Proposal of Smart Blood Banks Central Distribution System in Saudi Arabia

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Abstract. The goal of the Smart Blood Banks Central Distribution system is to be a substitute for the blood center in Saudi Arabia and to search for the required quantities of each blood type, save time, improve the process of exchange and distribute the blood units before expired. It will also promote a consolidation of hospitals in one blood bank and cooperation among them. These tasks need to develop an online intelligent distribution system that links all the hospital blood banks through one central system. The system should be able to process, store, distribute and exchange blood and blood components between blood banks under some conventions and regulations.

Keywords. Blood Bank, Blood Center, Blood Unit, Utilization, Smart System, Proposed System.

Introduction

The utilization of blood and blood components is increasingly becoming an important and indispensable component of clinical care especially in the surgically-related fields. In line with the hospitals emphasis on patient safety when facing shortages in blood and its components, they have to seek assistance from other blood banks. When we look to the blood bank system in Saudi Arabia, we don't see the concept of central blood banks. Meaning, there are more than 60 blood banks in the middle region works individually without any connection among them [1]. The lack connection led to significantly wastage for the most required and rarely source that annually may reach about 20\% especially in medium and small banks. The presence of those gaps leads us to propose such a system [2].

Through the extensive literature review about systems and papers that discusses similar idea in the same field we found that they are rarely and probably not exists. The presence of blood centers in other countries helped to eliminate a lot of problems that we are trying to resolve in the proposed system. Most of the systems that we found are basically depend on the concept of management in the first place. Those systems are focus on managerial...
functions such as reporting, inventory, accounting and monitored distribution of blood bags, and they are depending on connecting hospitals to one blood center, which means they always have the same source [3].

1. New Proposed System

Blood requests in Saudi Arabia are not in line with international stander and best parties; the concept of blood center is not exists yet like in other wealthy country that will defiantly reflect less complains of blood and its components. The main target of creating blood bank center in Saudi Arabia is to establish new policies / procedures in order to manage, control the process of requesting or replacement of blood and maintain the quality with high standard.

During side visits was done in Riyadh area and interviewing with Operations Analysts and Q.A. Coordinators of Blood Bank & Transfusion Services of Pathology & Laboratory Medicine in the largest blood banks, we realize all blood banks are struggling to get enough quantity to run their business. The idea of having large numbers of blood banks in same area without clear strategy, will negatively impact blood donators and patient life and lack the quantity of blood units in important hospitals which have much need, while other blood banks have a lot of not used blood units near to their expiry date.

After that, we recommend linking all blood banks in one smart distribution system. The system should be smart enough to meet the demands and achieve the balance between the m. Moreover, the system will control the distribution between different entities with consideration of priority, and when there are more than one request for a specific blood type, the system try to distribute the orders to several hospitals not to just one, taking into account a combination of factors. The effective way to build the system is make integration between the smart system and the blood banks systems to create connection among them. So, the system will play the main role as blood bank center which contain the individuals participant.

Trying to connect a large number of hospitals is not easy, for that we need a model or an algorithm to organize this correlation and facilitated at the same time. If we consider each hospital as a Node(j)and the connection between the system and hospitals as arcs with two directions, and the distance between hospitals on these arcs is X(i), it is possible to say we are talking about network model that have multiple source and destinations (Hospitals) Figure 1 [4]. This model supported by Linear Digital Programming algorithm which helps us to apply the calculations for the supply and demand on the blood units [5].
For each node (hospital) there are: constant minimum number of blood units, daily reserved blood units (reserved units for next day), updated minimum number and the available stock. By these numbers we can make equations to calculate then conclude the needy hospitals and the hospitals have surplus blood units as illustrated in the following case study.

1.1. Case Study
As represent in Figure 2 the ordering model for the smart system, we can see the nodes: A, B C, D and E are hospitals connecting to the central smart system. This case study was done for one blood type (e.g. O+) and the rest are in the same way. By the set of numbers available on each node we can calculate them to extract the status of each hospital by the following equation:

\[(\text{Available Stock}) - (\text{Updated Minimum}) = \text{Status};\]

Note that the updated minimum is not a piece of information provided by the hospital, it is calculated by the system as follow:

\[(\text{Constant Minimum}) + (\text{Daily Reserved}) = \text{Updated Minimum};\]

By the status sign and the number together we can conclude which hospitals are need blood and witch are supply it. For example in node A the result is (+5) the plus sign indicates that hospital A has extra five blood units that it can provide for other hospital. While in node E the result is (-15) the negative sign indicates that hospital E need for fifteen blood units. The system try to find this quantity from other hospital that have plus sign, it is not must be all from one hospital as it must achieve the balance between the taking units and the hospital size with the available blood stock and location. But in node D we find the result is equal to (0) which mean no need for more blood units and there are no supply units. Before the system start processing the orders, it must check the existence one of these cases:

- **Case#1**: Supply > Demand: The system will not facing any problem when the supply blood units are more than demands. In addition, there are still more blood units for supply in the system.
- **Case#2**: Supply < Demand: The problem will happen in such this case. In this situation the system starts to solve the highest priority orders. Priority is the value of negative sign number of result; the biggest value means the highest priority (e.g. -15 is high priority than -3). Thereafter, the smart system tries to provide the blood from available stock. When all available stock is consume and there are still high priority statuses, the system will enforce to withdraw the requested blood units from the constant minimum of appropriate hospital, and the needy hospital whose takes this blood units is responsible to return them as soon as they available in their stock.
- **Case#3**: Supply = Demand: In this case, all blood units provided from all hospital for this blood type were depleted, and no more blood units for providing.

The solution tries to make the best optimization for blood distribution across all linking hospitals by calculate the shortest distance between hospitals to increase the delivery speed. For example: when node C order blood units and node E will supply the units, the system must check the shortest path to node C, if node D need blood that can supply from node E the shortest path will (E-D-C= X3+X11), but if node D have status (0) which mean it doesn’t has an order the shortest path will direct from E to C(X1). The system will distribute the blood twice time in a day for the best network exploiting. Before starting the calculations the system will receive all information from all hospitals through XML files, which refers to bigness of receiving data, and saving all in the system database.
2. **Discussion**

As of today, the existing blood banks system in Saudi Arabia is incomplete, the reason behind that, poor cooperation between different facilities in relation to data and blood utilization that may led to wasting large amounts of blood/components. However, the proposal will provide blood and blood components faster and easier in order to save patients life. We can said the system has currently benefits by supplying the needy hospital with sufficient quantity of blood units as soon as possible, and the beauty of proposed system is to streamline the blood bank industry as in:

- Maximum utilization of resource with less waist of blood units.
- High level of integration between different organization or health care provider,
- Generate individual statistics reports for each hospital and comparing between them to find out which hospitals constantly order amounts of blood and accountability to know where the defects in their work.
- Planning and estimation the future needs of blood bank activities, that is help the hospitals to intensification blood donation campaigns in case the expected were large quantities.

3. **Conclusion**

The proposed smart solution can totally replace the current practice of ordering via telephone calls. The system will facilitate and simplify the workflow between different blood banks as well as blood data / storage. It also eliminates the problem of blood shortage and make sure to use blood before it is expired. After reviewing such a case and studying the opportunities, the system architecture will be the optimum solution to achieve our expectations.

**References**


