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Review Article

Innovative Practices In Transfusion Medicine: New Opportunities

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Introduction:

Various innovations have taken place in the field of transfusion medicine to enhance the blood safety but their implementation varies from developed countries to developing and under developing countries. Only selective innovations are being followed in developing countries including India because of cost constraints & lack of policy decisions.[1] The innovations which have taken place in last couple of decades are:

1. Blood donor policies, collection of blood, processing & storage

2. Laboratory testing technologies including infectious markers screening & Immuno- haematology (Blood group serology) [2]

3. Better Patient Blood Management

Blood donor policies & collection of blood, processing & storage

It was in 1971, Professor Richhard M.Titmus at London school of Economics published the concept to Gift Relationship: from human blood to social policy. The impact of this was far reaching to change the policy of collecting blood from paid blood donors to voluntary blood donors as this was proven after testing that infection rate in voluntary blood donors is less compared to voluntary blood donors.[3]

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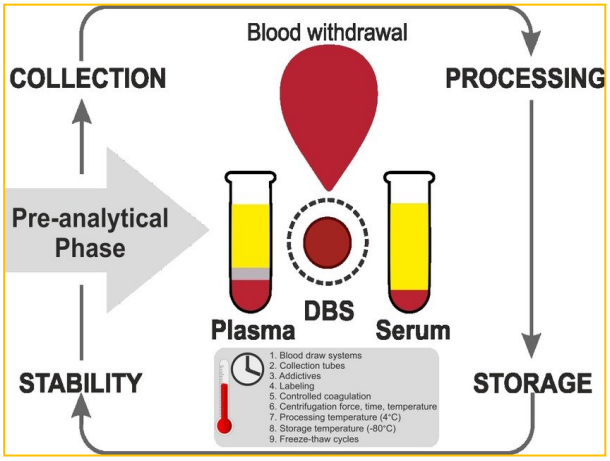


Fig 1. Blood Collection and Processing System

Advancements at the donor selection, blood collection, processing and storage

After general physical examination of blood donor, haemoglobin estimation is the first test in blood donor selection. This test has undergone innovation from Hemoglobincyanide (HiCN) Method/ Sahli's Method which are time consuming to point of care (POC) testing with new technology like hemocue that measures haemoglobin on board spectrum photometry. The development of sterile disposable plastic blood collection bags (double, triple, quadruple, quintuplebags with sample collection pouch) along with the innovations in the anticoagulant preservative solution, additives made the preparation of blood components easier & practical. Automation in component separation has decreased the man-hours and improved the efficiency and quality of blood components. With the introduction of blood collection bags with integral leucocyte filters, the process of providing leucoreduced blood components became easer & practical thereby improving the blood safety.[4]

The innovation of apheresis technology using cell separator machines (both continuous & discontinuous) for the collection of single donor platelets, single donor plasma, granulocytes, double unit red cells and peripheral blood progenitor cells has great impact in the modern transfusion therapy.[5]

