



Blood Supply and Demand in Korea: What is in Store for the Future?

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Purpose: Presently, Korea is facing new challenges associated with an imbalance in blood supply and demand. The purpose of this study was to examine trends in blood supply and demand in Korea over the past 10 years through 2018 and to propose what to prepare in the future.

Materials and Methods: Age demographics in Korea were analyzed using data from the Statistics Korea. Blood donation and blood supply data were analyzed using Blood Services Statistics 2018 by the Korean Red Cross. Blood transfusion data from hospitals in 2018 were obtained from the Health Insurance Review and Assessment Service.

Results: In 2018, 2883270 whole blood and apheresis units were collected in Korea. The Korean Red Cross supplied 4277762 blood components to 2491 hospitals. The overall blood donation rate was 5.6%, and the most frequent donors were young male donors. Leukoreduced red blood cells (RBCs) constituted 25% of all RBCs used, and 40% of all platelets were supplied by single-donor platelets. The self-sufficiency rate of domestic plasma with which to produce plasma-derived medicinal products was 68.7% in 2018. Blood use was the most frequent among patients aged 70–79 years.

Conclusion: Blood management in Korea is changing rapidly due to a low birth rate, rapid aging, and an increase in severely ill patients who require most of the blood supply. Therefore, future plans to promote donation at a national level and optimal use of blood in hospitals is necessary.

Key Words: Blood donation, blood supply and demand, Korean Red Cross

INTRODUCTION

The incidence of new HIV infections through blood transfusions in Korea in the early 2000s¹ presented a devastating challenge to the field of transfusion medicine and created apprehension throughout Korean society. The government acknowledged this as a national responsibility and endeavored to implement government-led initiatives to improve blood safety in 2004, in-

vesting more than 320 million dollars over 5 years.^{2,3} Furthermore, the Ministry of Health and Welfare introduced policies to strengthen management and supervision functions in blood transfusion services, which have been entrusted to the Korean Red Cross since 1982. In result, the infrastructure supporting blood supplies has evolved more than ever, with remarkable improvements in safety⁴ that have successfully prevented the spread of major blood-borne infectious diseases.⁵

Recently, Korea has faced new challenges associated with its changing demographics: Korea has the world's lowest fertility rate, along with the highest rate of aging, which has been accompanied by an increase in serious illnesses that require transfusions.^{6–8} Previous studies in other countries have predicted a lack of blood supply due to similar demographic changes.^{9,10} Indeed, in Korea, blood supplies acquired via blood donations have decreased, while demand has increased dramatically. The aging population has been found to be a major reason for the blood shortage. Similarly, studies have indicated that most of the blood is transfused to elderly patients, whereas blood is

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donated mainly by young donors.⁹⁻¹³

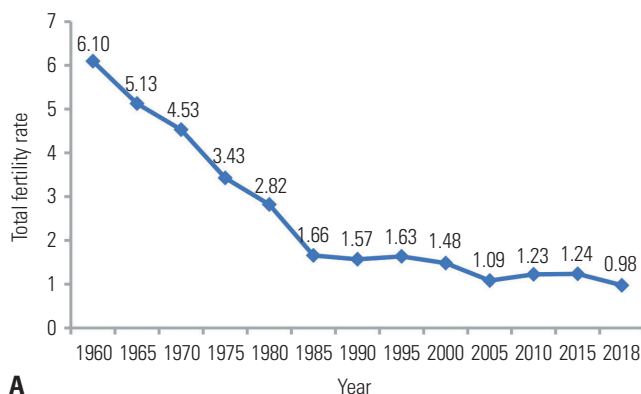
The World Health Organization has defined blood transfusions as an essential medicine.¹⁴ It is crucial to avoid potential circumstances in which a critically ill patient cannot be managed appropriately due to a lack of blood available for transfusion. Fortunately, Korea has sufficient medical safety nets to alleviate these concerns. However, there is a responsibility to prepare for the future, including the growing requirement for blood, especially red blood cells (RBCs), which depend completely on blood donations. Therefore, it is important to analyze the demographics of the country and changes in blood use for major diseases that frequently require the use of blood components.

