SIBAS: A blood bank information system and its 5-year implementation at Macau

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Abstract

Automation systems and information technology can greatly help medical facilities to improve their working efficiency and optimize the whole workflow. This article surveys electronic information management in blood donation and transfusion service, and explores the rationale and archetype of blood bank information systems, then exemplifies a successful in-running system—Sistema Integrado de Bancos de Sangue (SIBAS), which is developed by the Institute of Systems and Computer Engineering of Macau (INESC-Macau) in cooperation with the Macau Blood Transfusion Center (CTS-Macau). Its implementation and the related lessons are briefly introduced too. In essence, this article is oriented to serve as a reference of contemporary blood bank information systems.

Keywords: Blood banks; Information management; Workflow control; Automation systems; Electronic records

1. Introduction

Blood donation and transfusion service involves collecting, processing, storing and providing human blood intended for transfusion, performing pre-transfusion testing, cross-matching, and finally infusing into a patient [1]. Therefore, generally speaking, the blood bank system consists of the independent blood centers, which collect, store and distribute human blood, and hospital blood banks charging of transfusion-related services. Given the life-threatening nature of blood and blood components, it entails the rigorous controlling, monitoring and the complete documentation of the whole procedure from blood collection to blood infusion.

However, in face of the tremendous amount of data and information in a daily interval, various errors inevitably lead to significant risks in the mentioned procedure of blood donation and transfusion service. Errors at the time of administration of blood or blood components are the most frequent documented site of error cumulating in the transfusion of the wrong blood [2]. Furthermore, preceding errors in blood sampling, laboratory testing and especially inventory management of blood components were found to be an important contributory factor in many of such incidents too [3,4].

Information and computer technology has been widely deployed in medicine, and reveals the great potential to improve efficiency as well as quality. In terms of blood donation and transfusion service, combined with various automation apparatus, it can obviously ease and secure most procedures of donor screening, blood collection, laboratory testing and cross-matching, etc. Especially, as to the issue challenging blood banks, namely, the complete documentation for possible backward inspection, the introduction of information and computer technology can effectively relieve workload of blood banks and reduce the incidence of “wrong blood” episodes [5–8].

As a consequence, worldwide researchers initiated many pilot projects early in 1960s–1980s [9–14]. Then, with the systemization of computers in blood banks [15–17], US Food & Drug Administration (FDA) officially recommended the implementation of blood bank computerization in 1988 [18]. It pointed out “Automated or electronic data systems used in blood and plasma establishments should have the capacity to trace the history of every donation forward through final disposition of each component and from each transfusion,
infusion or sale backward to the original donor”. And FDA published the detailed requirements for blood bank computerization in 1989 [19]. Further, in accordance with the development of information and computer technology, FDA has to keep updating the instructive specifications exemplified by the subsequent publications in 1994, 1997 and 2005 [20–22]. Meanwhile, other developed countries and regions, including the United Kingdom and France, also developed corresponding blood bank computing standards [23–27]. Nowadays, it has been well established about the necessity and feasibility of blood bank computerization. In face of such exigent demands, many institutes and vendors have devoted to this field of blood bank computerization. For instance, merely in the United States, FDA licenses a series of computer software for blood bank computing [28]. Different from Hospital Information System (HIS), here it is noteworthy that most of these released computer software are designed and optimized for the specific blood banks. Despite several industrial consensus for specific aspects of blood bank and transfusion service [29], lacking of widely accepted standards definitely hampers the development of blood bank information systems. Therefore, even though some general industrial concepts exist about system and information models, it is still time now to inspect the essential role, mission and framework of blood bank information systems, and explore the feasible standard and consensus. Anyway, a clear development framework and the effective implementation reference will definitely contribute to the success of blood bank information systems.

