionist must start transfusion **against physicians "WRITTEN ORDERS"** after following the above steps.

C. Starting the transfusion:

a. The transfusionist must take the **informed written consent of the recipient.**

b. He must keep a record of verification of recipient's identification, verification of the blood bottle and all the parameters, with his own signature. It is necessary in case transfusion reaction occurs.

c. Reconfirmation by a second individual to prevent any human error in identifying the information is desirable.

d. Record of the patient's vital parameters prior to initiation of the blood must be maintained.

e. Patient record is to be checked once again to verify correct identification.

f. The needles to be used are no. 21 or 20 gauge Scalp Vein OR Venflow needles. In paediatric transfusion, no. 23 gauge scalp vein needle is used.

g. Record the date and time of starting the blood transfusion,

h. Record the vital parameters every 15 minutes. Alteration of vital parameters is the first indication of transfusion reaction.

i. Record the termination of blood transfusion.

j. Record the amount of blood transfused.

"THERE IS NO NEED TO WARMTHE BLOOD BEFORE TRANSFUSION"

D. Care during transfusion:

1) First half an hour is very crucial.
2) Risk of catastrophic event like ABO hemolytic reaction and anaphylactic reactions are maximum in the first 1/2 hr, hence requires close monitoring.
3) Risk declines sharply after 1/2 hr. of safe transfusion.
4) Record vital signs every 15 minutes.
5) The rate can be increased if the initial transfusion for 1/2 hour is uneventful.
6) Observe the patient throughout the transfusion.

E. Rate Of Transfusion:

1. Rate should be slow in first 1/2hr.
2. If no reaction, then the rate can be increased depending on recipients haemodynamic status:
   - Haemadynamically stable — 2 hours for complete transfusion.
   - Haemodynamically unstable - 4 hours.
3. Transfusion of unit of blood must be completed within 4 hours.

4. The time limit is empirical, is based on the time it takes for the blood bag to reach a room temperature. Since blood is an excellent culture media, keeping the blood bag at room temperature for longer duration could result in bacterial overgrowth.
5. In case medical condition of recipient demands that transfusion is to be given slowly over a longer period, ask for split units of blood from the blood bank and give each unit over 4 hours.
6. Rapid infusion may be necessary in certain clinical settings. In such conditions use MECHANICAL DEVICES for rapid transfusion. Blood pressure cuff is unsuitable for providing external pressure on the blood bag.

F. Discontinuing transfusion:

a. Record the time, volume and type of component given.
b. Record the patient's condition and vital parameters after the transfusion is over.
c. Transfusionist must identify himself clearly with his signature.
d. Return the transfusion form to transfusion service i. e. blood bank.
e. Observe the patient for one hour.
f. Post transfusion monitoring- the haematocrit, platelets and coagulation factors is necessary. Inappropriate rise in Haematocrit may indicate a delayed transfusion reaction.
g. Monitor patient for PTH (Post Transfusion Hepatitis)

Blood transfusion filters:

- All blood components must be administered using filters.
- Blood components like cryoprecipitate, platelets, fresh
- frozen plasma may also be administered using blood
- transfusion sets with filters.
- Purified factor VIII, IX are provided by needles with inline filters.
- Standard blood transfusion filter size is 170-260 microns.
- Filter removes microscopic clots, cellular debris and undesirable particles.
- For routine transfusion microaggregate filters are not necessary.
- Microaggregate filters have a pore size of 20-40 microns.
- Microaggregate filter removes decomposed platelets, WBC and fibrin generated after 5 days of storage of blood with sizes of 20-160 micron, which are pathologically implicated in ARDS, **TRALI** (Transfusion related acute lung injury), pulmonary dysfunction.
- Microaggregate filters are routinely used for transfusion in cardiovascular surgery e. g. CABG
- Microaggregate filters are inappropriate to use in massive transfusion because it slows the rate of transfusion.
- Microaggregate filters in paediatric cases can result in haemolysis.

If the flow rate is slow:

- Elevate blood container (bag).
- Check patency of needle and size.
- Examine filter for excess debris.

- Examine blood bag for presence of clot.
- Add normal saline 50 to 100 ml.

Blood warming:

- As blood flows drop by drop it attains body temperature quickly therefore warming of blood is NOT necessary for routine blood transfusion.
- Blood warming results in increased metabolism, reduced 2-3 DiphosphoGlycerate (DPG) and increases the risk of bacterial overgrowth.

Indications for Blood warming are:

19) Massive transfusion 100 ml/minute or 1 blood bag every 3 minute in which case the recipient may develop hypothermia and arrhythmias.
20) Exchange transfusion in a neonate.
21) Cold agglutinin disease.

Blood warming:

Blood warmers are available which warm the blood as it is flowing through the tubing.

- ❖ The whole blood bag should not be warmed.
- ❖ Microwave should not be used for blood warming.
- ❖ While thawing Fresh Frozen Plasma or warming the blood the outlet port of the bag should be protected.

Undue blood warming occurs in clinical practice because of:

a) Delay in initiation of the transfusion.

b) Transfusion over prolonged duration.

c) Storage in unmonitored refrigerator.

d) Delay in completion.

Addition of drugs & medications to the blood bag is prohibited:

- Addition of drugs may cause a change in the blood e. g. ringer lactate results in clotting of blood and is contraindicated along with blood.
- 5% dextrose results in haemolysis.
- Changes in drug can occur because of pH and ionic molecular constituents.
- If there is a reaction, it is impossible to ascertain whether the reaction is due to the blood or the drugs added to the blood, therefore no drugs should be added to the blood unit, exception-normal saline and 5% albumin under medical supervision.

Few undesirable practices:

1. Blood warming using water-bath.
2. Delay in transfusion after issue from the blood bank.
3. Use of unmonitored refrigerator for storage of blood and blood component, e. g. nursing station refrigerator.
4. Rate and duration of the transfusion.
5. Routine pretransfusion medication.
6. Insertion of medication.
7. Use of same transfusion set for more than one transfusion.

8) Directed donations.
9) Platelets stored in refrigerator.
10) Walking donor program.

DON'TS FOR BLOOD TRANSFUSION:

1) Don't use blood from non-licensed blood bank.
2) Don't delay initiation of blood transfusion.
3) Don't warm the blood.
4) Don't use routine pre-transfusion medication.
5) Don't infuse over more than 4 hrs,
6) Don't leave patients unmonitored.
7) Don't add any medication to blood bag.
8) Discard blood if not utilized.
9) Don't ask for all the blood bags at one time.
10) Don't use unmonitored refrigerator for storage.
11) Don't use transfusion set for more than one blood bag.
12) Don't wet outlet port of blood.
13) Don't store platelets in refrigerator.
14) Don't be complacent while checking identifying information.
15) Don't insist for immediate relation's blood and directed donation.

Clinicians have a dual responsibility:

1. Identifying the need for blood transfusion.
2. Avoiding un-indicated transfusions.

Adverse Reactions to Blood Transfusion

Mukesh Desai

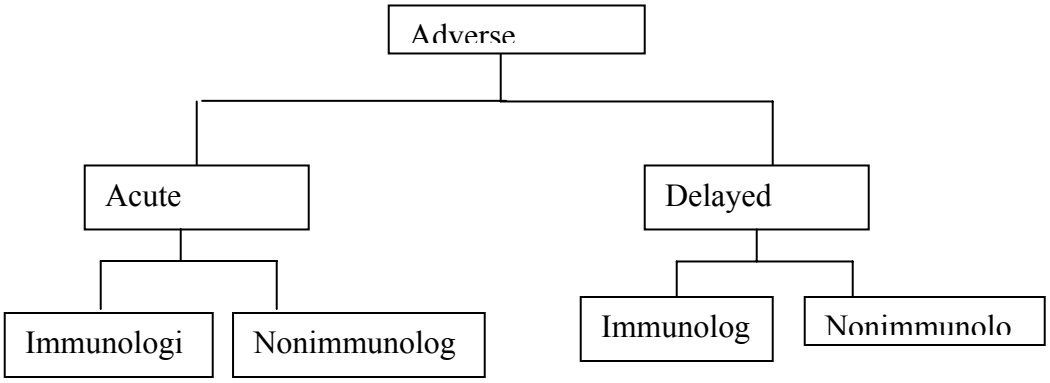
Introduction:

Any adverse reaction that occurs during the administration of blood and blood component must be considered as transfusion reaction unless proved otherwise. Transfusion reactions occur in 7% to 10% of all recipients of blood or blood components, fortunately majority of them are minor reactions. It may be immediate or delayed and may have immune or non-immune mechanism. 10% of these reactions are hemolytic and 90% of these are non-hemolytic.

Incidence of ABO mismatch blood being infused is 1: 30, 000 blood bags. 1 out of 10, ABO mismatch transfusion is fatal and 81% of fatality is due to clerical human errors which can be minimised and prevented by adhering to strict identification procedure. Early recognition and initiation of treatment could further reduce mortality. This is added responsibility of the

transfusionist. The initial presenting symptom of a serious hemolytic transfusion reaction is similar to febrile non-hemolytic transfusion reaction.

Any adverse reaction should be treated as potentially life threatening. Transfusion reactions may be divided as follows:



ACUTE ADVERSE REACTIONS (<24 HRS):

Occur in less than 24 hours of transfusion.

A. Immunologic:	**Usual aetiology**
• Haemolytic transfusion reaction	• ABO incompatibility
• Febrile non hemolytic transfusion reaction.	• Cytokines, anti leucocyte antibodies
• Allergic	• Antibodies to plasma proteins
• Anaphylaxis	• Antibodies to IgA
• TRALI	• Antibodies to leucocytes or complement activation

B. Nonimmunologic:	Usual aetiology
▪ Marked fever with shock.	▪ Bacterial contamination
▪ Atypical reaction with hypotension	▪ Associated with ACE inhibitors.
▪ Congestive heart failure	▪ Volume overload.
▪ Air embolism	▪ Air infusion via line
▪ Hypocalcaemia	▪ Citrate toxicity
▪ Hypothermia	▪ Rapid infusion of cold blood
▪ Hypokalemia and hyperkalemia.	▪ Red cell storage.

DELAYED ADVERSE REACTION TO TRANSFUSION (> 24 HRS):

The reaction occurs after 24 hours.

A. Immunologic:	Usual aetiology
▪ Alloimmunization to RBC, WBC, platelets, plasma protein, HLA.	▪ Exposure to antigen of donor origin.
▪ Haemolytic	▪ Anamnestic antibody to RBC antigen.

