Perspective

Solving problems in Blood transfusion with efficient technology

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Abstract:
Blood transfusion is a life-sustaining procedure. But there are several hurdles in safe blood administration which can cause transfusion transmitted infections (TTI) and acute transfusion reactions and even death. Besides, human errors anywhere in the transfusion chain add fuel to the fire. Blood borne Infections like Hepatitis B and Hepatitis C are highly prevalent in Pakistan affecting about 7.4% of the general population. Among acute transfusion reactions, Febrile nonhemolytic reaction and the allergic reaction are the most common. Moreover, a variety of human errors and near-miss events in transfusion have been reported in the past. Technology has played an important contribution in upgrading the quality of life and healthcare. The main goal of this review is to point out the problems in blood transfusion and to hint at possible solutions with the use of Technology. In addition to following the WHO strategies for safe blood transfusion, blood safety can be ensured by incorporating haemovigilance systems, pathogen reduction technologies and certain approaches to reduce the risk of bacterial contamination. Human errors can be halted via a Management Information System called "Blood Bank Management Information System (BBMIS)" which can recognize and arrest such errors simultaneously.

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Introduction:

Blood transfusion is done primarily for sustaining the life and health of patients with transfusion dependent thalassemia, anaemia with deteriorating health, intense injury, surgeries, haemorrhage and pregnancy-related complications. In addition to whole blood, certain blood products like RBCs, fresh frozen plasma (FFP), platelets and cryoprecipitate are usually transfused. Convalescent plasma was trialled in the treatment of COVID19[1].

About 118.4 million donations are collected globally each year. WHO has recommended the screening of blood for at least four major infections transmitted via blood: HIV, Hepatitis B, Hepatitis C and Syphilis. In this regard, screening of blood for infections and removal of infected blood from the supply is of utmost significance. Blood banks play a pivotal role in the healthcare system of any country by providing aseptic and matched blood, thus contribute to save lives and improve health of patients. The major goal of blood banks is to ensure safe blood banking practices to halt the spread of such infections. A safe blood supply consists of collecting blood from the donor, proper screening, storage and finally transfusion to a compatible recipient using sterile supplies and aseptic techniques during the whole procedure[2].

Every year about 3.5 million blood donations are carried out in Pakistan[3]. Blood borne Infections like Hepatitis B and Hepatitis C are highly prevalent in Pakistan involving about 7.4% of the general population[4]. Transfusion carries a high risk of such infections if donors are not properly screened. According to a systematic review, the cumulative frequency of HBV, HCV, HIV, syphilis and malaria was 2.04%,2.44%,0.038%,1.1% and 0.11% respectively among the donors upon screening. Furthermore, not all the donors are screened for syphilis and malaria. Also, there is a lack of proper rep-

orting of Transfusion Transmitted Infections[5].

Transfusion is always associated with some risk of unfavourable reactions, which vary depending on the type, severity of the reaction and the patient's susceptibility for it. Such reactions are collectively termed as "Adverse transfusion reactions". It can be an immediate reaction or a delayed type of reaction. Similarly, depending upon the pathogenesis, it can be an immune or nonimmune type of reaction. According to the recent cross sectional studies conducted on tertiary care units in Pakistan, Febrile nonhemolytic reaction and allergic reactions are the most common acute transfusion reactions[6]. Other transfusion reactions include: Transfusion-transmitted infection (TTI), acute haemolytic transfusion reaction (AHTR), delayed haemolytic transfusion reaction (DHTR), Transfusion associated acute lung injury (TRALI) and Transfusion associated circulatory overload and Graft vs. host disease (TAGVHD).

To ensure safety and effectiveness in transfusion, Safe blood transfusion program (SBTP) was initiated by the government of Pakistan with the assistance of German government. Upgradation of 59 existing hospital blood banks and development of 10 modern Regional Blood Centres (RBCs) nationwide was carried out in the first phase of this project (2010-16). The second phase of this project is underway and will help further improve the system of blood transfusion in Pakistan on its completion. It includes further growth of RBCs' network and upgradation of existing Hospital Based Blood Banks (HBBs)[1]. Complete implementation of this program at the national and provincial levels will provide a strong base to guarantee the safe and efficient supply and administration of blood products all over the country.

Technology has brought revolution in many areas of life both in terms of quality and quantity. Extensive market search for IT solutions resulted in data collection and data flow software enabling high throughput with a paperless system. It is not uncommon to use the technology in different fields of healthcare for the purpose of identifying and preventing the human errors at the same time[7-9].The purpose of this review is to suggest possible solutions to the several problems in blood banking and transfusion with the use of technology.