2. Rationale of blood bank information systems

2.1. Role of blood centers in transfusion service

According to its formal definition, the whole life cycle of blood donation and transfusion service involves collection, processing, storage, transportation, pre-transfusion testing, and final infusion. Although these operations may take place in a single hospital blood bank, in fact, they are often performed in two separate places. For example, the blood for transfusion is usually collected in the independent blood centers (or blood establishments), which then process, store and disseminate it for utilization by a hospital’s transfusion service. Hence, unless special notification, the term “blood bank” hereinafter will be defined as a blood center responsible for maintaining an adequate supply of needed blood and blood components, and releasing the blood for transfusion service. And a hospital blood bank refers to the blood and transfusion division in that hospital.

However, from the viewpoint of blood circulation, the role of independent blood banks seems questionable. Generally speaking, the integral transfusion service can be sketched as in Fig. 1. Due to the separate operations in blood banks and hospital blood banks, many factors inevitably increase the risk of blood transfusion service in terms of secondary infection, misplacement and so forth. Then, why the independent blood bank? As a matter of fact, hospital blood banks were firstly introduced into blood transfusion service. Moreover the autologous blood donations are often settled in hospital blood banks. But, benefited from the advances of science and technology for blood preservation and circulation, nowadays the mode of independent blood banks is widely accepted for voluntary, directed and aphaeresis blood donation service in most countries and regions [30].

Obviously, an environment-friendly blood bank, compared with hospital blood banks, is more conducive to the mood of blood donors, which is of importance for donor recruitment and retention. On the other hand, with the discovery of more and more transfusion–transmitted diseases, it necessitates a series of sophisticated blood testing and analyzing apparatus for the secure blood donation and transfusion service. The centralized blood banks hence contribute to decreasing national medical expenditure on these apparatus and related professional training. The reason is also justifiable from the viewpoint of blood processing and production. Finally, the independent blood banks can effectively guarantee the impartial blood distribution and supply. In other words, such model has been proved to optimize the national blood utilization.

At the same time, hospital blood banks also play the key role in blood transfusion service. First of all, to guarantee safe blood transfusion, cross-matching and validation are indispensable operations before formal blood infusion. In the second, although most blood banks run in the 24/7 mode, any hospital has to preserve an appropriate portion of blood in its blood bank so as to ensure the quick response to medical emergencies. Finally, as mentioned previously, the autologous blood donation and transfusion is recommended to be conducted within a hospital blood bank according to the patient’s residence. Consequently, although blood analyzing and processing can be submitted to a tertiary blood center, the hospital blood bank is in essence a self-contained system.

In a whole, the integral network of blood donation and transfusion service should comprise blood centers, hospital blood banks and small or ambulatory blood stations. If we see their advantages and disadvantages, obviously, the successful operation and management of blood banks should be attributed to modern information and computer technology. In the first, the donor screening procedure calls for the computerized and networked donor information systems so that blood banks could preclude the ineligible donors in time. Secondly, if all blood inventory information systems can run transparently and subject to the surveillance of independent committees, it is possible to revise and optimize the traditional network of blood donation and transfusion service. For instance, the blood center can be affiliated as a complex hospital blood bank. Of course, all depend on the advances of computerized and networked blood bank information systems.

2.2. Automation systems in a blood bank

In a blood bank, automation benefits from a broad range of systems and apparatus, including automated manufacturing equipments, control systems, automated laboratory systems, computers including laboratory or manufacturing database system, etc. And all of them are organized in a hierarchy of
hardware, software and network components [31]. In essence, these systems firstly attempt to automate various processing, testing and producing activities so as to avoid human-introduced contamination and errors. At the same time, these automation systems are designed to streamline diverse operations taking place in a blood bank such as donor screening, data analyzing, blood management and dissemination, etc. [23,32]. Nowadays all of these activities have been deeply intertwined with the computerized and networked information system in a blood bank.