In this study, we analyzed trends in demographic statistics, blood supplies from blood collection centers, and the number of events for transfusion at hospitals in Korea. We have also provided suggestions for management of blood transfusion services in the future.

MATERIALS AND METHODS

The age demographics of the Korean population and predictions for future population structures were analyzed using data from the Statistics Korea.^{15,16} Using these data, we analyzed the recent birth rate and age distribution in Korea. Annual data on blood donations and blood supplies were analyzed based on Blood Services Statistics 2018, annual report by the Korean Red Cross.¹⁷ We described donor characteristics and trends in blood donations based on the Korean Red Cross annual report.

Data on analyses of blood transfusions for the past 5 years (2014–2018) were obtained from the Health Insurance Review and Assessment Service, which is responsible for the national insurance benefits.¹⁸ For analysis of the number of transfused patients according to age group, only data for 2016 were available. Self-sufficiency rate was calculated based on dividing domestic plasma collections by total use of plasma. Data analysis and graphical visualization were performed with Microsoft Excel 2013 (Microsoft Corporation, Richmond, WA, USA).



RESULTS

Birth rate and age distribution in Korea

The total fertility rate in Korea was 1.05 in 2017, which is far below the average of 1.70 for member countries of the Organization for Economic Co-operation and Development in 2017 (Fig. 1A).¹⁵ Changing patterns in the proportions of each age group are shown in blue, red, or green lines from 1960 to 2060 by prediction data from the Statistics Korea.¹⁶ The proportion of people over 65 years old is expected to increase, while the proportion of people aged 0–14 years is expected to decline (Fig. 1B).

Changes in the number of blood donations and donation rate

There are three blood collection centers in Korea, where blood was collected from 2883270 donors in 2018. Total blood [RBCs, platelets, fresh frozen plasma (FFP)] from the Korean Red Cross Blood Center, which supplies 93% of all blood used, was supplied to 2491 hospitals as 4277762 units. The blood donation rate was 5.6% of the total population (51606633 people).

Age- and sex-specific characteristics of blood donors

Before 2000, teens and people in their twenties constituted more than 80 percent of all donors. Since then, the number of middle-age donors has increased. Between 1996 and 2018, the proportion of 40–49-year-old donors increased from 2% (53180 people) to 11% (328103 people). The proportion of 50–59-year-old donors also increased from 1% (12998 people) to 5% (130933 people).

However, most of donors were still in their twenties. In 2018, the proportion of blood donors was higher in younger generations: 68.4% were teenagers or young adults in their twenties, 26.2% were 30–40 years old, and 5.3% were 50–60 years old (Fig. 2). The proportion of male blood donors was approximately 73.1%, and the proportion of female donors was approximately 27% in 2018 (Fig. 3).

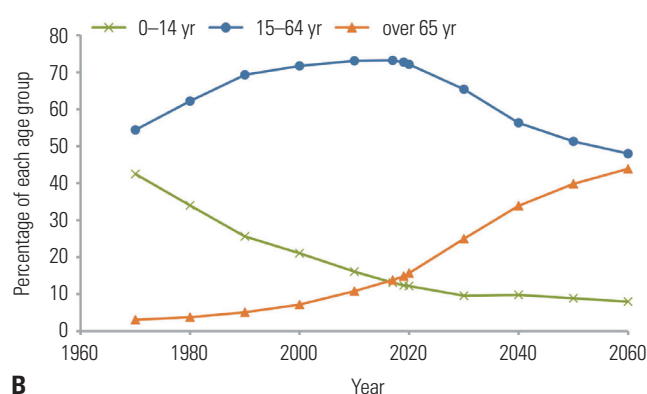


Fig. 1. (A) The total fertility rate continued to decline from 1960 to 2018, with the lowest rate in 2018. (B) Compared to the past, the proportion of people over 65 years has increased, and the proportion of people aged 0–14 years has decreased.

