

# Status of Transfusion Medicine Education in Iran

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## Abstract

**Background:** Optimal use of blood and blood components requires theoretical and practical knowledge in transfusion medicine. While the importance of education in transfusion medicine has long been recognized, a vacancy is widely felt in this regard in Iran. In this study, the current status of transfusion medicine education in Iran is evaluated using a review of studies conducted in this field.

**Methods:** To access articles related to transfusion medicine education in Iran, an electronic search was performed in databases, including Magiran, SID, IranMedex, Google Scholar, PubMed, ScienceDirect, and Scopus and the related articles were evaluated.

**Results:** Knowledge of transfusion medicine was not optimal in various medical groups and there was no effective theoretical and practical education and training for transfusion medicine in medical universities. Almost all the studies concluded that transfusion medicine curricula should be implemented for both undergraduate and postgraduate students, because of its great importance in clinical practice.

**Conclusion:** Educational program of transfusion medicine is a basic need of medical education for medical students, interns, residents, nursing, and midwifery students in Iran. Considering our status and capacities and by using educational programs in the world, curricula are suggested for different educational levels. Implementation of these training programs plays a vital role in improving patients' safety and also reduces the high costs of treatment with blood products.

**Keywords:** Education, medical students, nursing, transfusion medicine, students.

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## Introduction

It is important for physicians and clinical care providers to have sufficient knowledge on the subject of transfusion medicine in their practice to provide optimal use of blood and blood products for patients.<sup>1-3</sup> Blood transfusion is one of the most common medical procedures in hospitals and its proper use requires theoretical and practical knowledge in transfusion medicine.<sup>4,5</sup> Ordering blood for patients is done by the physician who are the most important factor determining the amount of blood and blood products to be used in medical centers. The administration of blood and blood components is performed by nurses, midwives, or operating room staff and their knowledge of multiple stages of patients' care during transfusion has a significant impact on patients' safety.<sup>6,7</sup> Although blood transfusion is sometimes life-saving, it can be associated with a wide range of adverse effects or potential risks for the patients.<sup>8</sup> Therefore, blood transfusion should only be ordered in cases where the use of blood products is vital to the patient and cannot be replaced by any other alternative.<sup>9</sup> In addition, excessive and inappropriate blood transfusion imposes high costs on the national health system.<sup>2</sup> These include the costs of processing and storing blood products in blood centers, costs of pretransfusion tests, treating unwanted transfusion reactions, and costs of increased hospital stay. Of more than two million units of donated blood, nearly 6 million blood products are annually produced in the country and the cost of each unit

of blood is estimated to be about two million Rials, which is only a small fraction of the total costs of treatment with blood products.

Blood transfusion is one of the five most overused medical procedures. To ensure optimal blood use, physicians should be familiar with evidence-based practice in transfusion medicine.<sup>10</sup> Most physicians who order blood for patients have not received adequate training in the field of transfusion medicine in university and are not properly familiar with modern methods and evidence-based practice.<sup>11,12</sup> In a study in American Medical Colleges, it was observed that medical students received less than three hours education in transfusion medicine. Also, training was not enough during the residency.<sup>10</sup> A forum conducted to determine education in transfusion medicine around the world concluded that in many countries, medical students received some education in transfusion medicine, but the educational content varied among countries and even between different universities in the same country and no national curriculum was defined for it. Almost all participants believed that education in transfusion medicine should be improved for medical students and residents due to its great importance in clinical medicine.<sup>5</sup> Also, studies have shown that transfusion knowledge of nurses or nursing students was inadequate which could lead to irreversible complications in patients.<sup>6,7</sup>

Improving knowledge is a key factor in reducing inappropriate blood use and proper care of patients who need blood transfusion. Similarly, concerning the limited blood supply, it will maintain blood supply for patients who really need it. In Iran, several studies have investigated the awareness of medical students, residents, physicians, nurses, midwives, and other health care practitioners in recent years. The aim of this study was to evaluate the current status of transfusion medicine education in Iran by reviewing studies in the field.

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## Materials and Methods

In this paper, -studies conducted in the field of transfusion medicine were reviewed. To access the related texts and articles, keywords including “transfusion medicine education, blood transfusion, knowledge, awareness, medical students, residents, nurses, and Iran” were searched in Persian and English in multiple databases and electronic indexed resources including Magiran, SID, Iranmedex, PUBMED, SCIENCE DIRECT, SCOPUS, and Google Scholar and the related resources were extracted. Thus, until 2015, all resources in line with the current study were assessed. Fourteen related sources were obtained which were all original research articles. The obtained sources were carefully studied and the results were presented in main points related to each source.