First of all, its information system enables the genuine autonomous blood processing without human intervention. Those processing results can be automatically imported into its information system as electronic data in database via various hard/soft interfaces. In the second, thanks to the integral information system, the heterogeneous operations in the blood donation and transfusion service can be really streamlined due to the consistent data and information. Similarly, the close network of blood donation and transfusion service can be built to cope with those challenging issues such as global optimization of blood dissemination, tracking adverse transfusion reaction, and the possible backward inspection, etc.

Coming back to the blood bank information system, there are two alternatives widely accepted in the blood donation and transfusion service. The first one is to build the blood bank information system as a subsystem of HIS, exemplified by the blood bank module in Sushrut® HIS [33]. Such paradigm is recommended for hospital blood banks because it close integrates with other HIS modules like in-patient management, billing, and out-patient management, etc. On the contrary, most independent blood banks prefer to the standalone blood bank information systems, which exchange information with outside systems via the special interfaces.

To understand the intrinsic difference between two alternatives, it is necessary to capture their respective missions of HISs and blood bank information systems. A HIS is generally developed with the objective of streamlining the treatment flow of a patient in the hospital, which allows doctors and other medical personnel to perform in an optimized and efficient manner. Hence, the HIS is in essence a patient-oriented system with the underlying objective to improve hospital efficiency. As to blood bank information systems, one of their objectives is no doubt to optimize the streamline of blood donation and transfusion service. However, the most important is to track every unit of blood and blood components from donation to infusion so that the safety could be fundamentally guaranteed. Obviously, such difference rooting in their missions brings the distinct models and frameworks in nature.

3. Design considerations

3.1. Information in a blood bank

Few healthcare operations are as complex as managing blood and blood components. A blood bank needs to handle daily hundreds and thousands of pieces of data and information covering from blood donation to blood distribution. Therefore, to develop a robust blood bank information system, the first task should locate in archiving those related heterogeneous data and information. Here, it is addressed in accordance with the life cycle of blood components from original donor to final patient, as shown in Fig. 2.

Recruiting healthy donors is the first whilst crucial step to guarantee the safe blood donation and transfusion service. Thereby, it is necessary for any blood bank information system to provide the effective solution for donor screening and tracking. Traditionally, donor screening is based on the self-conscious questionnaire covering general information of personal data, medical record and donation history. The additional information includes simple physical examination, post-donation reactions and subsequent blood testing results [34]. However, in contemporary blood bank information system, more and more objective data and information, such as accurate donation parameters and believable medical information from hospitals, are desired to improve the safety of blood donation and transfusion service [35].
At the same time, owing to the automated interface to variable labeled and verified through their unique barcodes. Printers and readers, most materials in that blood bank can introduced errors. For instance, with the help of barcode blood bank information system, can effectively reduce human-data acquiring interface, a salient feature of contemporary modules of intelligent decision-support. Automated omy: the interfaces for automated data acquisition and the autonomous system. And two major aspects embody its autonomous features, including blood transfusion records and patients’ transfusion records. Again, the computerized and networked management substantially promotes the quick response ability of blood banks to various medical emergencies.

Final part of information is comprised of the feedback data and messages from outside transfusion facilities with the help of electronic data interchange (EDI). More than the substituting role of text documents, a contemporary blood bank information system contributes to blood donation and transfusion service through the complete chain of information interchange and share. As a consequence, the blood information can be considerably enriched due to those feedback information including blood transfusion records and patients’ transfusion reaction, etc.

### 3.2. Autonomous information system

A blood bank information system is in essence an autonomous system. And two major aspects embody its autonomy: the interfaces for automated data acquisition and the modules of intelligent decision-making support. Automated data acquiring interface, a salient feature of contemporary blood bank information system, can effectively reduce human-introduced errors. For instance, with the help of barcode printers and readers, most materials in that blood bank can be labeled and verified through their unique barcodes. At the same time, owing to the automated interface to various blood testing and processing apparatus, most of raw data and detailed information can be archived without human intervention, which not only guarantees the consistency of blood bank information but also improves blood bank working efficiency.