Trends in blood donations and supplies

Before 2005, the amount of whole blood collected was much higher than the amount of RBCs used, resulting in a lot of blood waste (Fig. 4). With implementation of the blood safety improvement project, the blood supply balance was adjusted, with efforts to shift whole blood donors to plasma apheresis donors. However, in recent years, with decreases in donor numbers and with a shortage of RBCs for transfusion, plasma donors have been converted to whole blood donors.

Annual supply trends of blood components for transfusion

In Korea, almost no whole blood is used; RBCs and leukoreduced RBCs are used for transfusion. The leukoreduced RBCs constitute approximately 25% of all RBC used, and 40% of all platelets are single-donor platelets (SDPs). Demand for FFP and cryoprecipitate has remained almost constant (Table 1).

Plasma collection for plasma-derived medicinal products

The self-sufficiency rate of plasma is represented as the pro-

portion of domestic plasma from total plasma used. The self-sufficiency rate was maintained at 50–70% from 2004 to 2014. The self-sufficiency rate was highest (95.4%) in 2015, but has steadily decreased to 68.7% as of 2018 (Fig. 5).

The number of hospitals according to blood use

The Korean Red Cross Blood Collection Center supplied 2045380 red blood units to 2491 hospitals in 2018. We divided annual blood use into eight sectors: 1–50, 51–100, 101–500, 501–1000, 1001–5000, 5001–10000, 10001–50000, and >50000 units (Table 2). In 2076 hospitals (83% of the 2491 hospitals), the annual blood volume used was less than 500 units. In addition, 69% of the total blood supply was used by only 95 hospitals (3.8% of 2491 hospitals).

Number of transfusion patients according to age group by year

In 2016 compared with 2010, the number of transfusions in patients aged 70–79 years and over the age 80 years increased by 122% and 174%, respectively. Blood use was most frequent among patients aged 70–79 years (Fig. 6).

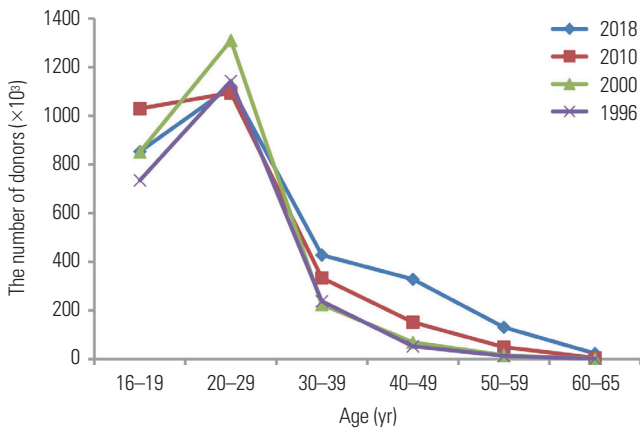


Fig. 2. The number of blood donors by age group in years 1996, 2000, 2010, and 2018.

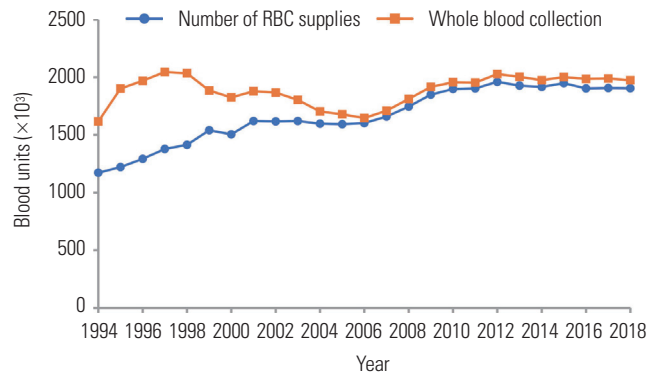


Fig. 4. Trends in whole blood collection and red blood cell (RBC) supply for transfusion.