## Results

Studies have assessed the transfusion medicine knowledge of medical students, interns, residents, nursing or midwifery students, physicians, and health care providers in Iran. In most studies, the basic knowledge of blood transfusion has been assessed. Only few studies have evaluated a broader range of knowledge, including basic knowledge, the clinical use of blood components, contraindications, or complications of blood transfusion. Seven studies assessed the knowledge of nurses or other health care providers (midwives and operating room staff) and seven studies investigated physicians and medical students. One study also assessed the knowledge of laboratory science students. In a study, the practice of health care providers about the principles of blood transfusion has been evaluated by self-assessment and another by the researcher.

Blood transfusion requires sufficient knowledge and clinical skill. The personnel who administer blood components must be trained in transfusion procedures as well as recognition and management of adverse reactions. Standard protocols for the administration of blood should be taught to nursing or midwifery students to minimize errors. Nurses should know about the storage conditions of blood products, patient care during blood administration, and approach to blood transfusion reactions. Knowledge and high precision are necessary for patient identification before blood sampling for pretransfusion tests and administration of blood components and if not performed correctly, lethal reactions may ensue. One of the most important causes of death related to blood transfusion is wrong blood transfusion and the awareness and knowledge of nurses are very important to prevent this life-threatening complication. The results showed that nurses had little information about blood transfusion. Salarvand *et al.* showed in their study that only 13% of nurses had the desired information about blood transfusion and 87% had average to poor information.<sup>13</sup>

Purfarзад (2010), on the knowledge and practice of nurses in Arak, showed that only half of the nurses had good knowledge about blood transfusion. The lowest level of knowledge was related to transfusion reactions. Among these nurses, 64% reported good performance and none reported poor performance. This measurement was not accurate because it was based on self-assessment of performance.<sup>14</sup> In a study conducted by Piri *et al.* on nurses' knowledge on blood administration (patient care before, during, and after blood transfusion, transfusion complications, and pretransfusion tests), half of the medical team had moderate

to poor knowledge which can be a significant risk for patients.<sup>15</sup> A study by Asadi-Fakhr *et al.* showed that 78.3% of the operating room staff had insufficient knowledge of acute hemolytic transfusion reaction, and only 3% had sufficient information regarding the storage conditions of blood products. In this study, the staff's performance was evaluated undetectably by checklist and it was shown that only half of the employees recorded patients' vital signs during blood transfusion.<sup>16</sup> Aslani *et al.* showed that nurses' knowledge of techniques and complications of blood transfusion is not at an acceptable level and the risk of complications in patients requiring blood transfusion was more due to lower quality of care.<sup>7</sup> A study by Tabiei *et al.* also showed that knowledge was weak in almost half the nurses and there was a significant relationship between nurses' knowledge and performance.<sup>17</sup> Youssefian *et al.* assessed the awareness of medical staff in crowded wards at two hospitals in Zahedan. The mean knowledge score was  $12.3 \pm 3.3$  out of 20.<sup>18</sup>

Keramati *et al.* investigated the minimum necessary knowledge of blood transfusion medicine in four groups, including medical students, interns, residents, and nurses. The scores reflected low awareness level in different medical groups in blood transfusion medicine and this level of awareness was not desirable, especially in most ordering residents of anesthesiology, surgery, and orthopedics. There was no significant difference between the scores of residents and interns, showing lack of training in the residency programs regarding blood transfusion medicine. Interns start their professional life as general practitioners in medical centers shortly after graduation and start prescribing blood transfusion, while they do not even have the minimum required information related to blood products.<sup>19</sup>

Salimi *et al.* evaluated the knowledge of medical graduates from different universities of medical sciences on the basics of transfusion medicine. Among them, 93% gave correct answers to less than half of the questions and no significant difference was observed between the different medical universities graduates. Over 80% of participants believed that they had received no education in medical universities in blood transfusion and 90% were willing to take a training course.<sup>20</sup>