As to intelligent decision-making support, two intrinsic challenges call for the development of autonomous information analyzing technology in blood banks. The first one stems from the fact that most blood bank staff lack of professional IT skills. And the other one comes from the challenge of tremendous and heterogeneous data and information. Without the effective analyzing and decision-making support tools, any blood bank information system will not be fully embraced by blood bank staffs, which no doubt impairs its deserved status. Consequently, two paradigms including data-driven and knowledge-driven decision support modules have advanced to answer the aforementioned challenging issues.

### 3.3. Streamlined information system

As mentioned previously, barcode technology is an essential tool for the implementation of automated blood bank information system. As a matter of fact, the full participation of barcode technology promotes blood bank working efficiency too. For example, since all blood materials are uniformly barcoded, the involved working procedures such as laboratory testing and component producing can be undertaken simultaneously. Of course, besides barcode technology, the streamlined workflow should be firstly ascribed to the application of information and computer technology in blood banks. Thanks to network and information technology, it is possible to synergize various activities in blood bank via information interchange and share. As a consequence, one feature of contemporary blood bank information system is able to streamline overall blood bank procedure so as to improve working efficiency whilst keeping the high-performance safety of blood donation and transfusion service.

### 3.4. Close information system

The term “close” implies two aspects of blood bank management: firstly, a blood bank information system should
accomplish the complete information flow from blood donation to blood infusion; secondly, the blood bank information system should keep as a black box to unauthorized users. Workflow synergy and information synchronization are particularly appreciated in contemporary blood bank information systems. It means that any data or information in blood donation and transfusion service will play a global role. On the other hand, facing the harsh network environment permeated with Trojan and virus software, blood banks should pay more attention on the issue of data security. It is necessary to build blood bank information systems in a hierarchical framework. Any operation on database should be rigorously verified and monitored. Similarly, the privilege of every group of users should be clearly configured so that even authorized users are only able to conduct the permitted operations.

### 3.5. Open information system

Paradoxically, at the same time, blood bank information systems should subject to the open platform for information interchange. As discussed in above, to form a complete information flow, blood bank information systems need to exchange various data and messages with outside subjects, such as hospital blood banks at least. However, due to diversified information systems in blood donation and transfusion service, it is no doubt a challenging issue to implement the effective open interface for EDI. In this field, the related exploration includes “United Nations/Electronic Data Interchange for Administration, Commerce and Transport” (UN/EDIFACT), “American Society of Testing and Materials” (ASTM), and “Health Level Seven” (HL7) [41–43].

### 3.6.Essences of blood bank information

As a whole, contemporary blood bank information systems should pay more attention on the following characteristics of information in blood donation and transfusion service:

1. **Information credibility**: Firstly, in terms of health information, besides donor’s subjective response, more objective items, including electronic patient/health records, are introduced to assure information credibility so that the eligibility of blood donation could be improved. In the second, donation and transfusion information is checked and verified throughout the whole procedure with the help of barcode technology. Thirdly, as to blood information, not only is it guaranteed by barcode technology but also it benefits from various automatic testing and processing apparatus in blood donation and transfusion service.

2. **Information integrity**: It is mentioned that blood bank information systems appreciate the close information flow in order to improve information integrity of donors as well as blood components. Obviously, thanks to information interchange and share, candidate donors can be evaluated in all sides because of donation reaction, blood testing results, subsequent blood utilization, and electronic patient/health records. Moreover, the integral blood information can be built from initial blood donor, involved staffs and materials to the final blood recipient.

3. **Information synergy**: A salient contribution of blood bank information systems lies in promoting blood bank working efficiency. However, the concurrent operations of blood analyzing and processing threaten the safety of blood donation and transfusion service. Therefore, information synergy plays a very crucial role in this field. Here, barcode technology is recommended and has been practically proved effective for such synergic workflow.