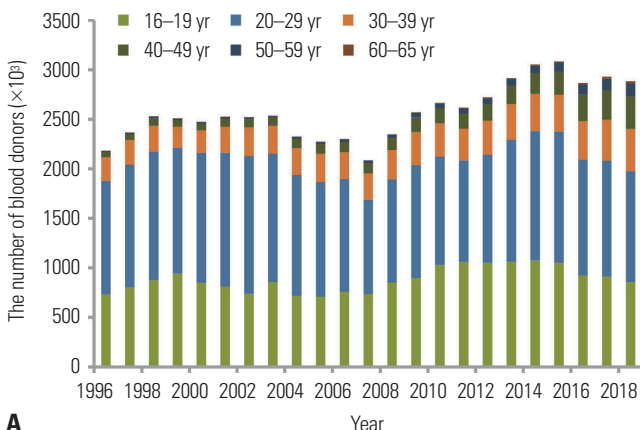


Fig. 3. The number of blood donors by age group (A) and sex (B) per year.

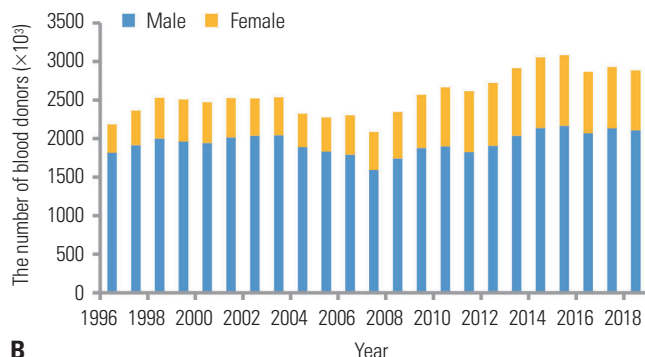


Table 1. The Number of Blood Components Supplied by Blood Collection Centers to Hospitals for Transfusion

Blood components	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Whole blood	2617	2294	1770	1662	1620	1355	1218	1033	901	764
RBC	1749692	1778890	1763675	1804884	1758244	1732761	1732738	1660547	1632363	1602462
Leukoreduced RBC	97701	116859	138186	154038	167833	181553	215361	241168	274026	301918
RDP	1555167	1604136	1622597	1618091	1512358	1354735	1250343	1165443	1409124	1547189
SDP	80538	92785	104172	118653	130343	165718	197198	216722	204130	204756
FFP	610776	605202	617105	631812	597092	586739	573284	552142	532712	530605
Cryoprecipitate	47871	54385	65043	70158	74145	75997	76970	83191	83044	89950

RDP, random-donor platelet; SDP, single-donor platelet; FFP, fresh-frozen plasma.

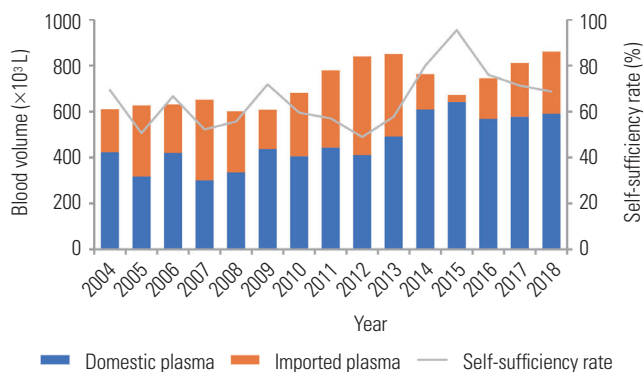


Fig. 5. Blood volume of plasma, in thousands of liters, collected in Korea per year. Data are shown as the proportion of domestic and imported plasma and the self-sufficiency rate of domestic plasma.