Gharehbaghian *et al.* assessed the level of medical knowledge on transfusion medicine among 1242 participants. The mean score of general knowledge of physicians on transfusion medicine was  $16.7 \pm 8.4$  out of 50. The scores of awareness among general practitioners and specialists more involved in blood transfusion were not significantly different from the scores of awareness for other specialists. Less than 30% of physicians had correct knowledge about leukoreduced or irradiated components and only 10% of physicians were aware of the effect of blood transfusion on the immune system. Among physicians, 4% to 8% were aware of autologous blood donation and storage conditions of blood products. While 68% believed that patients without cardiovascular disease with a hemoglobin level of 9 g/dL should receive blood,<sup>21</sup> studies have shown that hospitalized patients with a hemoglobin level of 7 to 10 g/dL who have not received blood had lower morbidity and mortality rate and shorter length of hospital stay.<sup>22</sup> The majority (99%) of physicians believed in the need for educational programs to improve their knowledge of transfusion medicine.<sup>21</sup>

In Kasraian's study, the awareness of the first year residents was measured regarding the indications of different blood products, transfusion administration, and transfusion reactions. The mean score of knowledge was  $15 \pm 3$  of 29 and 25% had a score of less

than 13, showing insufficient knowledge.<sup>23</sup>

In a study by Amuzeshi *et al.*, the knowledge of medical students, interns, first and second year residents, nursing, midwifery, operating room, and laboratory sciences students was determined and 86% had a low awareness level. The highest scores belonged to laboratory students, who have 3 credits of blood banking and transfusion in their curriculum.<sup>24</sup>

Liaghatdar *et al.* showed the efficacy of a 6-day training course for medical students in a blood transfusion center on familiarity with blood transfusion chain and more than 85% of the students considered these courses useful and it was suggested that education in blood transfusion medicine should be administered in cooperation with blood transfusion centers in the clinical education sector of the medical universities.<sup>25</sup>

Kasraian's study on the awareness of physicians and nurses in the field of transfusion medicine before and after education showed the impact of education on increasing the awareness level. In this study, only 23% of physicians and 16% of nurses who had received education in the field of blood transfusion were significantly more aware than those who were not trained. Among the participants, 98% believed that more training is needed in the field of blood transfusion.<sup>26</sup>

## Discussion

The results of studies have shown that the awareness of students, physicians, and clinical caregivers needs to be improved. In general, most activities in the blood transfusion chain are based on human interventions.<sup>7-29</sup> Since the risk of therapy with blood transfusion is essentially based on human error,<sup>30</sup> it is important to educate physicians who play a key role in use of blood products and health care providers who are responsible for patient care.<sup>31-34</sup> Personnel who participate in the administration of blood components must be trained in transfusion procedures and in recognition and management of adverse reactions.

In studies conducted in Iran, more than 90% of the participants believed that they required educational programs to improve their knowledge of transfusion medicine. The most important element is the need to change.<sup>1</sup> The next step is development of educational programs in line with the latest advances in transfusion medicine. Education must be completed during medical school or residency, because re-training or changing habits after starting professional practice will be very hard. The target group of these programs is thus medical students, interns, residents, and students of nursing, midwifery, and other related fields. It is necessary to provide specialized training courses of blood transfusion during medical education for residents who are most involved in blood transfusion, such as the residents of pathology, who will manage blood transfusion services of hospitals in the future and also residents of clinical fields, such as hematology/oncology, anesthesiology, internal medicine, pediatrics, obstetrics/gynecology, and surgery.<sup>35-37</sup>

### Transfusion medicine education in the world

The need to improve education in transfusion medicine has been known for many years. Michel *et al.* (1988) showed that in the United States medical students, residents, and physicians of clinical fields need more education in the field of blood transfusion.<sup>38</sup> Transfusion Medicine Academic Awards (TMAA Group, 1989) awarded grants to 40 medical universities to develop a transfu-

sion medicine curriculum for their students at different levels, including medical students, residents, and fellowship.<sup>8</sup> Since then, researchers have tried to develop a coherent plan. The TMAA Group (1995) released training programs for medical students, residents, and fellows.<sup>39</sup> Today, in most countries, transfusion medicine is a specialized field or a specialty or fellowship of pathology or hematology/oncology.<sup>4</sup>