4. **Information security**: Same as other medical facilities, information security is always an inevitable issue with regard to life-threatening products in blood banks. The related topics include protecting donor privacy, preventing unauthorized data operation, and information system disaster recovery, etc. A robust blood bank information system should guarantee not only the consistent data recovery but also quick disaster response due to its 24/7 uninterrupted operation mode.

### 4. SIBAS at Macau

#### 4.1. Blood donation and transfusion service at Macau

Macau Special Administration Region belongs to the territory of People’s Republic of China, covers the area of about 27 km², and populates near 470,000 residents. In Macau, the medical and health service providers can be classified as governmental and nongovernmental facilities. The former includes government health centers and the Conde S. Januario Hospital while the latter consists of medical entities subsidized by the government and other institutions such as Kiang Wu Hospital, the Workers’ Clinic and Tung Sin Tong Clinic, as well as various private clinics and laboratories.

However, in terms of blood donation and transfusion service, the Macau Blood Transfusion Center (CTS-Macau) is in sole charge of nonremunerated Macau-wide blood collection and legal supply of blood components. Meanwhile, blood transfusion service is mainly implemented in two complex hospitals: the Conde S. Januario Hospital and Kiang Wu Hospital. In 2004, total 12,035 residents registered for blood donation and about 10,457 units of blood were collected. Over 2240 patients accepted transfusion service in two complex hospitals with a consumption of more than 26,800 units of blood components.

CTS-Macau keeps promoting the safety of blood donation and transfusion service at Macau. And presently it has passed through ISO9001:2000 quality management system. At the same time, its affiliated laboratories for blood testing and processing also participate in “United Kingdom National External Quality Assessment Service (UK-NEQAS)” and “National Serology Reference Laboratory of Australia (NRL)” so that all blood components could rigorously comply with the standards of European Transfusion Committee. In 1999, to further improve its service performance and quality, CTS-Macau cooperated with Institute of Systems and Computer Engineering
of Macau (INESC-Macau), initiated the computerized and networked blood bank information system—Sistema Integrado de Bancos de Sangue (SIBAS).

4.2. Infrastructure of SIBAS

Any process or procedure within a blood bank must subordinate to the safety of blood donation and transfusion service no matter in the sight of blood donors or blood recipients. Once a donor reaches the blood bank, a unique donor number and donation number will be firstly assigned to this donor; before his/her donation, the nurses will conduct a series of simple physical examination; then, based on the donor’s background information and the nurses’ examination results, the doctor will make the final decision whether this donor is suitable for blood donation without influence on his/her health condition. If donor screening is successfully passed, this donor is eligible to enter the area of blood collection for blood and blood specimen. After donation, this donor will be requested to have a rest and the nurse will record his/her post-donation reactions.

Then the blood specimen will be transferred to professional laboratories for blood ABO/Rh grouping and testing blood transmitted diseases, including hepatitis (a liver infection), HIV (the virus that causes AIDS), HLTV I/II (the virus associated with a rare form of leukemia), and syphilis, etc. Meanwhile the whole blood is submitted to be separated into red blood cells, platelets, plasma, and other human blood clotting agents. If the validating results from blood testing laboratories are negative, the produced blood components will be conveyed to blood stock for inventory management. Otherwise, those blood components and blood specimen should be incinerated in time.

As introduced in previous, automation systems including information and computer technology have participated in the blood bank in all sides and substantially improved its operating efficiency. Coming to CTS-Macau, nowadays it owns full-function Intranet/Internet network system, adopts all-round autonomous blood testing and producing apparatus, utilizes the barcode-based blood tracking and managing paradigm, and has fully realized the computerized and networked blood bank information system, whose practical infrastructure is shown in Fig. 3. The involved apparatus and systems can be generally categorized as following:

1. **Personal computers**: Include desktop computers, laptop computers, and tablet PCs; run under Windows-compliant environment including Windows 98®, Windows 2000®, and Windows XP®. These computers scatter in every division of the blood bank such as reception, collection area, laboratories, stocks, and even blood mobiles. Most of them connect to blood bank databases through Intranet network in order to share and interchange blood bank information.