Table 2. The Number of Hospitals according to RBC Use

RBC use (unit)	Hospitals (%)
1–50	1186 (47.6)
51–100	314 (12.6)
101–500	576 (23.1)
501–1000	147 (5.9)
1001–5000	173 (6.9)
5001–10000	39 (1.6)
10001–50000	52 (2.1)
>50000	4 (0.2)
Total	2491 (100.0)

DISCUSSION

For blood transfusion services, especially those involving RBCs, it is important to balance the supply and demand of blood. If the supply of blood is higher than the demand, valuable blood products will be discarded. Conversely, if the supply does not meet the demand, patients who need transfusion may not be able to receive transfusion in time.¹⁹

In Korea, the blood supply for transfusions is managed by the Blood Management Act, and all blood donations have been made by voluntary non-remunerated blood donors. In Korea, there are three blood collection centers that supply blood components to hospitals. Among them, the Korean Red Cross plays a major role in blood collection⁶ and is involved in tasks, such as the manufacturing, testing, and distribution of blood prod-

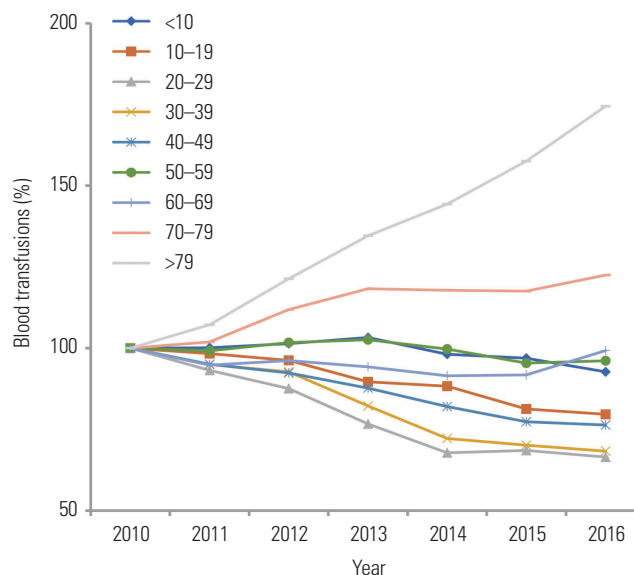


Fig. 6. The percent of blood transfusions compared to blood transfusions performed in 2010 by age.

ucts. Approximately 93% of the blood for transfusion is supplied by the Korean Red Cross, with the remaining 7% supplied by two private blood collection centers. Data for all blood donors are managed by the Blood Information Sharing System. The online system is available to check each donor’s donation history, including infectious disease screening results at the place of donation.²⁰

Recently, with a decrease in the number of blood donors and an increase in the demand for blood transfusions, there has been a worldwide concern about the shortage of blood products in the future.^{21–24} In Korea, RBC stock levels have occasionally fallen below 3 days, depending on the blood type,²⁵ and recently, a concern for a future blood shortage due to the low birth rate of Korea and an aging society has emerged.

According to the World Population Ageing 2019 report from the United Nations, the percentage of older people worldwide will increase between 2019 and 2050, with the highest growth rate (23 percentage points) in Korea.²⁶ It is predicted that the old-age dependency ratio (number of individuals over 65 years old per number of individuals 20 to 64 years old) in Korea will reach the second highest level in the world by 2050 (ratio=79), following Japan’s highest old-age dependency ratio of 81.