▪ TAGvHD	▪ Engraftment of transfused functional Lymphocytes.
▪ Post Transfusion purpura	▪ Antiplatelet antibodies.
▪ Immunomodulation	▪ Not well understood.

B. Nonimmunologic:	**Usual aetiology**
▪ Iron overloads	▪ multiple transfusions.
▪ Transfusion transmitted diseases	▪ HCV, HBV, HIV-I, HIV-II, malaria, syphilis.

RECOGNITION OF ACUTE TRANSFUSION REACTION:

Signs and symptoms of Acute hemolytic transfusion reactions are:

1) Fever with or without chills.
2) Rigors with or without fever.
3) Pain at infusion site or in chest, abdomen or flanks.
4) Acute hypotension or hypertension.
5) Tachypnoea and hypoxemia.
6) Nausea with or without vomitting.
7) Hemoglobinuria.
8) Urticaria, flushing, itching or oedema.

THE ROLE OF TRANSFUSIONIST IN CASE OF AN ACUTE TRANSFUSION REACTION:

He is the first to suspect and first to take action.

1) ***STOP*** *the* transfusion immediately.
2) ***NOTIFY*** *the* responsible physician.
3) ***MAINTAIN I. V. line*** *with* normal saline drip.
4) ***CHECK*** for all identifying information for clerical error.
5) ***Notify*** Blood bank personnel and patient's physician immediately:
6) Conditions requiring aggressive management need to be ruled out immediately. A physician must evaluate the patient thoroughly to diagnose an Acute haemolytic transfusion reaction, Anaphylaxis, TRALI, transfusion induced sepsis.
7) *Initiate* appropriate therapeutic measures.
8) Collect blood samples to be sent to blood bank for counter **checking in 3cc EDTA and 5 cc in plain tube.**
9) Collect blood for coagulation profile in l0cc citrate tube, plain tube for biochemistry, electrolytes and appropriately for blood cultures.
10) ***Return*** the discontinued blood bag along with IV administration set, attached IV solutions, all related forms **and labels to the blood bank.**
11) In case the reaction is limited to urticaria or circulatory overload there is no need to evaluate post reaction blood or urine samples.
12) ***Observe*** the post reaction urine sample for Hemoglobinuria

indicative of Auto Immune Hemolytic Transfusion Reaction by monitoring the hemodynamic status, urine output, ECG, ABG. etc.

THE ROLE OF BLOOD BANK LABORATORY

a) Check for error of identification: Recheck all the steps of transfusion process. IN CASE OF MISIDENTTFICATION SEARCH FOR OTHER PATIENT AT RISK.

b) Visual check for hemolysis:
   - ❖ Post reaction plasma for hemoglobinemia.
   - ❖ Elevated bilirubin by 5-7 hrs.
   - ❖ Post reaction urine sample for hemoglobinuria

c) Serological check for incompatibility Direct Agglutination testing.

2. FEBRILE NON HEMOLYTIC TRANSFUSION REACTION (FNHTR):

is defined as rise in temperature of 1°C with or without rigors.
***It** occurs early during transfusion or 1-2 hours after completion.*

Incidence: It is common. Incidence is 0. 5 to 1%. Higher incidence is seen with multiple transfusions and in multiparous females.

Aetiology: Antibodies to leucocytes; Cytokine release.

Clinical picture: Fever with or without chills, mild rise in temperature; responsive to antipyretic.

Warning sign: Severe rigors, temperature more than 40°C suggest bacterial sepsis.

Recurrence: 1 out of 7 with previous Febrile Non Hemolytic Transfusion Reaction.

Management: It is a diagnosis of exclusion. Stop transfusion till hemolytic transfusion reaction ruled out. Blood can be restarted if hemolytic reaction is ruled out. Restart blood transfusion slowly. If hemolytic reaction is ruled out, Chlorpheniramine 50 mg & paracetamol may be administered as a supportive treatment.

Prevention: a) Use Leucodepletion filters if history of more than 2 FNHTR. b) Saline washed RBC. c) Premedication with paracetamol.

3. ALLERGIC URTICARIAL REACTION:

Incidence: 1 to 3%.

Aetiology: Antibodies to donor plasma proteins.

Clinical picture: Allergic urticarial reaction occurs towards the end of transfusion or immediately after it and is characterized by itching, urticaria, flushing rash, rarely laryngeal oedema, bronchospasm.

Management:

- No Need to stop transfusion.
- IV chlorpheniramine 25mg.
- IV hydrocortisone 100 mg.
- Subcutaneous adrenaline 1: 1000, **ONLY** if laryngeal oedema.

Prevention:

a. Prophylactic chlorpheniramine before transfusion.

b. Saline washed **RBC.**

ACUTE IMMUNE HEMOLYTIC TRANSFUSION REACTION (AIHTR):

Incidence;

1: 30, 000 blood bags transfused in Britain.

1: **33, 000 to** 1: 12, 000 in USA.

Fatality rate: Commonest cause of transfusion related mortality. 10% in Britain, 6% in USA.

Aetiology: It is almost always due to **ABO mismatch** blood transfusion. Rarely it is due to anti Lewis, anti P and anti H blood groups. It occurs in emergency, ICU setting or in operation theatre, wherever blood transfusion is being given. It is a clerical error in labelling or mixup of samples **or a HUMAN ERROR** is the cause of this serious event. Technical error in grouping and compatibility testing.

Pathophysiology: It is a catastrophic event following hemolytic reaction when transfused RBCs interact with preformed antibodies in recipient. Severity is related to amount of transfused blood. Reaction may occur with as little as 10 to 15 ml of blood. Most reactions occur in the first 1/2 hr of initiation of transfusion.

a) *Neuroendocrine response.*

Ag + Ab + Xlla factor leads to activation of kinin bradykinin pathway—* Increased capillary leak vasodilatation hypotension Shock.

b) *Complement activation:*
C3a-C5a leads to shock, hypotension, bronchospasm
C5-9: hemolysis

c) *Coagulation activation:*
Disseminated Intravascular Coagulation

d) *Cytokines release:*
IL6, IL8, TNF alpha fever, hypotension.
Activation of coagulation pathway DIC

e) *Renal failure*

Clinical features:

1) Symptoms: Transfusion recipient complains of chills, flushing, sweating, chest pain, pain at the infusion site, back pain, abdominal discomfort, nausea, vomiting and restlessness.

2) **Signs:** Fever with rigors, tachycardia, dyspnoea, hypotension, tachypnoea, pallor, cyanosis, anuria / oliguria, shock, DIC and hemoglobinuria.

3) **In an Unconscious patient:** Hypotension, hemoglobinuria, uncontrolled bleeding (DIC)

"Any febrile reaction —

treat as AIHTR unless proved otherwise"

TREATMENT and work up of AIHTR:

STOP THE BLOOD COMPONENT TRANSFUSION ***IMMEDIATELY.***

- Maintain IV access with crystalloid.

- ❖ Maintain blood pressure and pulse (vital parameters).
- ❖ Maintain adequate ventilation.
- ❖ Give a diuretic and/or institute fluid diuresis.
- ❖ Obtain blood and urine samples for transfusion reaction workup.

IF INTRAVASCULAR HEMOLYSIS IS CONFIRMED then

a. Monitor renal status (BUN, Creatinine).
b. Monitor coagulation status (PTA, PTT, fibrinogen, FDP).
c. Monitor for signs of hemolysis (bilirubin, LDH, haptoglobulin).
d. If sepsis is suspected send appropriate blood cultures & start appropriate antibiotics.

Prevention:

All the precaution to be taken to minimize human error.

a. Well drawn protocols are to be followed.
b. The duties of phlebotomist to medical technologist to transfusionist are to be delineated and followed strictly.
c. Education of the transfusionist is a must as he has the last opportunity to prevent misidentification and the first one to identify transfusion reaction.
d. It is desirable to have a well defined transfusion team.

NON IMMUNE HEMOLYSIS - BACTERIAL CONTAMINATION:

Aetiology:

1) Healthy donor with transient bacteraemia, asymptomatic

carrier of bacterial infection, contamination of anticoagulant in blood bag, defect in plastic bag, improper handling of needles, inadequate sterilization of skin, all can contribute to bacterial contamination

2) Bacterial contamination may occur during component preparation
3) It can also occur during storage; platelets stored at 20-22°C.
4) Fluctuations in temperature can favour bacterial growth.

Organisms:

The common bacterial contaminants are psychrophillic gram negative bacteria; pseudomonas, Citrobacter Freundii, E. coli, Yersina enterocolita, Bartonella, Brucella, Staphylococci, Diptheroids.

Reaction: The adverse reaction is due to endotoxin.

Risk of bacterial contamination:

1. 1: 500000 Red blood cells.

   1: 10200 platelets.

   1: 19 500 platelet pheresis.

2. Improper storage conditions increase the risk, therefore blood bag should never be stored in unmonitored nursing station refrigerator.
3. Blood warming prior to transfusion favours bacterial growth.
4. Following conditions also favour bacterial contamination, therefore these errors should be avoided.

a. Giving blood over prolonged duration > 4 hrs.
b. Using blood transfusion set for more than one bag.
c. Entry port contamination while thawing blood component.
d. Insertion of medication.

Fatality rate is 26%.

Clinical features: Clinical features are like endotoxinemia progressing to endotoxic shock with MODS. Patients present with fever of 40° C with rigors, abdominal cramps, diarrhea, vomiting, hemoglobinuria, shock, DIC, renal failure.

Treatment and workup:

- STOP TRANSFUSION.
- Inspect blood bag for signs of bacterial overgrowth, cells or plasma brownish or purple, clots, plasma opaque or muddy, peculiar odour, hemolysis.
- Examine the blood from bag by smear preparation and Gram stain for bacteria and cocci.
- Send cultures from blood bag at 4° C, 20-24° C, 35-37° C.
- Treat patient with proper and adequate antibiotics.
- Treatment similar to AIHTR.

Prevention:

- Attention to the storage conditions of blood.
- Proper sterilisation of phlebotomy site.
- Sterile connecting devices while component preparations.
- Inspection of blood prior to issue.
- Education of transfusionist regarding proper administration of blood.

ANAPHYLACTIC REACTION:

Incidence: 1: 18, 000 to 1: 170, 000

Aetiology: Antibody to donor plasma protein. Most commonly Anti IgA

***Clinical** features:* It occurs after infusion of few ml. of blood. Patient complains of:

1. Cough, bronchospasm,
2. Respiratory distress,
3. Abdominal cramps, diarrhoea, shock, loss of consciousness, ABSENCE OF FEVER.