Method:

In this study, the published articles related to transfusion were searched using online search engines like "PubMed" and "MEDLINE". Using the terms "transfusion problems", "blood transfusion in Pakistan", "blood banking", "human errors in blood banking" in combination with the "use of technology" published articles from May 2002 to May 2022 were selected and reviewed by all authors.

Blood safety:

All the blood services, need to follow the following important measures, as suggested by WHO, to make sure that blood to be transfused is safe for administration:

1. It is recommended to have a **coordinated national system,** which can guarantee that all the recipients avail the required amount of blood in proper time.

2. Strict measures are to be taken while **selecting a low-risk donor** who must provide blood voluntarily without any objective of gaining profit of any sort.

3. Since a variety of infections can be transmitted via blood, all blood to be transfused is required to be **screened in a proper fashion**. Moreover, blood grouping and the process of matching are crucial before administration.

4. We all know that arranging blood for transfusion is not an easy task, so blood and related products **should be reserved** for only those cases whose lives are dependent on it. Otherwise, IV fluids and measures other than transfusion should serve the purpose.

5.Quality systems should be properly implemented which include quality management, standards, training of all staff and quality assessment.[2]

Although certain measures like taking a detailed history of the donor and donor blood screening have increased the safety of the blood product, there is still a risk of pathogen-related complications in the recipients. Technology can help prevent such complications:

Hemovigilance Systems:

Hemovigilance (HV) is an important tool for the monitoring of the entire blood chain. It helps to improve safety and quality during blood donation and transfu-

sion. At present, HV is practically absent in Pakistan. Implementation of HV in Pakistan will require a significant amount of effort and time. The initial step to be taken is the foundation of Hospital Transfusion Committees in hospitals. The Authority has asked all hospitals in Punjab to frame Hospital Transfusion Committees. Numerous medical hospitals in Lahore and some in other districts likewise have done it. These Hospital Transfusion Committees are required to team up with the Blood Transfusion Authority to arrange hemovigilance data. Furthermore, these panels will attempt to improve blood safety and perform audit of the utilization of blood in hospitals to guarantee its judicious use[10]. Information Systems can be applied in hemovigilance to collect, organize, and analyse the reports of transfusion reactions and adverse occurrences happening all over the national blood transfusion chain. An investigation which was conducted by gathering data from the "International Hemovigilance Network (IHN)", talked about the contribution of Information Technology in advancing Hemovigilance frameworks[11].

Pathogen Reduction Technologies:

To reduce the risk of Transfusion transmitted infectious diseases (TTIs), the use of pathogen reduction technologies is suggested. These technologies involve usage of solvent & detergent, a psoralen compound or riboflavin, the combination of the latter two with UV light to make pathogens in blood products non-infectious. In Europe, such a system has been active for more than a decade. However, its certain limitations should be taken into consideration. Even after the application of such technologies, there is still a chance that certain non-enveloped viruses and bacterial strains present in the blood are not inactivated. Moreover, the other limitations include cost increase, toxicity, alloimmunization, impaired cellular function[12].

Reducing the Risk of Bacterial Contamination:

To diminish the danger of microbial contamination of the blood product, a combination of following strategies can be applied:

- Disinfecting the venepuncture site with povidone-iodine or isopropyl alcohol with tincture of iodine.
- Using a diversion pouch during the collection, which gathers the initial few millilitres of blood that is likely contaminated.
- Performing either culture or rapid bacterial detection tests on the platelet products that are at high risk of getting contaminated. [12]

Human Errors in Blood Banking and the Role of IT:

Blood banking involves repetitive actions making it vulnerable to errors having fatal consequences. In the blood banking world, IT takes one human error to kill. Several incidents have been reported in the media regarding wrong blood transfusions in Pakistan[13,14]. According to some previous studies, human errors do occur during blood banking[15,16] and transfusion[17-21]. Such human errors, including the near misses as well the actual errors, have been reported via voluntary, anonymous and retrospective reporting approach in the past[22].

Practically all the blood banks face difficulties of process infringement and human errors i.e. mislabelling of a blood sample, erroneous handling of blood units and bedside error of the wrong patient's identification. Blood group editing is likewise a major issue. In 2016, technologists' editing was high at 1.6 % but diminished to 0.6 % in 2018. In 2016, a new blood bank information system was presented and entering the results was difficult initially which resulted in these errors[23].