In Japan, Malaysia, and Korea, medical students take blood transfusion courses in their second to fifth years. Malaysian medical students become familiar with blood groups, blood compatibility, blood products, and transfusion in the third year. They are educated about the clinical aspects of blood transfusion in the fourth year and are taught in small groups in blood centers and visit blood centers and their products in the fifth year. In Japan, students visit blood centers in the fifth year. In Sweden, blood group serology is taught in the second year of medical education and the clinical use of blood products is taught in the fourth year. In some countries, medical students learn immunohematology in the second year, processing, indication, and complications of blood transfusion in the fourth year, and emergency and massive blood transfusion in the sixth year.<sup>5</sup>

In the United States, medical students learn immunohematology issues, principles of treatment with blood products, and complications of blood transfusion in the second year and are trained in the third and fourth years with one-month rotation in pathology at blood banks and blood donation centers. Australia also has added pathology rotation for interns recently, where they learn both laboratory (such as antibody screening, the importance of patients, and pre-transfusion blood samples identification) and clinical aspects of blood transfusion (such as optimal use of blood, approach to transfusion reactions, and concept of hemovigilance) in the rotation.<sup>5</sup>

At the beginning of residency, education is provided with an emphasis on clinical aspects of blood transfusion medicine. Residents of pediatrics, internal medicine, surgery, anesthesiology, emergency, and obstetrics/gynecology learn the clinical guidelines of blood transfusion. In most countries, blood transfusion education is mandatory for pathology and hematology residents. But for other residents, it is compulsory in some countries and optional in others. In the United States, pathology residents are trained twice in about 6 weeks during their residency. During a blood transfusion course for pathology residents or fellowships of hematology/oncology, blood transfusion consultations (including dealing with the complications of blood transfusion, ongoing challenges in improper blood transfusion, and monitoring blood administration) are first referred to residents. During the weekly meetings conducted for all residents, consultations from the previous week are reviewed and checked again under supervision of the medical director. Therefore, residents become familiar with all events of blood transfusion services in their hospital until the fourth year. Residents of pediatrics, internal medicine, and anesthesiology learn blood transfusion in a period of 2 to 4 weeks through lectures and in small groups. The education is compulsory in these residencies and accompanied by a written exam. Board exam also includes some questions related to blood transfusion. Residents visit blood donation centers in two-day courses to be familiar with the activities of these centers.<sup>5</sup>

Korean residents receive four months of education in apheresis, plasmapheresis, autologous blood, antibody screening and identification, hospital committees, management of blood consump-

tion, and consultation in clinical wards.

In India, residents of specialties dealing with blood, participate in a two-week course on blood transfusion and in Indonesia, pathology residents are trained for two weeks in local blood centers.

#### Training transfusion medicine specialists or fellows in the world

Another aspect of blood transfusion medicine is educating transfusion specialists. Efforts to train transfusion specialists cannot be separated from efforts to achieve other educational goals.<sup>38</sup> In Germany, blood transfusion is a separate specialty and physicians are trained for three years in transfusion medicine and two years in clinical fields, such as anesthesiology, surgery, internal medicine, pediatrics, and obstetrics/gynecology. In many other countries, transfusion medicine is a subspecialty of other disciplines. In the United States, transfusion medicine subspecialty is a one-year fellowship course after primary certification in pathology, internal medicine, pediatrics, obstetrics/gynecology, anesthesiology or surgery. Other medical specialties should spend a two-year fellowship. In France, there are different diplomas for a transfusion specialist and in Japan, it is believed that transfusion medicine should be a distinct specialization.<sup>5</sup> Transfusion medicine specialists are expert in relevant areas of hematology, immunology, and infectious diseases, both clinically and from a laboratory standpoint. The responsibility of transfusion specialists is establishing standards for clinical use of blood products, addressing the legal aspects of transfusions, and monitoring the clinical aspects of blood transfusion in hospitals.<sup>38</sup>

#### Transfusion medicine education in Iran

Iranian medical students become familiar with the serology of blood groups and related issues in the form of brief immunology lessons (about one or two sessions). But they have no training courses during internship on the clinical use of blood transfusions.<sup>5</sup> Recently, a number of medical universities have provided an optional 0.5 credit transfusion medicine for internship. In residency, also, only pathology residents and hematology/oncology fellows receive a one-month training course on blood transfusion and other residents who are extensively involved in blood transfusion issues receive no official education. Nursing and midwifery students also participate in a 0.7 credits of blood disorders, 0.1 of which (about one or two training sessions) is related to blood transfusion and the provided content, mostly the basic and practical aspects, are rarely addressed; they also receive no specialized training in clinical skills of blood transfusion in internship.<sup>25</sup> Operating room students also have two courses on blood diseases, but only 0.5 credit of blood transfusion and no practical training.<sup>24</sup>