Treatment: **Stop transfusion immediately**

- Treat the shock like other anaphylactic shock.
- Epinephrine 0. 3 to 0. 5 mg subcutaneous or IM 1: 1000 solution.
- In severe cases 1 : 1 0 000 IV
- Steroids, IV hydrocortisone 100 mg stat
- Antihistaminic IV, B_2 agonist.

Prevention:

- Encourage Autologous blood transfusion.
- Plasma component prepared from IgA deficient individuals.
- TRANSFUSE BLOOD COMPONENTS THAT LACK IgA.
- Extensively washed RBCs.
- Deglycerolised RBCs.
- Maintain donor file.

TRALI (Transfusion Related Acute Lung Injury):

Incidence: Rare

Aetiology:

Immune reactions between leucocytes of the recipients with preformed antibodies present in the transfused blood.

Pathophysiology:

1. Migration of activated neutrophils to lung.
2. Microvascular occlusion.
3. Capillary leakage and pulmonary oedema.

Clinical presentation is characterized by;

- Idiosyncratic presentation within 4 hrs of transfusion.
- Marked respiratory distress.
- Fever, Hypoxia, hypotension, clinical signs of pulmonary edema.
- X-Ray showing Bilateral pulmonary infiltrate.

Treatment:

- ❖ Supportive care
- ❖ High dose steroids
- ❖ Ventilator support.

Prevention:

- Washed RBC.
- Microaggregate filters.
- Leucodepletion for blood and blood component.

TRANSFUSION ASSOCIATED GRAFT VERSUS HOST DISEASE - Ta GvHD:

Incidence: Very rare.

Aetiology:

- The recipient receives the viable lymphocytes in the transfused blood. They proliferate and initiate Graft vs Host Diesease.
- Immunocompromised host
- HLA compatible donor

  Blood relative,

  HLA matched component,

  Population with limited HLA diversity.

Target organs: Bone marrow, Skin, Liver, Gastrointestinal tract.

Clinical features: Disease becomes apparent 10th to 12th day after the transfusion. The clinical features include:

1. Erythroderma.
2. Jaundice and liver enzyme abnormalities.
3. Diarrhoea, 3 to 4 liters of watery diarrhoea.
4. Pancytopenia.

Diagnosis: is by a) HLA typing, b) Skin biopsy.

Patient at risk:

1. a. Neonate,

   b. Premature babies,

   c. Premature babies with Hemolytic disease of newborn (HDN),

d. Intrauterine transfusion,

e. Full term and HDN requiring Exchange transfusion,

f. Full term with neonatal alloimmune, thrombocytopeinia requiring mothers platelets.

2. a. Severe Combined Immune Deficiency,

b. Wiscott Aldrich Syndrome,

c. Purine nucleotide,

d. Nezloff syndrome,

e. phosphorylase deficiency,

f. Congenital immune deficiency.

3. Fresh maternal and paternal plasma.
4. Transfusion from blood relative.
5. HLA matched blood component.
6. Donor of the same ethnic background with limited HLA diversity.
7. In Leukaemia estimated risk is 0. 1 to 1%.
8. In Lymphoma estimated risk is 2%.
9. HLA matched allogenic BMT.
10. Post BMT.
11. Solid tumors on intensive chemotherapy.

Components implicated in TaGvHD:

Whole blood,

Packed cells,

Granulocyte pack,

Platelets,

Fresh plasma.

Components not implicated in TaGvHD:

FFP.

Cryoprecipitate.

Comparison of TaGvHD and GvHD in BMT:

	TaGvHD	**BMT GvHD**
Incidence	**0. 1** to 1. 0%	**30 to 70%**
Onset	2 - 47 days	35 to 70 days
Pancytopenia	Frequent	**Rare**
BM	Hypocellular	Not affected
Duration of illness	<54 days	5 months
Mortality	87-100%	5 - 10%

Prevention: Irradiation of blood and blood component for patients at risk, Dose: 2500 rads

Irradiation of:

a) Cellular component intrauterine transfusion
b) Identified 'at risk' cases for GvHD
c) Transfusion of cellular components between blood relatives.
d) Transfusion of HLA selected products

Mortality: 87 to **1**00%

Anaphylactoid reaction to ACE inhibition.

Reaction: Episode of flushing and hypotension in patients on ACE inhibitors

Mechanism: Prekallikrein present in blood and blood product is converted to vasoactive bradykinin whose metabolism is inhibited by ACE inhibitors resulting in hypotension.

***Procedures** associated.*

- Therapeutic plasma exchange with albumin replacement
- Contact of plasma with dialysis membrane
- Leucocyte reduction filters
- Low-density lipoprotein adsorption column
- Staphylococcal A adsorption column.

DELAYED HEMOLYTIC TRANSFUSION REACTION:

Two types: a) Anamnestic response to transfused RBCs
b) Primary alloimmunisation.

***Incidence* 1**: **11**000 to **1**: 5000
0, 05% to 0. 07% of transfusion recipient

Clinical presentation: More common in multiple transfused & Muciparous women

- Occurs 3 - 7 days post transfusion.
- Extravascular hemolysis.
- Absence of anticipated Hb or HCT rise following blood

transfusion.

- Jaundice
- Fever
- Rarely hemoglobinuria
- Primary alloimmunisation not delayed

Antibodies implicated.

Common antibodies	uncommon antibodies
Anti jka	Anti Al
Anti E	Anti PI
Anti D	
Anti C	
Anti K	
Anti Fya	
Rarely Anti HLA	

Investigations:

a) Draw fresh blood to test for alloantibodies.
b) Compare with previous sample.

Treatment. Rarely necessary.

Observe urine output.

Blood transfusion that lack the corresponding antigen.

Prevention: Blood that lacks the responsible antigen.

Issue medical alert card to these patients.
Maintain record of the offending antibodies.

POST TRANSFUSION PURPURA :

Incidence: Uncommon

Presentation:

Acute severe thrombocytopenia 5 - 10 days after transfusion in a previously pregnant female or multiple transfused individual. Typically perimenopausal or menopausal women. Rare in males.

Pathophysiology:

Patients platelet lack HPA -1 a (PLAl - platelet specific antigen system). 2 % of population. Antibodies destroy both HPA-Al positive and HPA-Al negative platelets.

Course:

Self limited, recovery in 21 days.

Treatment. -Steroids controversial.
-Plasma exchange,
-IVIgG,
-RDP patient completely refractory hence contraindicated,
-HPA-Al antigen negative platelet of benefit but difficult to arrange.

Prognosis: Good. Recurrence is rare.

Prevention: -Washed platelet concentrate.
-Blood from Human Platelet Antigen- la negative patients.

PLATELET REFRACTORINESS:

Incidence: 20 to 70 % cases requiring multiple platelet transfusion.

Criteria: -Lack of accepted corrected count increment of two platelet transfusion,
-Poor response to three platelets in 2 weeks.

CCI = $\frac{\text{Post transfusion count - } \textit{Pre} \text{ Transfusion Count x BSA } (M^2)^*}{\text{No. of Platelet administered x } 10^{11}}$

Causes: Platelet alloimunization
Non immune causes

Immune causes:
ABO mismatch
Anti HLA antibodies
Platelet specific allo and autoantibodies
Drug dependent antibodies.

Most common cause: Anti HLA antibodies Produced by passenger lymphocytes. May disappear.

Strategies for prevention:
-ABO matched single donor apharesis platelets
-Leucodepletion using leucocyte filters
-HLA matched platelets difficult. Need a donor pool of 2000 to 3000 donor
-Irradiation of HLA matched platelets is a must.

* BSA = Body surface area (M^2)

Artificial Blood

Ipsit Vahia **Kunal Kotkar**
Ajay Nair **Hemangi Shah**
Dharam Kumbhani **Pooja Belligund**

Introduction:

In the world of medicine today, technology plays almost as great a role as traditional arts of diagnosis and clinical skills. One aspect of medicine where technology has revolutionized treatment is Emergency Medicine.

Nothing is more exemplary of technology changing our concepts of medical management, than artificial blood.

Artificial blood holds great promise and could be that all important breakthrough in the field of blood transfusion that we desire.

Although up to now, we can only claim artificial substitutes for the perfusion function of blood in addition to plasma expanders, continuous improvements and astounding potential have evoked much interest in this entity.

History:

The concept of introducing extraneous substances into the blood stream, goes back to as early as the 16th century, when bloody battles resulted in a direct need for transfusion. Ringers solution was used as early as the late 1800s.

While early research on artificial blood was started as early as 1920s by Sellards and Minot, who experimented with haem emulsions as potential replacements for whole blood, it was the massive need for blood during the 2nd world war that actually triggered concentrated efforts into developing a viable blood substitutes.

Dr. Thomas M. S. Chang, who is today regarded, as the 'Father of Artificial Blood' has been associated with some of the best original research done on artificial blood. He has also chaired several International Committees dealing with legal and ethical aspects on the use of Artificial blood and continues to pioneer this science even today.

Robert Geyer, another pioneering researcher, discovered perflurocarbons which are another facet of the science of artificial blood and are in fact subjected to studies on their application as oxygen carrying molecules in situations other than just blood substitution.

Need:

In order to appreciate the need for viable blood substitutes it is important to consider several factors.

Transfusion medicine, despite all the advancements in technology still faces problems that cannot be remedied:

- **Shortage:** A very important limitation especially during disasters, wars, emergencies, when it is needed most.
- **Disease transmission**: HIV, HBV, HCV to name some of the most common pathogens.
- **Short shelf life:** This leads to a large amount of wastage of blood.
- **Rare blood groups:** This can be a problem, especially in under populated areas or in a situation where there is a large demand for blood.
- **Immunological incompatibility.**

The use of artificial blood can potentially bypass all these problems.

Types & Composition:

It is essential for us to appreciate that products laying claims to the epithet artificial blood, in effect only perform two functions. They can serve as plasma volume expanders or replicate the oxygen carrying function of natural blood, effectively duplicating the function of red blood cells. Research is underway to develop substitutes for platelets and leukocytes but remains in the preliminary stages. Two types of substitutes are commonly used today and they are:

1. Plasma Expanders:

These are compounds, which are either entirely synthetic or processed from natural proteins, that serve as infusion solutions which expand intravascular volume.

