Original Article

J Trauma Inj 2025;38(3):232-236
https://doi.org/10.20408/jti.2025.0061

Journal of Trauma and Injury JTI

pISSN 2799-4317 • eISSN 2287-1683

Estimated blood storage requirements for a North Korean invasion of South Korea and South Korea's preparedness

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Purpose: Hemorrhage is the leading cause of preventable battlefield deaths, and up to 30% of casualties could survive with timely transfusions. In a potential North Korea–South Korea conflict, ensuring adequate blood supply would be crucial for military medical readiness. This study estimated the 2-week blood demand in such a conflict and evaluated South Korea's preparedness to meet it.

Methods: A multifaceted approach was employed, incorporating historical casualty data, medical literature on battlefield transfusions, South Korean blood supply reports, and military blood logistics models. Projections indicate 80,000 to 150,000 casualties within the first 2 weeks, with 30% of military and 15% of civilian casualties requiring transfusions. The estimated total blood demand ranges from 360,000 to 600,000 L, surpassing current South Korean reserves.

Results: Despite a 100,000-L prewar storage goal, weekly replenishment needs could reach 150,000 to 300,000 L, placing immense strain on collection, storage, and distribution systems. Key shortages include packed red blood cells, fresh frozen plasma, and platelets, with projected deficits of up to 120,000, 70,000, and 30,000 units, respectively. The logistical challenges of storing and transporting platelets, given their 5-day shelf life, make them particularly vulnerable to depletion. To address these shortages, a multipronged strategy is required, including pre-war stockpiling, mobile blood banks, rapid military-civilian coordination, international cooperation with US and other allies, and prioritization of whole blood over component therapy.

Conclusions: South Korea's current blood reserves are insufficient for a large-scale war. A combination of strategic stockpiling, military-civilian coordination, and alternative blood sources (synthetic oxygen carriers, prewar autologous donation programs) is essential to sustaining medical operations and improving survival rates.

Keywords: Armed conflicts; Republic of Korea; Democratic People's Republic of Korea; Blood transfusion; Blood preservation

Received: March 13, 2025
Revised: April 28, 2025
Accepted: May 2, 2025

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INTRODUCTION

Background

Hemorrhage remains the leading cause of preventable death on the battlefield. Studies indicate that up to 30% of soldiers who die in action or from wound complications might have been saved with early intervention and effective hemorrhage control [1]. Providing safe and timely blood transfusions during a large-scale conflict is a critical element of military medical readiness. Due to its proximity to North Korea, South Korea faces unique challenges in maintaining an adequate blood supply during a full-scale war. Military blood management should emphasize sufficient collection, minimal storage time, rapid transportation, and immediate use to minimize wastage [2].

Objectives

The primary objective of this study was to estimate the blood demand for a 2-week North Korea–South Korea conflict and assess South Korea's preparedness to meet these requirements. Historical war simulations, military assessments, and expert analyses provide a solid framework for estimating casualties and transfusion needs.

METHODS

To estimate the blood requirements and storage needs for a potential North Korea–South Korea conflict, this study drew upon casualty projections from military studies, medical literature on battlefield transfusions, current South Korean blood supply data, and military blood logistics and distribution models. Data from historical chemical and biological warfare incidents, wargame simulations conducted by organizations such as RAND Corporation [3], historical Korean War analyses, casualty surge modeling from the Congressional Research Service [4], and US-Korea Institute (USKI) [5] were analyzed to estimate potential casualty rates in a chemical and biological weapons attack. Casualty projections were triangulated across multiple independent studies and official defense sources to minimize potential bias. Transfusion benchmarks per injured soldier were derived from prior conflicts like Iraq and Afghanistan [6], while national blood collection and storage trends were evaluated using reports from the Korean Red Cross and other health organizations [7,8]. Finally, strategies for blood logistics, storage, and emergency replenishment were examined through frameworks provided by the North Atlantic Treaty Organization (NATO) and US military medical organizations (US Department of Defense Center of Excellence for Trauma) [9–13].

Ethics statement

This study did not require institutional review board approval nor informed consent because it was a literature-based study.

RESULTS

Casualty estimation

A RAND study estimated that a renewed Korean War could result in 250,000 to 500,000 casualties within the first 90 days, with 80,000 to 150,000 occurring during the initial 2 weeks [3]. Additionally, a 2019 South Korean defense report predicted that Seoul, due to its high population density and proximity to the demilitarized zone (DMZ), could experience several hundred thousand casualties within the first few days of an attack [3].