2. **Servers**: Support information share and workflow synergy. Here, two measures are adopted to guarantee data safety and network robustness. The first one is to implement one-to-one service strategy, namely, a serve (maybe as virtual machine) is specially designed and optimized for the specific service such as data management (independent database for donor, donation, laboratory, stock, staff and materials, etc.), document management (printing, scanning, and faxing, etc.), Virtual Private Network (VPN) to hospitals and health bureau, and Internet information accessing. Secondly, there is a server for synchronous database backup and a magnetic tape server for daily database backup.

3. **Automated blood testing apparatus**: CTS-Macau makes good use of various automated blood testing and producing apparatus so as to assure the quality of testing results and final blood products. For instance, there are a series of sophisticated instruments for blood tests in CTS-Macau, including Microdom’s “Mitis2” for blood typing and antibody screening test, Vitros’s “ECi” for blood immunodiagnostic test, Roche’s “MagNA Pure LC System” and “Cobas Amplicor” for microbiologic test, etc.
4. Peripheral apparatus and instruments:
- **Barcode reader and printer**: Zebra® barcode printers are deployed in reception division for donation number label printing and in component division for product label printing. Every division of the blood bank is equipped with barcode readers so that a series of complex processing could keep rigorous consistency [44,45].
- **Electronic donor card read/write machine**: CTS-Macau is always desired to provide the best service to blood donors. Electronic donor card may be the most welcomed one. It can not only store the donor’s basic data in magnetic bar but also print the fine picture about the donor’s donation information. The whole solution is based on the thermo re writable card technology of Rewrite Card Technology Inc.® [46].
- **Donation monitoring apparatus**: CTS-Macau adopts Terumo®’s “T-RAC System” to control donation procedure and accurately reflect the donor’s health condition, including duration, volume, average/minimal/maximal flow rate, and venepuncture delay of the collection, etc.

4.3. Software implementation and taking effect

Based on the preceding discussion, a blood bank information system has to face the challenging issues on workflow synergy, data integrity, and information security, etc. Here, SIBAS follows the client/server framework, namely, implementing data management, user role controlling, EDI in server end while providing the distributed information processing ability in an integrative operation environment in client end (Fig. 4).

In terms of data and information management, SIBAS provides the all-round Oracle®-based database solution in server end:

1. **Data archiving**: The independent Oracle® databases are configured, respectively, for the data and information of blood donors, donation, blood laboratory testing, blood producing and inventory management, etc. In general, there is an optimized database for every division of CTS-Macau so that the efficiency of data management and information accessing could be substantially improved.
2. **User role controlling**: In SIBAS, there is a specific database for use role management and controlling. Before any operation on real database of blood bank information, the user has to pass through a series of independent procedures of identification and verification. On the other hand, the user’s any operation on blood bank information will be recorded for backward inspection in this database.
3. **Middleware**: To improve the efficiency of data operation and information accessing, SIBAS makes good use of the concept and method of middleware, namely, packaging procedures, functions and triggers in Oracle® database for data operation. Then the client end just submits its request and receives the desired results.
4. **Data mining for decision-making support**: SIBAS owns the powerful decision-making supporting function. First of all, there are various statistic reports based on SQL statements for accurate decision-making information. Moreover, benefited from Oracle® Data Mining (ODM) toolkit, SIBAS also provides fuzzy decision-making ability for the discovered associated rules, etc.
5. **Data backup and disaster recovery**: As mentioned previously, there are independent servers for synchronous and
daily backup, respectively, both of which are blind for blood bank users. Two HP® servers run synchronously for hot backup with the help of Oracle® Recovery Manager (RMAN) while a third-party backup system, Veritas®, combined with HP® magnetic tape database, is charge of the daily incremental backup.