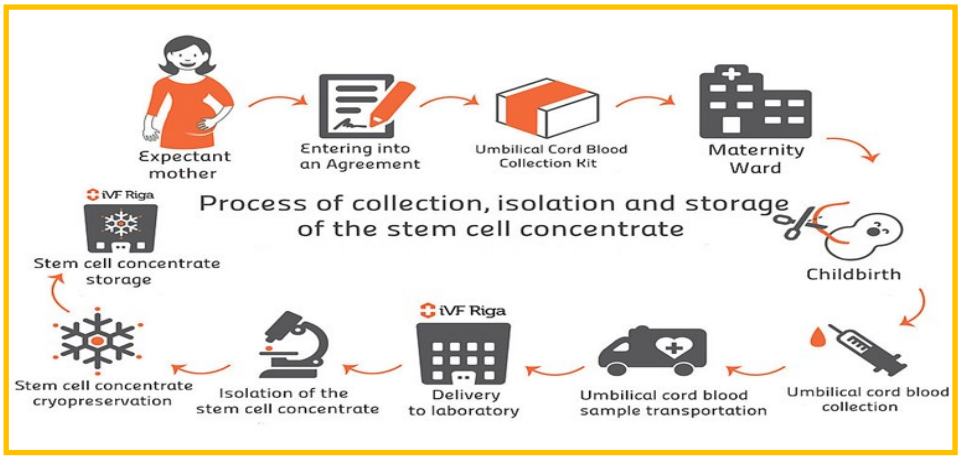


Fig 2. Process of collection, isolation and storage of the stem cell concentrate

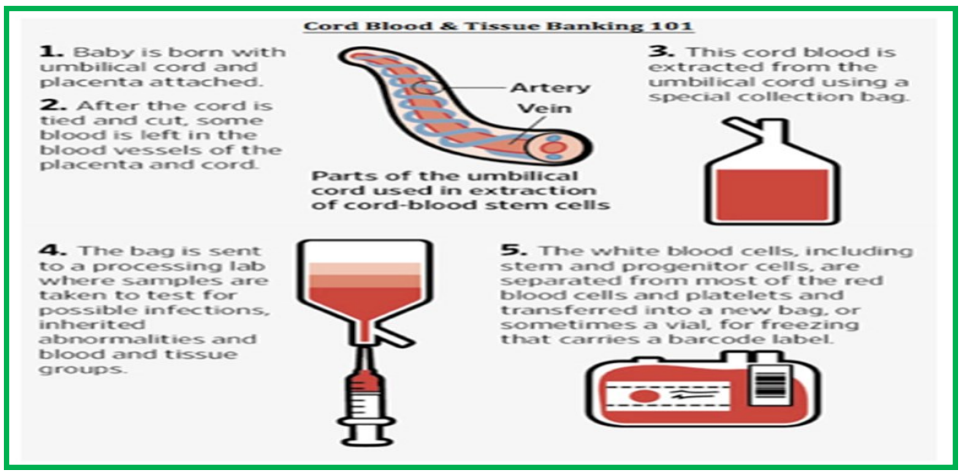


Fig 3. Cord Blood & Tissue Banking

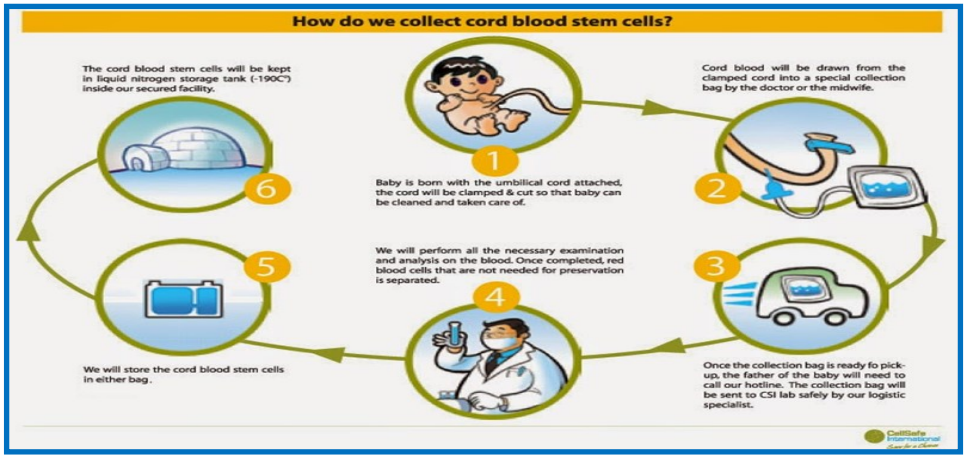


Fig 4. Cord Blood Stem Cells Collection

Testing technologies

The innovation in testing technologies both in immunohaematology (blood group serology) & infectious markers screening has greatest impact on blood safety.[5] The innovation in Immuno-haematology laboratory (blood group serology) the back bone of blood banking has moved slowly from tile/slide/ tube/semi-automated to fully automated technologies. Most recent innovation in immunohaematology laboratory is the functional or cellular immunoassay such as monocyte monolayer assay, antibody dependent cellular cytotoxicity assay and chemiluminescence test. The development of monoclonal antibody reagent was the greatest innovation in blood group serology laboratory. The innovation of molecular typing in going to have an important impact in blood group serological laboratory. [6]