In a 2-week war scenario, military casualties, including those among South Korea, the United States, and North Korea, are estimated to range between 150,000 and 550,000. Civilian casualties are projected to be equally severe, numbering between 250,000 and 500,000 [4,5]. Approximately 30% of military casualties and 15% of civilian casualties are likely to require blood transfusions due to severe injuries. Under battlefield conditions and constrained medical evacuations, each critically wounded patient is estimated to need 6 to 10 units of blood, equivalent to roughly 1.5 to 2.5 L per patient. Although the combined medical response capacity of South Korea and US forces is expected to treat 40% to 50% of critically wounded personnel within the first 2 weeks, any delay in blood supply logistics could significantly increase mortality rates.

Estimated blood demand

Based on the projected casualties, the estimated blood requirement for military personnel, including those from South Korea, the United States, and North Korea, is between 247,500 and 412,500 L over a 2-week period. Civilian demand is estimated at 112,500 to 187,500 L. In total, the combined blood transfusion demand in this scenario is between 360,000 and 600,000 L (Table 1).

Blood storage and logistics considerations

To meet the anticipated surge in demand, an immediate blood storage goal of at least 100,000 L must be established prior to conflict, with supplies distributed strategically among major military and civilian hospitals. However, given the intensity and duration of combat, weekly replenishment requirements may range

Table 1. Blood requirement calculations

Variable	Military casualty		Civilian casualty
	South Korea and US Forces	North Korea	
No. of estimated casualties	150,000	400,000	500,000
No. of severely wounded cases[a)]	45,000	120,000	75,000
Amount of blood required per patient (U)	6–10	6–10	6–10
Total estimated amount of blood needed (L)	67,500–112,500	180,000–300,000	112,500–187,500

The estimated combined blood transfusion demand is between 360,000 and 600,000 L.
[a)] Approximately 30% of military casualties and 15% of civilian casualties.

from 150,000 to 300,000 L, depending on the scale of hostilities and casualty rates.

To maximize efficiency, blood components should be prioritized according to battlefield resuscitation protocols (Tables 2, 3) [12]. Packed red blood cells (PRBCs) should be used primarily to treat patients in hemorrhagic shock, ensuring rapid restoration of oxygen-carrying capacity. Fresh frozen plasma (FFP) is vital for patients requiring massive transfusions and for managing coagulopathy, particularly in cases of severe trauma or blast injuries. Platelets are critical for hemostasis, especially in patients suffering from blast-related injuries and traumatic brain injuries; however, their short shelf life (approximately 5 days) presents logistical challenges for sustained supply chains.

Recommended blood component storage

The estimated demand for whole blood is between 40,000 and 80,000 units; however, current supplies in South Korea range from 30,000 to 40,000 units, resulting in a shortfall of 10,000 to 40,000 units. Similarly, the projected requirement for PRBCs is between 100,000 and 200,000 units, while available supplies are only 50,000 to 80,000 units—a deficit of 50,000 to 120,000 units. For FFP, the estimated demand is between 60,000 and 120,000 units, but current supplies only total 40,000 to 50,000 units, leading to a shortage of 20,000 to 70,000 units. Platelets, which are crucial for managing severe battlefield trauma, exhibit the largest supply gap; demand is expected to be 20,000 to 40,000 units, while current reserves are only 5,000 to 10,000 units, resulting in a deficit of 15,000 to 30,000 units. These figures underscore the urgent need to increase blood stockpiles, particularly for PRBCs and platelets, which are critical for treating combat-related injuries. Enhancing emergency blood collection programs and collaborating with allied forces for rapid resupply will be essential to address these shortfalls (Tables 4, 5).

Blood substitutes and emergency sources

In addition to stored blood, alternative resuscitation methods must be explored to mitigate shortages during prolonged conflicts. Synthetic oxygen carriers (e.g., Hemopure, Hemoglobin Oxygen Therapeutics; PolyHeme, Northfield Laboratories) could serve as viable alternatives when whole blood is insufficient. Additionally, autologous blood donation programs should be expanded during prewar planning to ensure a steady supply of compatible blood products during crises.

DISCUSSION

The US Joint Trauma System (JTS) and NATO military medical protocols recommend using stored whole blood as the preferred product for prehospital resuscitation. Clinical data from conflicts in Iraq and Afghanistan indicate that whole blood is superior to crystalloid or colloid resuscitation fluids regarding survival and hemodynamic stability [14].

Recent US military blood utilization data reveal a shift toward low-titer type O whole blood because of its logistical advantages. This transition from component therapy (PRBCs and FFP) to whole blood reflects a growing recognition of its efficiency in combat zones [15,16].

As of 2020, South Korea collected 2.6 million units of blood annually. However, projections indicate that collections could decline to 1.4 million units by 2050, even as demand may peak at 5.1 million units by 2045 [7]. Current reserves would be insufficient for a prolonged war; therefore, emergency mobilization, international logistical support, and alternative blood sources would be necessary.