Handling Errors Via Information and Communication Technology (ICT):

It is not uncommon to use the technology in different fields of healthcare for the purpose of identifying and preventing the human errors at the same time[8,24]. However, the problem of recognition and elimination of human errors in transfusion in our country was not addressed until **The Indus Hospital Blood Centre (TIHBC)** introduced a "Blood Bank Management Information System **(BBMIS)"** to be applied to recognize and arrest human errors in transfusion simultaneously. As soon as the human error occurs, the BBMIS will prevent the further proceeding of activity. The system minimized errors to zero or near zero, ensuring that all regulations were followed all the time, even in the face of high throughput. To achieve this purpose: First, A detailed list of all possible human

Table 1: *Strategies to identify different types of errors in transfusion* (22)

Sr. #	Type of error	Identification strategy
1.	Mismatch of the patient blood group: It can be due to "Wrong blood in tube (WBIT)" error or incorrect sample selection for testing.	Checking patient blood groups via management information system.
2.	When the unit is issued to the wrong patient	There is a verification of the blood component by the system at its issuance: ▪ For red cell products, the verification of the crossmatch of the unit. ▪ For fresh frozen plasma (FFP) and platelets, there is verification of the compatibility of the blood groups via charts contained in it.
3.	User tried to make a component that is unsafe for the patient	During an interview with the donor a detailed history of medicine intake and disorders is taken. The information system records and saves this data along with volume and time of collection of the unit from the donor. This prevents production of unsafe components. For example, if the person has a history of intake of aspirin it is not permissible to prepare platelets under such condition
4.	When there is no valid quality check of serology reagents	The system is designed to deny reach to the specific test worksheet and generates an alert signal if someone tries to start a test utilizing that reagent
5.	Misinterpretation of blood group	The system can verify results automatically in real-time via an incorporated truth table of all possible forward as well as reverse blood group reactions.
6.	Mismatch of the donor blood group	At blood group verification done just before the final allotting of the blood group to the blood bag, the system can match blood group results in real-time to identify any mismatch between the blood group on the vacutainer tube and the segment of the blood bag.
7.	When there is mislabelling of blood groups on the blood container	Donor is assigned an identification number. There is scanning of the blood group barcode label with the donor identification number and its auto-matching with the confirmed blood group of the donor.
8.	When the product to-be-wasted is rescanned for use after unit verification	The safety status of the unit is verified by the information system at each step of the blood banking after unit verification to prevent issuance of unsafe Blood product.

errors in the blood banking was prepared. Then, root cause analysis was performed on each of them and finally steps to prevent each error were defined[22].

Whilst the list of human errors is long, human errors can be divided into two major groups: Data entry errors and decision errors.

A) Data entry errors:

These can be avoided by:

- Minimizing the data entry fields to where unavoidable i.e. donor demographics
- Using option based drop-down selections and enabling rapid identical data entry formats
- Using Barcode scanning for transmission of critical data on Blood unit.
- Drugs and vaccine lists with autofill-colour coded
- Auto transmission of "action messages" to the individual performing the consecutive step in the process.

B) Decision errors:

These can be avoided by real time verification of all decisions performed by the software against the "truth tables" of all possibilities. The system is designed to verify each entry in such a way that it identifies the error at once, prevents further processing and notifies the user about that error through instructions displayed on the screen. In order to proceed further, the user has to correct that error. At the same time, the system alerts the admin via an email. There are HR productivity and performance reports which serve to identify measurable performance indicators[22].

Here is the table which describes different types of errors related to transfusion and provide strategies to identify them[22].

Results from a study based on a similar electronic system of blood transfusion in a hospital in Zhejiang, China not only ensured optimal accuracy in terms of recording the blood transfusion consent data but also proved this system to be a time saving and cost-effective investment[25].

Virtual Blood Banking:

Through virtual blood banking, it is now possible to place online orders of blood for transfusion and get their delivery done at remote areas simultaneously. Such system uses networked computers as a guide for the selection of appropriate blood to minimize the transfusion risks. The virtual blood bank can guarantee that the patient receives the exact amount of the right blood product on demand[26]. Though such system is not prevalent in our country, several efforts by local blood bank websites such as "TrueDrops", "Blood.pk", "Blood for All", "Pak Donor", "Mera Blood", "iDonate" and "Pak Blood" are noteworthy.

Conclusion:

There are several challenges in blood banking and transfusion including adverse transfusion reactions, transfusion transmitted infections (TTI) and human errors which are a potential threat to human life and quality of healthcare. One of the notable ways to address such an issue can be the use of information and communication technology (ICT) for blood banking and transfusion. It is a promising way to identify human errors which are then required to be corrected before allowing any further processing of transfusion. In this way it makes a "blood banking surveillance system". However, certain hurdles in implementing such system are to be taken into account: increased cost burden, struggle to change and the requirement of highly skilled staff to operate it.

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