2. RBC Substitutes:

There are of two basic types-

- Modified Haemoglobins - these are essentially human haemoglobins extracted from outdated blood.
- Perflurocarbons - Synthetic organic compounds that can take over perfusion

Plasma Expanders:

These can be either crystalloids or colloids. Crystalloids include solutions like normal saline, dextrose and ringer lactate which can serve as volume substitutes and maintain plasma osmolarity. Colloid plasma expanders encompass a wide range of substances. These compounds hold water and actually expand volume over the amount infused. While the debate about crystalloid use vis-a-vis colloid use continues, guidelines are being drawn.

Colloid expanders can be of several types:

- **Gelatin:** These are modified gelatin polymers, which were among the earliest used colloid expanders, but are now being phased out due to an inherent risk of anaphylaxis.
- **Dextran:** This is a newer generation of colloid expander which uniquely not only expands plasma volume, but also serves to decrease blood viscosity, thereby improving perfusion.
- **Hydroxyethyl Starch (HES):** This is a polymerized form of plant starch which is structurally similar to glycogen and is therefore the safest of the plasma expanders.

- ❖ Albumins and Purified Protein Derivatives: These are prepared by fractionating albumin and other proteins from pooled human blood and then sterilizing and processing the albumin so that it is iso-osmolar with plasma. These carry the greatest risk of anaphylaxis.

Use of plasma expanders:

Both crystalloids and colloids have a specific role in overall management of hypovolemia and are life saving products for acute emergency situations requiring resuscitation.

General indications include hypovolemia, loss of blood or plasma, exsiccosis or post surgical states. These indications are applicable to all the available plasma expanders. They are usually used prior to blood transfusion, because no processing or testing of the patient is required for transfusion of expanders and hence can be infused immediately. Since they achieve hemodynamic stability immediately, except in cases of severe anemia or coagulation defects, often there is no need to transfuse blood or blood products at all.

Future Directions:

While research continues to further enhance safety profiles of these products, dextrans are currently enjoying a large share of research focus. This is due to potential applications, related to their ability to coat blood cells and prevent thrombus formation. This makes them particularly useful in vascular surgery, such as intravascular stent placement or surgery for DVT. Also, coating of erythrocytes causes mutual repulsion between erythrocytes, and this improves microcirculation. This

property has led to investigations of a potential role for dextrans in plastic surgery to improve perfusion and thereby hasten healing of skin grafts. Researchers are also investigating the possibility of using dextrans to minimise damage in patients with acute ischemic strokes.

Problems:

- **Anaplylaxis:** This remains the chief drawback with plasma expanders. It is particularly prevalent with gelatins and albumins while HES and Dextrans have a very low reported incidence.
- **Disease transmission:** The incidence of transmission of disease is negligible when compared with blood, but cases have been reported.
- **Nephrotoxicity:** It is reported especially with dextrans.
- **Volume overload and electrolyte imbalance:** Can be prevented by careful titration of transfused amount and monitoring.

RBC Substitutes:

Modified Haemoglobin:

This is essentially human haemoglobin (Hb), which is extracted from the stroma of erythrocytes obtained from outdated blood in blood banks. This Hb is then sterilized, purified, polymerized, complexed with compounds that enhance its functions and then encapsulated in an artificial cell and has proved to be not only more efficacious, but has a safer toxicity profile.

Mechanism of action:

Extracted Hb, once pyridoxylated and polymerised and coupled with 2, 3 bisphosphoglyceride (2, 3 BPG) follows the oxygen curve of normal Hb in the blood. The pyridoxylation and 2, 3 BPG have taken care of the shift of the oxygen dissociaiton curve to the right, that occured with earlier modified Hbs. In addition, the polymerization achieves a respectable hematocrit by increasing the molecular weight of this product.

Problems:

Adverse Effects include:

- Nephrotoxicity: resulting due to eventual haemolysis of the artificial cell.
- Vasoconstriction.
- Short half life.
- Reperfusion Injury - due to absence of superoxide dismutase and catalase.

Preflurocarbons:

This is an emulsion of synthetic hydrocarbons, that is essentially made up of the perfluorocarbon molecules and the emulsifying agents in an aqueous base. This emulsion is then homogenized and sterilized to form an intravenously injectable fluid.

Mechanism of action:

Perfiurocarbons are synthetic hydrocarbons with a molecular

size of 0. 2 micron that enter circulation, pick up oxygen from the lungs and deliver it to the tissues by diffusion. They also pick up carbon dioxide, which is then excreted in the lungs. These compounds are eventually excreted from the body by exhalation. The oxygen dissociation curve surpasses that of natural blood and can achieve an oxygen saturation of upto 70% as compared to the 20% by natural blood.

This ability of perflurocarbons to carry oxygen to tissues and release it by diffusion has generated great interest in its use in situations other than just blood substitution.

Problems:

- Vasoconstriction
- Bronchospasm
- Complement activation
- Infection

Uses of RBC substitutes:

Blood substitutes hold great promise as a resource in several situations where they either compensate for a blood shortage or aid in optimal utilization of available natural blood.

- Emergencies: In patients with hypovolemia from blood loss, they act to maintain perfusion until natural blood is made available.
- Elective surgeries: Autologous normovolumic haemoperfusion is a procedure where the patient donates

blood prior to surgery, is perfused with artificial blood during surgery and his own blood is re-transfused back to him post-surgically.

- Cerebral and myocardial protection: Due to the small molecular size, perfluorocarbons can perfuse parts of both the brain and heart that are underperfused from vaso-occlusion, making them potential life savers.
- Organ Preservation: Organs can be preserved in oxygen saturated perflurocarbon solution.
- Religious beliefs: In communities that do not accept blood products such as Jehovah's witnesses.
- Carbon monoxide poisoning: They can compensate for the inability of natural blood to carry oxygen.

Future Directions:

Clinical trials are currently underway to test the effectiveness of perflurocarbons as oxygen carrier in a variety of clinical settings where hypoperfusion states arise such as sickle cell anemia (sickling crisis), thalassemia and even Respiratory Distress Syndrome and meconium aspiration in infants, where studies have shown that simply flooding the lungs with perflubron (a commonly marketed perflurocarbon) dramatically improves circulating oxygen levels. They are also being looked at as a therapeutic option in treatment of anaerobic infections.

Perflucorocarbons are also being used as components of newer drug delivery systems and radio contrasts; carrying mediums

in newer imaging technologies where their small particle size enables them to reach vessels and parts of the body inaccessible to larger molecules.

Current scenario of blood substitutes:

Internationally, trials are still underway to prove the efficacy of RBC substitutes and while results have been very encouraging, there is still no FDA approval for any form of RBC substitute.

In several countries, including some centres in India, these products are made available as an option to patients requiring blood.

Plasma expanders however are FDA approved for use in clinical settings of hypovolumia and other uses of dextrans are currently under trial.

While there is till no legal or ethical stand taken in India regulating use of RBC substitutes, all the commercially available forms of plasma expanders are widely used and it would be safe to say that the future for artificial blood looks bright, especially in our country considering that so much of the problems that necessitate a blood substitute are prevalent in our healthcare system.

Blood Banks in Maharashtra

(Arranged Alphabetically)

AHMEDNAGAR

1. Ahmednagar Municipal Council Blood Bank, 3rd Floor, Late Balasaheb Deshpande Hospital, In Front of Asha talkies, Ahmednagar - 414 001, Dist-Ahmednagar. Tel. - 345646.
2. Dr. Jondhale's Nitya Seva Blood Bank, Shrirampur, Ahmednagar - 413 709, Dist- Ahmednagar. Tel. - (02422) - 24000/25000/22797
3. General Hospital, Blood BankSavedi Rd, Ahmednagar, Dist-Ahmednagar.
4. Jankalyan Raktapedhi Gadgil Ground, Nalegaon, Ahmednagar - 414 001, Dist-Ahmednagar. Tel. - (0241) - 346647.
5. Jeevandhara Blood Bank, Damodar Malpani Memorial Trust, Indira Gandhi Marg, Sangamner- 422 605, Dist-A'nagar. Tel. - (02425)-55011 /12.
6. Pravara Medical Trust Blood Bank, Pravara Rural Hospital, Loni, Rahata-413 736, Dist- Ahmednagar. Tel. - (02422) - 73600 Ext - 201.
7. Rotary Blood Bank, Rahuri Charitable TrustAcharyashree Anandshriji Bhavan, Near Water Tank Rahuri, - 413 705, Dist- Ahmednagar. Tel. -
8. Sanjeevani Blood Bank, Nishigandh, Vivekanand Nagar, Near S. G Vidhalay, Kopargaon - 423 601, Dist- Ahmednagar. Tel. - 22237.
9. Shakti Blood Bank, Dr. Wagh Hospital Compound, Bank Road., Kopargaon-423 601, Dist- Ahmednagar. Tel. - 23458.
10. Shri Sainath Blood Bank, Shri Sainath Sansthan, Shirdi, Taluka - Rahata, Dist. Ahmednagar - 423109 Tel. - 02423 - 55175, 55225.

AKOLA

11. Akola Diagnostic Centre Blood Bank, & Component Units Shivdwar, Civil Line Square, Akola - 444 001, Dist. -Akola. Tel. - 437179.
12. Dr. Arun Mankar Blood Bank, Mankar Smruti Hospital, Amankha Plots, Akola, Dist. -Akola. Tel. - 417230.

13. Dr. **Babasaheb** Tople **Memorial** Hospital, Blood Bank, Jathar Peth, Akola - 444 005, Dist. - Akola. Tel. - 420376.
14. Dr. Pimparkar Blood Bank, Opp. Bhate Club, M. G. Road, Akola - 444 001, Dist- Akola. Tel- 438271.
15. Dr. T. P. Lokhande Blood Bank, Opp. Judiciary Court, Ward No. 12, Papatkhed Rd, Akola - 444 10, Tel. - 07258 - 24090 Ext-20.
16. General Hospital Blood Bank, Dist. Gen. Hospital Compound, Z. P Road, Akola - 444 001, Tel. - 434401 Ext - 6.
17. Jeevan Blood Bank, College Road, Civil Lines, Akola - 444 001, Dist. - Akola. Tel. - 438383.
18. Laxmibai Deshpande Hospital,, D Hospital Compound, Murtizapur, Dist. - Akola. Tel. -
19. Reynolds Memorial Hospital & Affiliated Clinics Pusad Road, Washim - 444 505, Dist. - Akola. Tel. - 07252-33093.
20. Shriram Blood Bank, T. K Chambers, Ratanlal Plot. Square, Akola - 444 001, Dist. -Akola. Tel. -23175.
21. Women Hospital (Laxmibai Deshpande Hospital), Plot No. 2, Sheet No. 53, Opp Bldg, Akola - 444 001, Tel. - 433398.