To solve the blood shortage problem, efforts are needed to encourage teens and young adults to donate blood. Also, additional plans should target the middle-aged population and female donors, encouraging them to donate blood as well. Compared to donation data from 20 years ago, the number of blood donors from the middle-aged population is relatively low; however, that of older adults has not changed much (Fig. 2). This means that the donors who donated 20 years ago when they were young did not continue to participate in blood donations in their middle-age years. In relation therewith, a perceived potential risk on health may affect attitudes toward blood donation. Baig, et al. reported²⁷ that the reasons for not donating blood were concerns about sterilization of equipment, unknown fears, and feeling weakness after donation. It is possible that this misconception of blood donation has affected the failure to continue blood donations by middle-age Koreans. Furthermore, a disparity between male and female donors has been observed in Korea; female donors constitute only about 20–25% of all donors, indicating that women need to be encouraged to donate blood. In addition, patient blood management should be applied to conserve restricted blood use in hospital settings.^{28–30}

In addition to blood product shortages, there have been changes in the patterns of blood use. While the demand for platelets is increasing, the use of RDPs is decreasing, and that of SDPs is increasing. Nearly 40% of total platelets are supplied by SDPs, which are preferred over RDPs to reduce exposure to multiple donor antigens and the risk for transfusion-associated infections.³¹ Demand for FFP has also increased as a replacement fluid for plasma exchange in tertiary care hospital settings, owing to ABO incompatible organ transplantation from living donors.^{32,33} However, guidelines for plasma transfusion have established a very limited spectrum of indications.^{34–36} In situations other than organ transplant surgery, the use of FFP has decreased due to guidelines on FFP transfusion; FFP use has not increased nationwide. Knowing how blood is used may be necessary for future planning.

Blood services have several characteristics that differ from other public services. To receive blood donations, people need to trust the blood donation system. As donors participate in blood donation with the intention to save someone else's life,³⁷ if there is any suspicion that the donated blood is not managed properly, the blood donation rate will drop. Therefore, blood services should be operated in the most moral and transparent manner.

It is costly to supply blood stably. The government should prepare additional blood supplies to account for unpredictable increases in demand in the future, while ensuring the safety of the blood. Blood services should provide sustainable services constantly, being able to accommodate various circumstances, including changes in population composition, climate change, and universal risks, such as war and disasters.¹⁹

There are limits to benchmarking practices in countries that offer good blood services, since blood services are influenced

by the specific environment, institutions of the country, and factors, such as epidemics, culture, and traditions. Some countries allow donors to be paid for blood collection,^{37–39} and while this model may be appropriate for their circumstances, it may not be applicable universally.

In this study, we used data from the Statistics Korea and the Blood Services Statistics 2018 report from the Korean Red Cross. The Korean data regarding the supply and demand of blood has not been widely published, despite the fact that the blood service system in Korea is relatively well organized. Analyzing Korean blood data will help to illustrate the patterns of blood supply and demand and to predict the future of aging countries with low birth rates.

In conclusion, Korea's low birth rate and aging population will face blood shortages faster than expected. Only planned countermeasures can address this situation, and an approach that seeks to increase the number of blood donors and to ensure optimal blood use in hospitals is needed. Motivating middle-aged and female donors to donate could help increase blood supplies in Korea. Also, blood donation education should be started from a young age to encourage blood donation. Policies to support various promotions and education should be developed so that the blood donation culture can spread naturally. Management of optimal blood use is also an important task. Setting up an integrated information system from donors to patients is a good solution for monitoring optimal blood use. Implementation of patient blood management for optimal blood use for transfusion is also required.

AUTHOR CONTRIBUTIONS

Conceptualization: Hyun Ok Kim and Sinyoung Kim. **Data curation:** Hyun Ok Kim and Juhye Roh. **Formal analysis:** Hyukki Min and Juhye Roh. **Investigation:** Hyukki Min and Hyun Ok Kim. **Methodology:** Hyun Ok Kim and Hyukki Min. **Project administration:** Hyun Ok Kim. **Resources:** Juhye Roh and Hyun Ok Kim. **Software:** Juhye Roh. **Supervision:** Hyun Ok Kim. **Validation:** Seung Jun Choi and Sinyoung Kim. **Visualization:** Juhye Roh. **Writing—original draft:** Juhye Roh and Hyun Ok Kim. **Writing—review & editing:** Seung Jun Choi and Sinyoung Kim. **Approval of final manuscript:** all authors.

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