Generally, medical students of Iran are not formally trained in their medical education and residency on transfusion medicine; and despite many developments in various fields of medical expertise and the use of modern specialized methods, blood transfusion medicine is still used traditionally by most of our physicians and many of them are unaware of the development of blood transfusion knowledge, to include strategies to reduce blood use, procedures of autologous blood, bloodless medicine, anemia treatment before the use of invasive and surgical procedures, medical and surgical techniques to minimize patients' blood loss, blood conservation methods during surgery, anemia tolerance, and evidence-based blood transfusions.<sup>21</sup> Also, requesting for blood in some surgical procedures is far from standard, leading to wastage of blood products.<sup>39-41</sup> Lack of familiarity with modern meth-

ods of blood transfusion and numerous improvements in internal medicine and invasive surgical procedures results in significant increase in blood consumption. Few studies have investigated the use of blood and blood products in Iran. Nevertheless, they have shown that blood consumption is much higher in their country than in other countries and blood products are used inappropriately.<sup>42-47</sup>

The results of Gharebaghian's study showed that physicians' knowledge of blood transfusion diminished with increased years of their professional work.<sup>21</sup> Different techniques are used by health care professionals in creating behavioral changes in their practice on blood transfusion. The results of studies have shown that simple interventions are effective and reduce inappropriate use of blood.<sup>1-3</sup>

#### The role of the High Institute for Education and Research in Transfusion Medicine and Iranian Blood Transfusion Organization in transfusion medicine education

The High Institute for Education and Research in Transfusion Medicine, as an academic institution has the regional and international role to acquire the competencies needed in transfusion medicine to provide services to national and regional state. For this purpose, training MSc and PhD students of hematology and blood bank, residents of pathology and hematology/oncology fellows during one-month training courses in transfusion medicine, holding international congresses for blood transfusion, publishing books, transfusion guidelines, educational materials, and conducting researches to improve transfusion science in the region are some of the activities of this institute.

Blood transfusion centers are involved in transfusion medicine education and training for multiple levels: training laboratory sciences students in their internship and masterships, training pathology residents in some centers, holding transfusion medicine courses for physicians, laboratory scientists, nurses and other healthcare professionals, monitoring hemovigilance system in hospitals, and providing educational materials. In Iran, since 2010, the hemovigilance system has been established in hospitals through the efforts of the Iranian Blood Transfusion Organization. Physicians, health care providers, and hospital blood bank experts are trained on clinical aspects of blood transfusion, how to deal with and report the complications of blood transfusion, and basics of standards of blood bank tests. Hemovigilance officials of blood transfusion centers of each province regularly monitor this system in hospitals.

Blood transfusion centers across the country are also responsible for supervising the activities of hospital blood transfusion committees. The goal of implementing this system is the optimization of blood use, through monitoring blood requests or audit of blood orders after blood transfusion, providing feedback on cases of inappropriate prescription or transfusion reactions. However, these committees need to play a more active role in supervising appropriate blood use in hospitals.

#### The proposed training programs in transfusion medicine

Considering the current state of transfusion medicine education in the country and taking the existing capacities into account, and using the educational programs in different countries, the proposed curricula for the various educational levels are proposed as the following.

#### Transfusion medicine curricula for nursing or midwifery students

- One theoretical course of blood transfusion medicine including serology of blood groups, blood products types and uses, standard protocols of blood transfusion, and blood transfusion reactions and one practical course in blood transfusion organization (introduction to blood donation, providing blood products preparation, storage or transportation of blood products, and hemovigilance system).

- Training clinical skills of blood administration practically in internship including patient's identification before sampling and blood transfusion, the patient's blood sample labeling, patient care before, during, and after blood transfusion, symptoms, signs and management of transfusion reactions, and hemovigilance system.

#### Transfusion medicine curricula for medical students, interns, and residents

Training with emphasis on theoretical aspects of blood transfusion at college and focusing on the practical and clinical aspects in internship and residency:

- In basic sciences, topics related to the serology of blood groups and immunohematology are presented theoretically and practically.

- In pathophysiology period, there is need for learning about blood donation, blood product processing, storage conditions, production of specific components and their indications, and tests on donated bloods.