AMRAVATI

22. Dr. Bhagwat Blood Bank, Opp Bhartiya Mahavidhalaya, Badnera Rd, Rajpeth, Amravati - 444 601, Dist - Amravati. Tel. - 675717- (0721).
23. Dr. P. D. M. H. C. Hospital & Research Centre, Shivaji Nagar, Block-A, 1 st Floor, Amravati-440 603, Dist. -Amravati. Tel- 665545.
24. General Hospital Blood Bank, Irwin Hospital Campus, Amravati - 444 601, Dist. - Amravati. Tel. - 663337/ 38/ 39.
25. Padmavati Blood Bank, Jamanalal Bajaj Nagar, Walcut Compound, Amravati - 444 601, Dist. -Amravati. Tel- 677859.
26. Shri Balaji Blood Bank & Blood Component Lab, 1st Floor, Asli Complex, Ambapeth, Amravati-444601, Tel. - (0721)-671600.

AURANGABAD

27. Govt. Medical College Hospital Blood Bank, Regional Blood Bank, Aurangabad, Dist. -Aurangabad. Tel- 334411 Ext-300.
28. Kamal Nayan Bajaj Blood Bank (Marathwada Medical Research Institute

Blood Bank), MMRI, 5-14-40, Adalat Road, Aurangabad - 431 005, Dist-Aurangabad. Tel. - 334447.

29. Lokmanya Blood Bank Blood Component & Cell Seperation Gopinath Chambers Chambers Basement Floor, Behind Jaidev Travels, Adalat Road, Aurangabad-431001. Dist. -Aurangabad. Tel. - (0240)- 342877, 328362, 335516.
30. Mahatma Gandhi Mission's Medical College & Hospital Blood Bank, N - 6, CIDCO, Aurangabad-431 003, Tel. - 484693 / 483401 Ext-311.
31. Marathwada Blood Bank, Champa Chowk, Shah Bazar, Aurangabad - 431001 Tel. - 0240-313849
32. Seth Nandalal Dhoot Hospital Blood Bank, Plot No. A -1, MIDC, Chikalthana,
    Jalna Road, Aurangabad - 431 210, Tel. - (0240) - 484192.
33. Swa. Dattaji Bhale Blood Bank, Dr. Hegdewar Hospital Campus, Garkheda Aurangabad-431001, Dist. -Aurangabad. Tel- 331195 / 343481 / 321239.

BEED

34. General Hospital Blood Bank, District Hospital Beed - 431 122, Dist. - Beed. Tel. -22618.
35. Swami Ramanand Tirtha Rural Medical Coll. & Hosp. Blood Bank, Ambejogai, Beed - 431 517, Dist. -Beed. Tel. - 47060 Ext-310.

BULDHANA

36. Ajantha Blood Bank, Sidhivinayak Nursing Home, Jambharun Road, Buldhana - 443001 Tel. - 41081
37. Dr. Murlidhar Kharche Memorial Jeevan Jyoti Blood Bank, Bharat Kala Road, Malkapur, Dist. -Buldhana - 443101, Tel- 22650
38. General Hospital Blood Bank, Buldhana- 443001, Tel. - 42423.
39. Bai Gangabai Ladies Hospital Blood Bank, Gondia, Bhandara - 441 601, Dist. Bhandara. Tel. - 07182-22050.
40. Civil Hospital Bhandara Blood Bank, General Hospital, Bhandara - 441 904, Dist. - Bhandara. Tel. - 52247 / 52532.
41. Government Hospital Khamgaon, Shegoan Rd, Buldhana - 444 303, Dist. - Buldhana. Tel. -
42. Leelavati Blood Bank, Buldhana, John Layout, Buldhana - 443001. Tel. - 43811.

43. Saibai Mote Hospital **Blood Bank,** At Post - Shegaon, Buldhana - 444 203, Dist. - Buldhana. Tel. - 52020.

CHANDRAPUR

44. Ankur Hospital Blood Bank, Balaji Ward, Chandrapur - 442 402. Dist-Chandrapur. Tel. - (07172)-51522.
45. Cristanand Education Society Blood Bank, Cristanand Hospital, Gujri Ward No. 2, Brahampuri, Chandrapur - 441 206, Tel. - 72016 / 72008.
46. Dr. Ninawe Blood Bank Hospital Ward, Kasturba Rd, Near Benglur Bakery, Chandrapur- 442402, Dist- Chandrapur. Tel. - 54884.
47. General Hospital Blood Bank, Civil Surgeon General Hospital, Chandrapur -442 401, Dist-Chandrapur. Tel, - 50400.
48. Sanmitra Mandal (Katyani Hospital) Blood Bank, M. G. Road, Chandrapur - 442 402, Dist. - Chandrapur. Tel. - (07172) - 52197.

DHULE

49. Dr. Deshpande Blood Bank, {Jalgaon Janta Sahakari Bank) Keshav Smruti Pratisthan Sanchilit, H No. 1410, 4th Lane, Dhule - 424 001. Dist- Dhule. Tel. - (02562)-32924.
50. Janseva Blood Bank, Fulwala Chowk, C. Sno. 1415/A/1/A, Agra Rd., Dr. Odhekar Bldg., Dhule 424001. Tel. - 233257, 238268
51. Jawahar Medical Foundation Blood Bank, Hutatma Shrishkumar Nagar, Sakri Rd, Opp. Jawahar Suthgirani, Morane, Dhule - 424 002, Dist- Dhule. Tel. - 24027 / 23674.
52. Jeevan Jyoti Blood Bank, Agra Road, Dhule - 424 001, Tel. -
53. 216. Shri Bhausaheb Hire Govt. Medical College & Hospital Blood Bank, Dhule - 424 001, Dist- Dhule. Tel. - 36569 / 39407.
54. Shri. Navjeevan Blood Bank, Plot No. 39, Vaibhav Nagar, Near LIC Colony, Dhule - 424 001, Dist- Dhule. Tel. -

GADCHIROLI

55. General Hospital Blood Bank, Civil Surgeon General Hospital, Gadchiroli - 442 605, Dist-Gadchiroli. Tel. - 22320 / 22340.
56. Rural Hospital Blood Bank, At Post & Tal - Aheri, Gadchiroli - 442 705, Dist. - Gadchiroli. Tel. -72071.

JALGAON

57. Central Railway Hospital Blood Bank, Bhusaval - 425 201, Dist- Jalgaon. Tel. - (02582)-23581.
58. Dr. Toke Blood Bank, Natraj Theatre Road, Gandhinagar, Jilha Peth, Dist- Jaigaon. Tel. -225517.
59. General Hospital Blood Bank, Jilha Peth, Jalgaon - 425 001, Dist- Jalgaon. Tel. - 226642 / 43 Ext-220.
60. Indian Red Cross Society Blood Bank, Near Civil Hospital, District Peth**,** House No. 153, Ward No. 33, Jalgaon - 425 001, Tel. - 226233.
61. Indian Red Cross Society Sanchalit Askaran Tarachand Jain Blood Bank, Jawahar Market, 1st Floor, Chopda, Dist. Jalgaon - 425 107.
62. Jeevan Surabhi Blood Bank, Laxmi Nagar, Chalisgaon - 424101, Dist. - Jalgaon. Tel. 23833.
63. Madhavrao Golwalkar Swayamsevi Blood Bank, C. S No. 2118/24, 273, Navi Peth, Jalgaon - 425 001, Dist- Jalgaon. Tel. - (0257)-234590.
64. Shraddha Blood Bank, College Rd, A3/1, Near Bhaskar Market, Jalgaon - 425 001, Dist- Jalgaon. Tel. - 235737.

JALNA

65. General Hospital Blood Bank, Civil Hospital Gandhi Chaman, Old Jalna, Dist. -Jalna. Tel. - 30942 / 30381.
66. Jalna Mission Hospital Blood Bank, Jalna Mission Hospital of PCMA, Jalna - 431 203, Dist- Jalna. Tel. - 30149.
67. Jankalyan Blood Bank, Gayatri Complex, 2nd Floor, Near Amarchaya Talkies, Jalna - 431 203, Dist. - Jalna. Tel. - (02482)-38397.

KOLHAPUR

68. Acharya Shree Tulsi Blood Bank, Gat No. 1232, Sangti Jaysingpur Rd., Udgaon, Tal. Shirol, Dist. Kolhapur(602322) - 28455 / 27955.
69. CPR Hospital Blood Bank, Chatrapati Pramila Raje Seva Sadharan Hospital, CPR General Hospital, Somvar Peth, 'C ward, Kolhapur, Dist. - Kolhapur. Tel. - 525684.
70. Dr. C. H. Kawchale Charitable Trust's City Blood Bank, 1980 Rajarampuri, 9TH Lane, Kolhapur - 416 008, Dist. - Kolhapur. Tel. - ((0231) - 526567.
71. Gadhinglaj Lions Welfare Association Lions Blood Bank, Magdum Colony

Gadhingtaj, Dist. Kolhapur Tel. 23100 (02327)

72. Kolhapur Municipal Corporation Blood Bank, 'D' ward, Near Kasba Gate, Police Station, Mahadwar Rd, Laxmibai Jadhav Dispensary, Kolhapur, Dist-Kolhapur. Tel- 521870.
73. Late Balasaheb Date, Lion Blood Bank, R. S. No. 576, Datye Mala, Ichalkaranji - 416115, Dist. -Kolhapur. Tel. - 436130.
74. Mahatma Gandhi Ho spital Blood Bank, Pargaon, Tal - Hatkanangale, Kothapur - 416037, Dist- Kolhapur. Tel. - 470276/477555.
75. Rajarshi Shau Blood Bank, Rotary Hall Collector Office, 253, K. E. Assembly Road, Kolhapur- 416 003, Dist. - Kolhapur. Tel. - 651640.

LATUR

76. Dr. Bhalchandra Blood Bank, Indian Red Cross Society, Gandhi Market, Latur-413512, Dist. -Latur. Tel. - 46078.
77. General Hospital Blood BankGeneral Hospital, Latur- 413 512, Dist. - Latur. Tel. - 42199/49183.
78. Shriram Blood Bank, H. No. 19/2, C. T. S. No. 4756/2, Tilak Nagar, Latur, Dist. - Latur. Tel. -.

MIRAJ

79. Smt. Anila Kantilal Kothari Blood Bank & Dept. of Haemato Oncology, Dr. D. K. Gosavi Memorial, Shri Siddhivinayak Ganapati Cancer Hosp. Sangli- Miraj Road, Miraj- 416 410.