In defending against a potential North Korean invasion, our strategic recommendations are as follows. First, increase military and civilian blood stockpiles before conflict. Second, deploy mobile blood banks and forward storage facilities. Third, enhance international cooperation (with the United States and NATO) to secure rapid blood supply. Fourth, prioritize whole blood over component therapy for battlefield transfusions. Lastly, invest in developing synthetic blood alternatives and extending the shelf life of platelets.

In summary, a large-scale North Korea–South Korea conflict

https://doi.org/10.20408/jti.2025.0061

Table 2. Military trauma transfusion ratios (massive transfusion protocols)

Component	Function	Usage in war trauma
Whole blood	Best for massive hemorrhage; contains red blood cells, plasma, platelets, clotting factors	Used if component separation is unavailable
Packed red blood cell	Oxygen delivery, resuscitation for hemorrhagic shock	2:1:1 Ratio in massive transfusions
Fresh frozen plasma	Coagulation factor replacement, reduces dilutional coagulopathy	1:1:1 Ratio in massive transfusions
Platelet	Clot formation, essential for blast injuries and traumatic brain injuries	1:1:1 Ratio in massive transfusions

Although both 1:1:1 and 2:1:1 transfusion ratios have been used, recent US military guidelines recommend 1:1:1 or the use of low-titer type O whole blood where feasible, to simulate balanced component therapy [12]. The 2:1:1 ratio may be used when plasma or platelets are limited.

Table 3. Immediate prewar storage (strategic reserve)

Component	Recommended immediate storage	Volume (L)	Clinical consideration
Whole blood	10%	10,000 –20,000	Used for emergency transfusion if separation is unavailable
Packed red blood cell	50%	180,000 –300,000	High demand for hemorrhagic shock
Fresh frozen plasma	30%	108,000–180,000	Essential for coagulopathy
Platelet	10%	36,000–60,000	Short shelf life (approximately 5 days)
Total	100%	360,000–600,000	Adjusted for estimated demand

Table 4. Demand-supply comparison table for South Korea's blood storage in a 2-week conflict scenario with North Korea

Category	Estimated value	Source
No. of casualties	80,000–150,000	RAND study, South Korean defense reports [3]
No. of patients needing transfusion[a]	16,000–30,000	Based on battlefield medical data [4]
Average amount of blood per patient (U)	10	Iraq and Afghanistan war data [6]
Total blood demand for 2 wk[b] (U)	160,000–300,000	-
Annual blood collection (South Korea) (U)	≈2.6 million	2020 Korean Red Cross data [7]
Monthly blood availability[c] (U)	≈216,000	-
Available blood for 2 wk[d] (U)	≈108,000	-
Projected shortage[e] (U)	52,000–192,000	-
Most critical shortage	PRBCs (short supply) and platelets (5-day shelf life)	-

PRBC, packed red blood cell.
[a]Approximately 20%. [b]Calculated using the formula, "no. of casualties × transfusion rate × units per patient." [c]Annual collection divided by 12. [d]Estimated half-month stock. [e]Calculated using the formula, "demand – available supply."

Table 5. Blood component demand-supply comparison (2-week war scenario)

Blood component	Estimated demand (U)	Available supply (U)	Shortfall (U)	Critical issue
Whole blood	40,000–80,000	30,000–40,000	10,000–40,000	Limited availability, requires quick transfusion
Packed red blood cell	100,000–200,000	50,000–80,000	50,000–120,000	Most critical shortage, 42-day shelf life
Fresh frozen plasma	60,000–120,000	40,000–50,000	20,000–70,000	Requires thawing, logistical challenge
Platelet	20,000–40,000	5,000–10,000	15,000–30,000	Severe shortage (5-day shelf life)

would render South Korea's current blood reserves critically insufficient to address the projected casualties. A combination of strategic prewar stockpiling, enhanced military-civilian coordination, and international blood supply agreements is essential to sustain medical operations. Adopting modern battlefield resuscitation strategies, with an emphasis on whole blood use and damage control resuscitation, will be vital to maximize survival rates.

ARTICLE INFORMATION

Author contributions

Conceptualization: KH; Funding acquisition: KH; Methodology: all authors; Project administration: KH; Visualization: CP; Writing–original draft: KH; Writing–review & editing: CP. All authors read and approved the final manuscript.

Conflicts of interest

Kun Hwang and Chan Yong Park are editorial board members of this journal, but were not involved in the peer reviewer selection, evaluation, or decision process of this article. The authors have no other conflicts of interest to declare.

Funding

This study was supported by the Korean Military Medical Research Project (No. ROK-MND-2024-KMMRP-006), funded by the Korean Ministry of National Defense.

Data availability

Data analyzed in this study are available from the corresponding author upon reasonable request.

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https://doi.org/10.20408/jti.2025.0061