- In internship, one training course should be established for teaching pretransfusion tests, obtaining patient's consent before blood transfusion, complications of blood transfusion, emergency or massive transfusion, patient care before, during, and after blood transfusion, and hemovigilance system. Visiting blood transfusion centers in one-week courses is suggested to familiarize interns with the activity of these centers. Cooperation of educational groups of Medical Sciences Universities with the Blood Transfusion Organization can provide special learning opportunities for students of medical groups and residents.

- In residency, comprehensive training in all aspects of blood transfusion, clinical use of blood components, autologous blood transfusion, aphaeresis, antibody screening and antibody identification, patient blood management, implication of evidence-based practice, maximum blood ordering schedule (MSBOS) for surgeries, massive transfusion, patient care during blood transfusion, and management of complications of blood transfusion should be performed. A training course in blood transfusion centers at the beginning of residency will be very helpful for blood ordering residents.

In addition, their knowledge should be evaluated through questions related to blood transfusion in a written examination at the end of each course and in internship, residency, and board exams.

Blood transfusion training must be implemented clinically, too. Although theoretical education is not fully implemented in our country, it is not also enough by itself. In countries where theoretical education is completely run, the clinical use of blood transfusion is still considered poor<sup>5</sup>. In other words, students cannot use their theoretical knowledge properly at the patient's bedside and lack of clinical education with emphasis on the proper practicing in blood transfusion is strongly felt. Therefore, informal training in clinical rounds for interns, residents and also for nursing students should be improved.

#### Training transfusion medicine specialists or fellows through establishment of fellowship courses

Correct transfer of skills to students requires skilled teachers who are familiar with the modern science of transfusion medicine. In most cases, clinicians and professors have insufficient evidence-based awareness of blood use and thus transfer contradictory messages on this issue.<sup>5</sup> Therefore, there is need for the clinical teachers and pathologists to be trained in a sufficient number on transfusion medicine to give the necessary training to students. Thereby, fellowship courses should be established in the fields of pathology, clinical specialties, or hematology-oncology subspecialty. Recently, the Institute of Blood Transfusion Medicine has proposed fellowship of transfusion medicine for specialists of internal medicine, pediatrics, obstetrics/gynecology, surgery, hematology/oncology, and pathology to the Ministry of Health and Medical Education.<sup>5</sup> This field is now formally recognized in many countries. In most of these countries, specialized courses are considered to train transfusion medicine specialists.<sup>5,48</sup> It is also necessary for nursing and midwifery trainers or postgraduate students, who later practice as trainers in university hospitals, to participate in training courses.

#### Continuous medical education for practicing physicians and health care providers

Different methods are suggested for improving practitioner knowledge; these methods include preparation of guidelines for appropriate blood usage based on up-to-date scientific evidence, holding training sessions, preparing leaflets, and implementation of e-learning programs that reduce the need for physical presence. Participation in these programs can be mandatory for the professionals so that continuing their activity depends on gaining minimum score of participating in these courses. To ensure that officially adopted guidelines are actually implemented in clinical practice, the following is necessary:

I. Arranging Hospital Transfusion Committees, where attendance of Surgical, Anesthetic, Obstetrics/Gynecology, Nursing, Hematological and Blood Compatibility Laboratory staff is mandatory, adherence to guidelines is periodically reviewed; adverse or fatal reactions to transfusion are reported and investigated.

II. Hospital Transfusion Committees peer audit exercises are regularly carried out and reviewed.

III. Peer review and auditing of Hospital Blood Compatibility Laboratory practice and adherence to guidelines also need regular review.

In conclusion, fundamental changes are needed in the educational system of transfusion medicine in Iran. Students must learn the basics of transfusion medicine in the early years to be prepared to learn clinical training skills in the next years and implement transfusion medicine skills as practitioners. In addition, continuing education should be considered for professionals. The implementation of these programs requires the cooperation of the medical universities with blood transfusion centers and the Institute of Transfusion Medicine. Likewise, it requires the presence of transfusion medicine specialists to transfer updated knowledge to students. Therefore, training fellows and specialists in transfusion medicine should be prioritized. Transfusion medicine education is the key element for improving blood recipient safety and also an effective way to prevent inappropriate blood use, preserve limited blood supply, and reduce costs.

## Conflict of Interest

The author has no conflict of interest.

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