Coming to the client end, SIBAS provides a uniform solution of blood bank information system for all divisions. Although it also follows the common modules such as donor recruitment, donation monitoring, laboratory blood testing, and inventory management, SIBAS can implement dynamic self-configuration according to the group privileges of different user roles. For instance, all users in the blood bank are grouped as reception, nurse, doctor, immunohematology, microbiology, validation, component, etc. In addition, the role “supervisor” is allocated for systematic configuration and maintenance.

In principle, every group of users lives only in its legitimate society. Namely it owns unique user interface suitable for the specific workflow, and calls different subroutines for data operations and statistic reports. Of course, despite rarely, SIBAS is powerful enough to permit such users granted more than one user role.

5. The 5-year implementation and discussion

The initiative of computerized blood bank information management was undertaken at CTS-Macau from October 1999. And INESC-Macau fully participates in this procedure since then. From the deployment of basic automated apparatus to the release of official SIBAS, INESC-Macau, cooperated with CTS-Macau, pursues to utilize advanced information and computer technology in blood bank automation system and information management.

Nowadays, SIBAS has been deployed in every division of CTS-Macau and provides various automated interfaces for barcode system, electronic donor cards, blood testing and processing apparatus, etc. In the supporting Oracle® database of SIBAS, it records the complete data and information of blood donation and transfusion service since 1999. Despite the comparatively tiny blood donation and transfusion service in Macau society, there are more than one million pieces of records arranged among about 300 tables of five independent databases. At the same time, the amount is still in an increasing rate of daily thousands of records. During the implementation and maintenance of such a complicated system, the following challenging issues should be specially mentioned and discussed.

5.1. Implementation challenges and solutions

The 24/7 uninterrupted running mode of blood bank information systems necessitates the quick response for technical support and service, especially for the situation of disaster recovery. However, owing to the reliable planning and designing, SIBAS has continuously run for more than 5 years without any serious accidents. Besides the monthly regular maintenance, till now, the requests for technical support and service can be categorized as the following: (1) technical training and tutorial; (2) abnormal data or inconsistent information; (3) database migration and revision; (4) new user specifications, such as user interface revision, workflow revision, automated interfaces for new apparatus and so forth. Obviously, most of these problems are in essence related to the scalability of SIBAS.

Although any revision or modification maybe influences its integration and robustness, three facts necessitate the fundamental updating of SIBAS:

1. The development of blood banks: Due to the absence of IT knowledge, it is implausible for blood bank staffs to provide perfect user specifications regarding a blood bank information system. In fact, the blood bank should consider the optimization of its workflow as a long-term strategy in face of the variations of blood donation and transfusion service, for example, the number of blood donors, the introduction of new apparatus and so on.

2. The development of blood donation and transfusion service: As a matter of fact, even the official standards keep evolving so as to provide safer blood donation and transfusion service. Obviously, the newly discovered blood transmitted diseases will no doubt call for the upgrade of blood testing procedure. In SIBAS, one of the underlying revisions in accordance with official standards is the upgrade of blood bank barcode technology from Codabar to ISBT 128.

3. The development of information and computer technology: It is inevitable to upgrade SIBAS so as to keep up with the fast development of hardware and software technology. For instance, Windows 98® was the mainstream operation system in 1999 while it has been upgraded to Windows XP® today. Similarly, Oracle® database has evolved from version 8.0 to 10g too. In CTS-Macau, the database was upgraded from Oracle® 8.0 to Oracle® 9i in 2004 because the latter can provide more flexible operations and support Chinese characters better.

At present, INESC-Macau still keeps tracking the newest technological development such as “Wireless WiFi LAN” and RFID, and explores their applications in blood bank information systems. Of course, with regard to life-threatening blood and blood components, any new technology should pass through the rigorous testing and assessment before its formal introduction to blood banks.

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References


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