MUMBAI

80. Abdul Fazalbhoy Blood Bank, Cama & Albles Hosp., Mahapalika Marg, Municipal Road, Mumbai- 400001, Tel. - 2611648.
81. Ambaji Blood Bank & Blood Components, Arjun Centre, Gala No. 14, Govandi St, Rd., Near Deonar Bus Depot, Mumbai.
82. Ambika Blood Bank, Shop No. 1 K. K. Smruti Apt, New Maneklal Estate, Ghatkopar(W)-400 086, Dist-Mumbai. Tel. - 5124322.
83. Anviksha Pathological Laboratory Blood Bank, Paras Darshan, M. G. Road, Ghatkopar(E), Mumbai - 400 077, Dist-Mumbai. Tel- 5136290 / 5125997.
84. Ashirwad Blood Bank, Narayan Mansion, 166-A, Dr. Ambedkar Rd, Dadar

T. T, Mumbai- 400 014 Tel- 4154826.

85. Asian Heart Institute And Research Centre's Blood Bank, 1st Floor, G/N Block, Opp. ICICI Tower, Near UTI Bldg., Bandra Kurla Complex, Bandra (East), Mumbai-400051.

86. B. Y. L NairHospital, New OPD Building, 2nd Floor, Dr. A. L Nair Road, Mumbai Central, Mumbai - 400 008, Dist-Mumbai. Tel. - 3098150.

87. Bandra Holly Family Hospital Society Blood Bank, ST. Andrews Rd., Bandra (W), Mumbai- 400 050, Dist-Mumbai. Tel-.

88. Bhabha Atomic Reasearch Centre (BARC) Hospital Blood Bank(BARC) Hospital, Anushaktinagar, Mumbai - 400094, Dist-Mumbai. Tel. - 5563137-40 Ext - 337 / 338 / 339.

89. Bhatia General Hospital And Blood Bank, Tukaram Javaji Rd, Tardeo, Mumbai - 400 007, Tel. - 3071286 / 87 / 97.

90. Bombay City Branch Blood Bank, Indian Red Cross Society Shahid Bhagatsingh Marg, Mumbai - 400 001, Tel. - 2663195 / 2663560.

91. Bombay Hospital Trust Blood Bank, New Marine Lines, Mumbai - 400 020, Dist-Mumbai. Tel. - 2067676 Ext - 215.

92. Borivali Blood Bank, Vitthal Apartment Road, Near Ram Mandir, Borivali{W) - 400 103, Dist-Mumbai. Tel. - 8935219 / 6203.

93. Breach Candy Hospital And Research Centre, Bhulabhai Desai Road, Mumbai - 400 026, Dist-Mumbai. Tel. - 3633651 / 3685406 Ext - 285.

94. Cumballa Hill Hospital And Heart Institute Blood Bank, August Kranti Maidan, Mumbai. - 400 036, Dist-Mumbai. Tel. - 3803336 Ext- 737.

95. Desai Blood Bank, Mulphul Baug, S. V Road, Khar Post Office, Khar (W) - 400 052, Dist-Mumbai. Tel. - 6499687.

96. Desai Municipal General Hospital Blood Bank, T. P. S. 1TTH, Santacruz (E), Mumbai- 400 055, Dist-Mumbai. Tel- 6182081 / 83.

97. Dr. Babasaheb Ambedkar Memorial Hospital, Central Railway Hospital Blood Bank, Byculla (E), Mumbai - 400 027, Dist - Mumbai. Tel. -.

98. E. S. I. S Hospital, Worli, Mumbai-400 018, Tel- 4933142/3.

99. G. T. Hospital Blood Bank, Near L. T. Marg Police Station, Mumbai - 400 001, Dist-Mumbai. Tel. - 2630552 / 53.

100. Greencross Immuno -Diagnostics Centre & Path Laboratories Blood Bank, Kamleshwar, Opp. Laxmi Narayan Temple, 40, Tagore Rd, Santracruz(W), Mumbai- 400 054, Dist-Mumbai. Tel-.

101. Haematology Laboratory, Parekh House, 14, Mama Parmanand Marg, Mumbai - 400 004, Dist-Mumbai. Tel- (369)-1297.

102. Harilal Bhagwati Hospital Blood Bank, S. V. P Rd, Borivali (W), Mumbai - 400 103, Dist-Mumbai. Tel. -.

103. Harkisandas Marottamdas Hospital Blood Bank, Rajaram Mohan Roy Marg, Prathana Samaj, Mumbai - 4 Tel. - 3855555/3822708.

104. Hi-tech Blood Transfusion And Allied Services, Jignesh Apt, Sainath Rd, Malad (W), Mumbai - 400 064, Tel. - 8886484 / 8808287.

105. Holy Spirit Hospital Blood Bank, Holy Spirit Hospital, Mahakali Road, Andheri (E), Mumbai - 400 093, Dist-Mumbai. Tel. - 8378822.

106. INHS Ashwini Blood Bank, The Commanding Officer, INHS Ashwini, Colaba, Mumbai - 400 005, Dist-Mumbai. Tel. - 2151666 Ext-3264.

107. Jaslok Hospital And Research Centre, 15, Dr. G. DeshmukhMarg, Mumbai-400 026, Dist-Mumbai. (d - 6422361 / 65.

108. K. B. Bhabha Municipal Hospital, R. K Patkar Marg, Water Field, Bandra (W) -400 050, Dist-Mumbai. Tel. -.

109. K. E. M Hospital Blood Bank, Parel, Mumbai -400 012, Dist-Mumbai. Tel. - 4136051 Ext-2016, 4135189. Fax-4185678

110. K. J. Somaiya Blood Bank, S. Ayurvihar Complex, Eastern Express Highway, Sion, Mumbai - 400 022. Tel. -

111. Lilavati Hospital & Research Centre Blood Bank, A -791, Bandra Reclamation, Bandra (W) Mumbai - 400 050, Tel. - 6455891 Ext - 2223.

112. Lokmanya Tilak Muncipal Medical College Blood Bank, Municipal Hospital, Sion, Mumbai - 400 022, Dist-Mumbai. Tel. - 4095099.

113. Malti Mohan Jeevak Trust Blood Bank, 1st Floor, Flat No. 192, Sai Kunj, Jeevak Hospital, Dadar (E)Mumbai - 400 014.

114. Mumbai Port Trust Hospital Blood Bank, Nadkarni Park, Wadala (E)Mumbai -400 037, Dist-Mumbai. Tel. - 4145100 Ext-5722.

115. Nowrosjee M. Wadia Hospital Blood Bank, Acharya Donde Marg, Parel, Mumbai - 400 012, Dist - Mumbai. Tel. - 4146963.

116. RD. Hinduja National Hospital And Medical Research, Veer Savarkar Road, Mahim, Mumbai - 400 016, Dist-Mumbai. Tel. - 4447752.

117. Paras Pathological Laboratory And Blood BankRidge Rd, Malbar Hill, Sheenathji Polyclinic, Near Teenbatti Mumbai-400006, Dist-Mumbai. Tel. - 3631017.

118. Petit Parsee General Hospital Blood Bank, Petit Marg, Cumballa Hill, Mumbai 400 036, Dist-Mumbai. Tel. -.

119. Pooja Blood Bank, 63-A, Air Auto House, P. K. Road, Mulund (W), Mumbai-400 080, Dist-Mumbai. Tel. - 5693688.

120. Prince Ali khan Hospital Blood Bank, Aga Hall, Nesbit Road, Mazgaon, Mumbai-400010, Dist-Mumbai. Tel. - 3754343.

121. R. N. Cooper Municipal General Hospital Blood Bank, Juhu, Vile Parle, Mumbai400 056, Dist-Mumbai. Tel. - 6207254 / 56 /58 Ext - 263.

122. Rajawadi Hospital Blood Bank, Seth V. C. Gandhi & M. V. Vora Muncipal General Hospital, Rajawadi, Ghatkopar(E), Mumbai-400 077, Dist-Mumbai.Tel. - 5115066 Ext-381.

123. Rashmi Blood Bank, Mani Vila, 124, M. P. Vaidya Marg, Ghatkopar: 77Dist-Mumbai. Tel. - 5135643.

124. Samarpan Blood Bank, 4/5/6, Swashraya Bldg, Ground Floor, Hingwala Lane, Near Swimming Pool, Ghatkopar(E)-77, Dist-Mumbai. Tel. - 5111313.

125. Shushrusha Citizens Co-operative Hospital, 698 B Ranade Road, Dadar, Mumbai - 400028. Tel. 24449161-62-63.

126. Sir. J. J Groups of Hospitals, Blood Bank, Byculla, Mumbai. - 400 008, Dist-Mumbai. Tel. - 3739400.

127. Smt. M. T Agarwal Municipal General Hospital, Mulund (W)Mumbai - 400 080. Tel. - 5640767

128. St. George's Hospital Blood BankRegional Blood Bank, St. George's Hospital,Fort, Mumbai-400 001, Dist-Mumbai. Tel. - 2620344.

129. Sushilaben R Mehta & Sir Kikabai Cardiac Blood Bank, Basement Rooms No. 1-12, Plot No. 96, Rd. No. 3, Near Gandhi Mkt, Mumbai-22 Tel. 4035455.

130. Tata Memorial Hospital Blood Bank, Dr. E. Borges Rd, Parel, Mumbai - 400 012, Dist-Mumbai. Tel. - 4127096/4161413.

131. Vaidya Blood & Component Pvt Ltd. (Chetna Blood Bank & Component Pvt. Ltd.) 1st Floor, Urmila Complex, B. K. Sandhu Marg, Chembur(E), Mumbai -400 071, Dist-Mumbai. Tel. - 5296716.

132. Smt. kapoorben Vasanji Lathiya Blood Bank, (Nanavati Hospital Blood Bank), S. V. Road, Vile Parle (W), Mumbai -400056, Tel. -.

NAGPUR

133.Ayush Blood Bank, Plot No. 7, Garud Khamb, Gandhi Putla. Central Avenue Gandhi Baug, Nagpur-440 018, Dist-Nagpur. Tel. - 770666.

134. Central Blood Bank, 1 st Floor, Parvati Towers, Indora Chowk, Kamptee Rd, Nagpur-440 017, Dist-Nagpur. Tel. - 641215.