Fig 5. Gel method for grouping and cross matching of blood

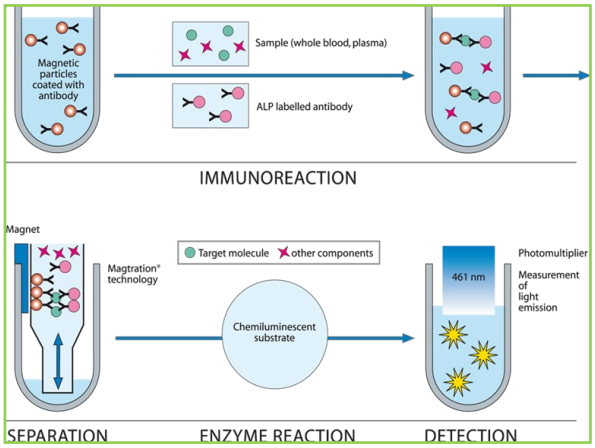


Fig 6. Principle of Chemiluminescence

Infectious markers testing laboratory

The development of Enzyme Immuno-Assay (EIA) for infectious markers screening has greatest impact on blood safety. The transfusion transmitted infection testing has taken a paradigm shift from rapid assays to ELISA and CLIA to Nucleic Acid Amplification tests (NAAT) thereby improving the blood safety drastically. HBsAg testing was introduced in the year 1968, followed by HIV in 1985 and HCV in 1990 in developed countries. Indian made HCV testing mandatory in 2000. In-spite of all these tests, there remains no zero risk blood. To further minimize the gap to known pathogens and eliminate the unknown, pathogen reduction techniques came into play which by use of different methods like solvent-detergent, amotosalen, riboflavin for inactivation by different principles. Verax PGD has evolved as a good POC testing for bacterial detection.[7]

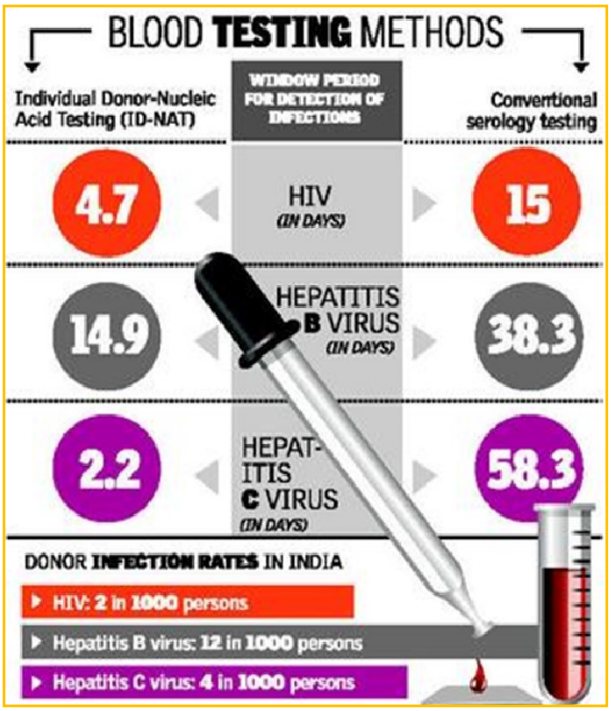
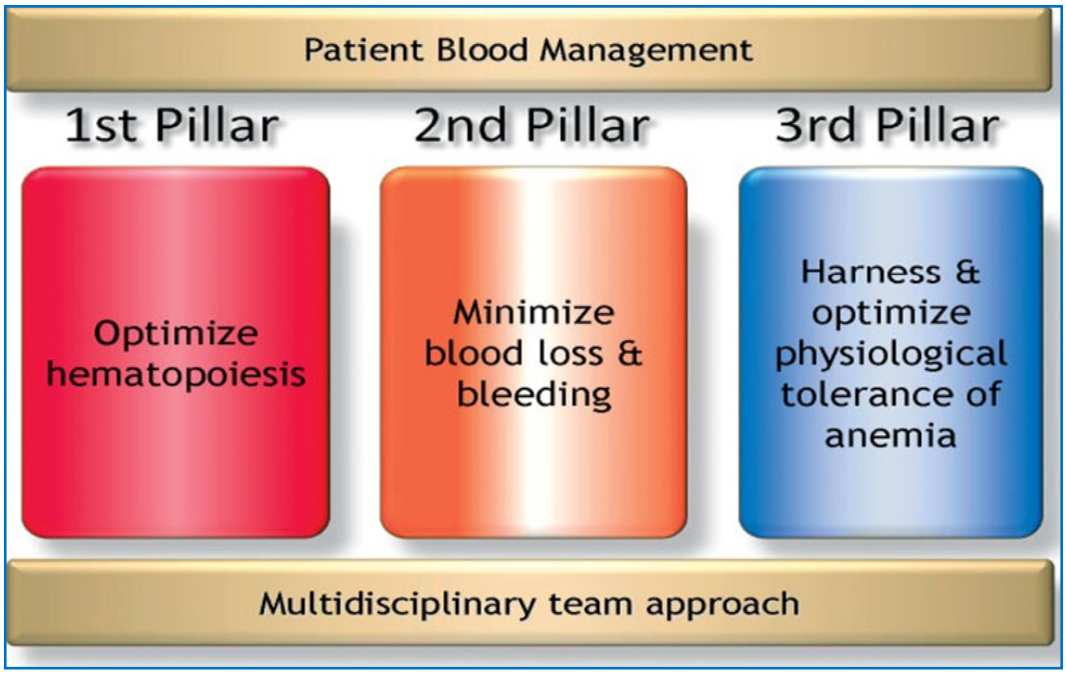