135.City Blood BankDwarka Sadan, 1 st Floor, Opp. Daga Hospital, GandhiBagh, NagpurDist- Nagpur. Tel. - 48615 / 44751

136. Daga Memorial Women Govt. HospitalGandhibag, Nagpur-440 002, Dist-Nagpur. Tel. -.

137. Dr. Hedgewar Blood Bank, 2, Sitaram Smruti, W. H. C Rd, Dharmpeth, Nagpur-440 010, Dist-Nagpur. Tel. - 528292 / 538900.

138. Govt. Medical College Blood Bank, 2nd Floor, Nagpur - 440 003, Dist-Nagpur. Tel- 744671 Ext-229.

139. Indira Gandhi Medical College & Hospital Blood Bank, Rammandir, Nagpur - 440 002, Dist- Nagpur. Tel. -.

140. Jeevan Jyoti Blood Bank and components, Wing No. ll, Block - A, 1st fir, J. P. Chamber, Madhav Nagar. Nagpur - 440 010 Dist. - Nagpur.

141. Lifeline Blood Bank, Component & Apheresis CentreNeeti Gaurav Complex, 2nd floor, Central Bazar Road, Lokmat Square, Ramdaspeth, Nagpur - 440010. Tel. 0712-536167-70.

142. Mure Memorial Hospital Blood Bank, Mure Memorial Hospital, Maharaj Bagh Rd, Sitabuldi, Nagpur-440 001, Dist. -Nagpur. Tel. - 523220.

143.R. S. T Cancer Hospital Blood Bank, Manewade Rd, Tukdoji Chowk, Nagpur-440 003, Dist. -Nagpur. Tel. - 748155 / 744441.

144. Rainbow Medical Services & Research Trust, M/s. Rainbow Blood & Component Bank, III rd Floor, Rainbow Medinova Diagnostic Services, 282 Central Bazar Road, Ramdaspeth, Nagpur-440010. Tel. 560101/102/ 103.

145. Shri. Sainath Blood Bank, Vinayak Apt, Ground Floor, Near Lakmat Square , Dhantoli, Nagpur-440 010, Tel. - 548151 / 552035.

146. SuperSpeciality Hospital & Medical Post Graduate Institute Blood Bank, Manewade Rd, Near R. S. T Cancer HospitalNagpur - 440 033, Dist. - Nagpur. Tel. - 746681 Ext-215 / 284.

147. Wankar Blood Bank, Rajkamal Complex, Panchsheel SQR, Wardha Rd, Nagpur - 440 012, Dist- Nagpur. Tel. - 523902.

NANDED

148. Govt. Medical College, Shri Gurugovind Shindji Memorial Hospital Ground Floor, St. wing, Survey No. 27, Nanded. Tel. - 35711/19.

149. Indian Red Cross Society Blood Bank, Parsi Anjuman Complex, Vazirabad, Nanded - 431 601, Dist. - Nanded. Tel. - 36699.

150. Sanjeevani Blood Bank, Travels Line, 3-1-297/1, Ghamodiya, Dayma Complex, Nanded - 431 601, Dist. - Nanded. Tel. -.

NASHIK

151. Ansar Blood Bank, Guruwar Ward, Khushamadpura, Chunabhatti, Malegaon, Dist- Nashik. Tel. - 431671.

152. Arpan Blood Bank & Blood Component Laboratory & Research Office No. 102, 103, Dr. Athawale Chamber, Opp. Gavkari Press, Tilak Road, Nashik-422 001, Dist-Nashik. Tel. - (0253)-311358.

153. City Blood Bank, S. No. 261/1, Kaveri Complex Balajiwada Tilak Road, Nandurbar, Nasik. Tel. - 02564-26400.

154. Civil Surgeon, Civil Hospital Blood Bank, Trimbak Road, Nashik Dist- Nashik. Tel. - 576106. Ext-216.

155. Diagonostic Centre Blood Bank (Service Of Society), Umiya Apt., A-wing, 2nd Fir, Canada Corner, Sharanpur Rd, Nashik - 422 005, Dist- Nashik.

156. Dr. G. M. Bhavsar Charitable Trust Blood Bank, Chidhade Lane, Post - Malegaon, Nashik - 423 203, Dist- Nashik. Tel. - (0255)-430543.

157. J. D. C. Bytco Hospital Blood Bank, Bytco Hospital, 1st Flr, Shhu Rd, Nashik Road, Nashik-422 101, Tel. -

158. Jankalyan Blood Bank, Umiya Apt, 2nd Flr., Dr. Hegdewar Chowk, Canada Corner, Sharanpur Rd, Nashik - 422 005. Tel. - 573493.

159. Rochabai Sugnomal Namwani Blood Bank, Cantonment Generel Hospital, VannerRd, Devlali Camp-444 401, Dist-Nashik. Tel- (0253)-541377

160. Seva Blood Bank, Nilkanth Building, Satana Naka, Satana Road, Malegaon, Dist. Nasik.

NEW MUMBAI

161. JVP Blood Bank & Transfusion Centre, 213 Arenja Arcade, 2nd Floor, Sector 17, Vashi, New Mumbai- 400705.

OSMANABAD

162. General Hospital Blood Bank, Civil Hospital, Osmanabad-413 501, Dist. - Osmanabad. Tel. - 26498.

163. Shrikrishna Blood Bank, Patanga Hospital Bldg, Ajay Nagar, Omarga, Tal - Omarga, Osmanabad -413 606Dist. - Osmanabad. Tel- 52004.

PARBHANI

164. General Hospital Blood Bank, General Hospital, Parbhani - 431 401, Dist-Parbhani. Tel. - 20037 Ext-14.

165. Gurumita Pathalogical Laboratory H. No. 91, Sadanand Krupa, Dr. R. P. Rd,Nr. RailwaySt., Parbhani-431401, Tel. - (02452)-23402.

166. Priyadarshani Blood Bank, ParbhaniDist- Parbhani. Tel. -

PUNE

167. Acharya Anandrushiji Blood BankSadashiv Peth, Poona Hopital & Research Centre, Pune-411 030, Dist-Pune. Tel. - (020)-4337627.

168. Akshay Blood Bank, Survey No. 2A/1/2, Unnatinagar, Gadital Hadapsar, Saswad Rd, Pune-411 028. Tel. - 6993247/48.

169. Armed Forces Blood Bank, Dept of Blood Transfusion, AFMC, Wanwari, Pune - 411 040, Dist-Pune. Tel. - 673290 Ext - 6037 / 38.

170. Bharati Hospital Blood Bank, Sector No - 28, Dhankawadi, Pune - 411 043, Dist-Pune. Tel. - 5711161/ 575182.

171. Deenanath Mangeshkar Hosp. & Res. Centre Blood Bank, 8/13/2, Erandawane, Near Mhatre Bridge, Pune -411 004(s400300, 402307.

172. Deendayal Memorial Hospital Blood Bank, Fergusson College Road, Pune - 411 004, Dist-Pune. Tel. - 5652497 / 5655657,

173. Dr. C. T. Shah Memorial Blood Bank, Dr. C. T. Shah Hospital Bldg., Daund, Dist. Pune (s02117-63938.

174. E. S. I. S. Hospital Blood Bank, Aundh, Pune-27. Tel. - 720104.

175. Garware Blood Bank, Talegaon General Hospital & Convalsent Home, Talegaon, Dhabhade Tal -Maval, Dist-Pune. Tel. - (02114)-26431.

176. Indian Red Cross Society (Late Manikbai Chandulal Saraf Blood Bank) Near Silver Jubilee Hospital, Baramati-413 102, Dist-Pune. Tel. -.

177. Indian Serological Institute Blood Bank, Anand Baugh, Navi Peth, Near

Vaikunth, Pune - 411 030, Dist-Pune. Tel. - 4335244 / 9906.

178. Inlaks & Budharani Hospital Blood Bank, Koregaon Park, Pune - 411001 Dist-Pune. Tel. -.

179. Jankalyan Blood Bank, 1003, Shukrawar Peth, Saras Baugh, Swargate Near Natraj Hotel, Pune -411 002. Tel. - 4441462 / 9527.

180. Jehangir Nursing Home Blood Bank, Superitendant Sasoon Road, Pune - 411001, Dist-Pune. Tel. - 020-622551 Ext-3122 / 33.

181. Lions Club of Shivneri Blood Bank, S. No. 253/2, Datta Prasad, Ward No. 4, Prop. No. 579, 2nd Floor, Pune - Nasik Rd., Narayangaon, Tal - Junnar, Dist. Pune.

182. Lokmanya Medical Foundation Blood Bank, 314/1/2, Ground Floor, Chinchwad, Pune - 411 033, Dist-Pune. Tel. - 759222.

183. Mathurabai Vasistha Blood Bank, K. E. M. Hospital Sardar Moodliar Road, Rastha Peth, Pune - 411 001, Dist-Pune. Tel. - 625600 Ext - 324.

184. Narayandas Ramdas Shah Blood Bank, S. No. 663/B, Shah Sanskrutik Bhavan, P. No. 353, Malwadi Rd. Indapur, Pune

185. Pune Chest Hospital Blood Bank, Aundh Camp, Pune -411 027, Dist- Pune. Tel. - 720603 / 720237.

186. Sasoon General Hospital Blood Bank, Ground Floor, Block No. 5, Pune - 411 00, Tel- 020-628000.

187. Talera Hospital Blood Bank, Pimpri Chinchwad Muncipal Corporation, Tanaji Nagar, Chinchwad, Pune - 411 033, Dist-Pune. Tel. - 757054.

188. Vishweshwar Blood Bank, CTS 171-A Padmashree Dr. Dy. Patil Medical Collegefor Women & Hospital, Pimpri, Pune- 18. Tel.: 7423844.

189. Wadia Trust Blood Bank, Poona Medical Foundation Sasoon Road, Ruby Hall Clinic, Post Box No. 70, Pune -411 001, Dist-Pune. Tel. - 636318 / 623391-98.

RAIGAD

190. District Blood Bank, B. B Civil Hospital, Taluka - Alibaug, Raigad - 402 201, Dist. -Raigad Tel. - (02141)-24457.

191. Jankalyan Blood Bank, Prop Late Kakasaheb Chitale Smruti Centre, Sarve No. 158/2, Jawahar Colony, Tal. Mahad, Dist. -Raigad. Tel. - (02145)-22604.

192. Late Dr. B. V. Limaye Blood Bank, Plot No. 8, Sector-1, CIDCO, Mumbai Pune

RoadKhanda Colony, New Panvel (W) - 410 206, Dist. -Raigad. Tel. - 7459322.

193. Shree Blood Bank, Shop No. 1, 2, 3, Yogeshwar Krupa, Old Thane Road,NearTaluka Police Station, Panvel, Dist. -Raigad. Tel. - 7450890.

194. Shree Swami Samarth Blood Bank, Ghar No. 412, 1st floor, Mangaon - Morba Road, Taluka - Mangaon, Dist. Raigad, Tel. 02140 - 61002.

RATNAGIRI

195. General Hospital Blood Bank, District Govt. Hospital, Ratnagiri - 415 612, Dist- Ratnagiri. Tel. -.

196. Indian Red Cross Society Blood Bank, Khareghat Road, Ratnagiri - 415 612, Dist- Ratnagiri. Tel. - (02352)-23262.

197. Shree Swami Samarth Blood Bank, At and Post - Dervan, Tal- Chiplun, Dist. Ratnagiri. Tel. 2355-34137, 34149

SANGLI

198. Blood Bank (Wanless Hospital)Miraj Medical Centre, Miraj - 416 410, Dist- SangIL Tel. - 22-2548.

199. General Hospital Blood Bank, General Hospital, Sangli - 416 416, Dist- Sangli. Tel. - 374651 / 54.

200. Indian Red Cross Society Blood Bank (Shirgaonkar Blood Bank) Opp. Civil Hospital, Plot No. 49, City Survey No. 601/7, Sangli - 416 416, Dist. -Sangli. Tel. - (0233)-373044.

201. Jeevan Rekha Charitable Trust, E/329, Ward No. 5, First Floor, Umarani Road, Jath, Dist. Sangli. Tel. No. (02344)48366

202. Rajaram Bapu Blood Bank, Near Christan Bunglow, Islampur, Sangli - 415 409, Dist. - Sangli. Tel. -.

203. Vasantdada Patil Blood Bank & Anu Haematological Research Centre, Mirasaheb Shopping Centre, Opp. City Police Station, Miraj-416410Dist- Sangli. Tel. -.

SATARA

204. Cottage Hospital Blood Bank, Plot. No. 290/91, Budhawar Peth, Station Rd,Karad, Dist- Satara. Tel. - 22459.

205. K. N. Gujar Memorial Hospital Blood Bank, Shaniwar Peth, T. P Scheme No. 2,

Final Plot No. 2Karad - 415 110, Dist- Satara. Tel. - 22868.

206. Krishna Hospital & Medical Research Centre, Near Debhewadi Road, Karad, Satara-415 110, Dist-Satara. Tel. - 41555/41556.

207. Late Sau Vijaya Mutha Blood Bank (Janseva Mandal), 529, B/1, Sadar Bazar, Satara-415 001, Dist-Satara. Tel. - (02162)23031/21586.

208. Phaltan Medical Foundations Blood Bank, Plot No. 16, Laxmi Nagar, Phaltan, Satara-415 523, Dist-Satara. Tel- 21197.

209. Sarva Samanya Hospital Blood Bank, Civil Hospital, Satara - 415 001, Dist-Satara. Tel. - 21494.

210. Swami Vivekanand Blood Bank, 1023, Saraswati Complex, Bramhan Shahi, Wai, Dist: Satara(s: (02167)2346.

SINDHUDURGA

211. General Hospital Blood Bank, Sindhudurgnagari - 416 812, Dist-Sindhudurga. Tel. - 28901(02362).

SOLAPUR

212. Chattrapati Shivaji Maharaj Sarvopchar Hosp. Blood Bank, O. P. D Building, 1st Floor, Shri. Chattrapati Shivaji Maharaj Hospital, Solapur - 413 003, Dist-Solapur. Tel. - 621221 Ext - 385.

213. Dr. Hedgewar Blood Bank, Sahyadri Shoping centre, Rly. Lines, Navi Peth, Solapur-413 001, Dist-Solapur. Tel. - 721215/281.

214. IMA, Sahakar Maharshi Shankarrao Mohite Patil Blood Bank, Old Pandharpur Road, GaneshNagar, Akluj - 413 101, Dist. - Solapur. Tel. -- (02185) - 22101.

215. Indian Red Cross Society, Sarjubai Bansila Bajaj Blood Bank, Bhakti Marg, Pandharpur-413304, Dist. -Solapur. Tel. - (02186)-23650.

216. Irapanna N. Bolli Blood Bank, Shri Markendya Charitable Trust & Medical Trust, 896/97, Bhavanarishi Peth, Bolli Mangal Karyalay, 1ST Floor, Ashok Chowk, Solapur - 413 002, Dist-Solapur. Tel. - 653829.

217. Rambhai Shah Blood Bank, 1 st Floor of Maternity Ward, Jawahar Hospital, Barshi. - 413 401, Dist- Solapur. Tel. - (02184)-22399.

218. Smt Gopabai Damani Blood Bank, Indian Red Cross Society, Dufferin Chowk, Red Cross Road, Solapur- 413 001, Dist-Solapur Tel. - 722106.

219. Solapur Blood Bank, 136, Aniani Chamber, Railway Lines, Solapur - 413

001, Dist-Solapur. Tel. - 627242,

THANE

220. Bassein Blood Bank & Component Centre, 23, Dewan No. 6 Premises co-op soc. Ltd., Plot No. 171 to 175, Navghar village, Vasai Rd. (E), Dist. Thane-401210 Tel. 95-250-390092.

221. Bhakti Vedant Hospital & Blood Bank, Sector-1, Shristhi Complex, Mira Road (E), Thane - 401 107, Dist-Thane. Tel. - 8126979.

222. Bhiwandi Blood Bank, H. No. 271, 1/2 Second Flr, Al- Hera Shopping Centre,Teen Batti, Bhiwandi, Dist. Thane-421302.

223. Central Hospital Blood Bank, Central Hospital Ulhasnagar- 3, Dist-Thane. Tel. -.

224. Chhatrapati Shivaji Maharaj Hospital Blood Bank, Kalwa, Thane - 400 605,Dist-Thane. Tel. - 5372774 - 89 Ext - 437.

225. Chidanand Charitable Trust Blood Bank, 2nd Floor, Shastrinagar 1 General Hosp, Kopar Rd, Dombivli (W) - 421 201, Dist-Thane. Tel. - 484393.

226. Civil Hospital (Vitthal Sayanna) General Hospital V. S. G Hospital, Tembhi Naka, Thane(W) - 400 601, Dist-Thane. Tel. - 5471541.

227. Mahatma Gandhi Mission Hospital Blood Bank, Sector-18, Kamothe, Navi Mumbai-410 209, Dist-Thane. **Tel.** - 7422459 / 3002 Ext -109.

228. Makhecha Pathology & Blood Bank, Dwarkadas Ratanshi Mansion, 147 Station Rd., Near Collector's Office, Thane (W) - 400 601, Dist-Thane. Tel. - 5341929.

229. Navi Mumbai Muncipal Corporation Hospital Blood Bank, Navi Mumbai Muncipal Corporation Hospital, Sector- 5, ESIS Hospital Bldg, 2nd Floor, Vashi, Navi Mumbai, Dist - Thane. Tel. - 7823190 / 7822779.

230. Navjeevan Blood Bank, Prakash Bhavan, Next to Dr, Mhaskar Hospital, Gokhale Road, Naupada, Below Allahabad Bank, Dist-Thane. Tel. -.

231. Patangshah Cottage Hospital Blood Bank, At Post - Jawahar, Thane - 401603, Dist-Thane. Tel- 02520/22407.

232. Plasma Diagnostic Laboratory & Blood Bank, Megdhoot, Behind Hotel Janaki, Opp. Manjunath HighSchool, Kalyan Road, Dombivali (E), Dist-Thane. Tel. - (911)-431932.

233. Sanjivani Blood Bank (Swami Vivekanand Medical Mission's), Sanjivani Hospital, Virar(W) - 401 303, Dist-Thane. Tel. - 502284.

234. Sankalp Blood Bank, Basement -2, **Riddhi** Siddhi Appt. Murbad Rd., Kalyan(W)-421304, Dist. Thane. Tel. 95251-894321.

235. Saria Blood Bank, Ravi Hospital, 1st Floor, 50, Anand Nagar, Veer Savarkar Nagar, Navghar, Vasai (W) - 401 202, Dist-Thane. Tel. - 912 - 332684.

236. Sri Satya Sai Blood BankPatkar Building, 2nd floor, Opp. Canara Bank, Patkar Road, Dombivli (E)-421201, Dist-Thane. Tel. - 449447.

237. Thane Small Scale Industries Association Blood Bank, TSSIA House Next to Thane Janata Sahakari Bank Rd No. 16/T, Wagle Estate, Thane (W) - 400 602. (s5971196 / 5803263.

238. Vaidya's Blood Bank, (Chetna Blood Bank & Component Pvt. Ltd.) 1st Fr. Vijay Niwas, M. G. Road, Naupada. Thane (W) - 400 602, Dist-Thane.

WARDHA

239. General Hospital Blood Bank, New OPD. Bldg., First Floor, Wardha - 442 001, Dist. - Wardha. Tel. - 43066.

240. Jawaharlal Nehru Medical College Blood Bank, Savangi(Meghe), Wardha - 442 004, Dist. - Wardha. Tel. - 40808 / 43542.

241. Kasturba Health Society Department Of Pathalogy MGIMS, Sevagram, Wardha - 442 102, Dist. Wardha. Tel. - 84341-55 Ext-265 / 273.

YAVATMAL

242. Aishwarya Blood Bank, First & Second floor, Plot No. 04 Surveu No. 3/2, Godhani Rd., Gurunanak Nagar, Mouza, Dist. Yavatmal-455001.

243. Gajanan Blood Bank, Satkar Bhavan, 2nd Floor. Home No. 68, Ward No. 9,Nehru Chowk, Yavatmal - 445 001, Dist. - Yavatmal. Tel. - 42985.

244. Laxmi Blood Bank, Chiddarwar Hospital, Motinagar, Pusad, Dist. - Yavatmal Tel. - 46535 / 46775 Std - [7233].

245. Nisha Blood Bank, 36, Shivaji Nagar, Yavatmal, Dist. - Yavatmal. Tel. - (07232) 44866

246. Satyshanti Blood Bank, Second Flr. Satyashanti Hosp. Opp. Bus stand at pusad - 445204 Dist. Yavatmal. Tel. 46095, 48095.

247. Vasantrao Naik Blood Bank, Govt. Medical College & Hosp Yavatmal - 445 001, Dist. - Yavatmal. Tel. - 42456.