Fig 7. Comparative study between ID-NAT & Conventional serology testing

Patient Blood Management (PBM)

Introduction of PBM has revolutionized the clinical transfusion medicine specialist and has gained momentum over the last decade. Proper patient assessment, judicious use of blood and blood components with adherence to maximal surgical world since a long time are becoming more popular in the country.[8] Increase in demand for apheresis product due to better responses has lead double unit collection for platelets and multi-component apheresis more common.[9]

Introduction of recombinant products like Recombinant factor VIII (Recombinate), Recombinant factor IX (Bebefix). Recombinant factor VII (Novoseven), vWf, AT III, Alpha1 protease inhibitor, haemopoietic growth factors like EPO, G-CSF, GM-CSF, TPO, ILS, TNF have increased the efficacious management of various conditions with minimizing the side effects. The ease of mobilization, collection and success of peripheral blood stem cells has mostly taken over the invasive harvest of bone marrow and it transplantation.[10] The science of transfusion is ever evolving and newer concept keep cropping up like dendritic cell therapy, CAR-T cell therapy, vigilance programs and artificial blood. It is the time frame when introduced into practice to call it a newer addition to the existing knowledge.[11]



Conclusion:

The field of transfusion medicine began 100 years ago, in 1990, with the discovery by Landsteiner of the ABO blood group system. This discovery demonstrated that plasma protein have defined specification. These plasma proteins, later termed antibodies, recognize epitopes on red blood cells. These discoveries constituted a starting point for blood banking. During the past 3 to 4 decades, significant advances have been achieved in improving the blood supply with respect to availability, safety and fractionation into components, such as red blood cells, platelet concentrates, and plasma proteins.[11]

Research Opportunities	Major Forecasts
Improved blood transfusion practices	**Optimal blood utilization**
♦ Develop measures to assess parameters for transfusion and the quality of blood prior to transfusion and to improve blood administration practices.	♦ Prevention of over transfusion & under transfusion ♦ Improvement of efficacy ♦ Prevention of adverse effects
Pathogen inaction	**Safety of blood supply**
♦ Develop in vitro approaches to PI and Leukocyte inactivation ♦ In vitro manipulation of blood products	♦ Prevention of TTI and leukocyte related adverse effects ♦ Artificial blood substitutes
Plasticity and commitment of multi potential stem cells	**Development of tissue regenerative medicine**
Advancement in **c**ytokines/chemokines in hematopoietic development	Advances in collection, storage and ex vivo expansion of stem cells for transplantation or gene therapy
♦ Mechanism of alloimmunization to blood cells & plasma proteins	♦ Treatment/Prevention of alloimmunization
♦ Approaches to tolerance induction to allogeneic cells ♦ Prediction of alloimmunization	♦ Prevention of platelet refractoriness ♦ Prevention of HDN/TA-GvHD ♦ Prevention of hemolytic reaction
Immunobiology of bone marrow & circulating lymphocytes	Development of novel cellular therapies Immunotherapies

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