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*Original Article*

# Application status of blood constituents during massive blood transfusion in some regions of China

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**Abstract:** Objective: This study aims to learn about the current situation of surgical massive blood transfusion in China's Class III general hospitals, which could provide the basis for the formulation of guidelines on massive blood transfusion. Methods: A multicenter retrospective research on the application status of blood constituents during massive blood transfusion was conducted and a comparative analysis on the distribution of the population infused with other blood constituents and the transfusion volume at different periods of time when red blood cells are infused in different units within 24 hours as well as on the blood applied for both the death group and survival group was made in this study. Results: In China, during massive blood transfusion the ratio of the dosage of fresh frozen plasma to the dosage of red blood cell suspension reached 1:1-2, while the dosage of platelet and cryocepitate appeared to be very small. Conclusion: During massive blood transfusion, clinicians in 20 Chinese hospitals paid more attention to the infusion of fresh frozen plasma while making the infusion of red blood cells. However, they paid little attention to the supplement of platelet and cryocepitate.

**Keywords:** Massive blood transfusion, blood constituents, retrospective analysis

## Introduction

Blood transfusion plays an important role in the process of rescuing severe patients in emergency and danger. Timely and sufficient blood infusion plays a key role in the rescue of patients loosing massive blood. Recent studies show that, during massive blood transfusion, high proportioned FFP and platelet infusion at the early stage may increase the survival rate of the patients and decrease the infusion volume of RBC [1-6].

In order to learn about the current situation of surgical massive blood transfusion in China's Class III general hospitals and provide the basis for the formulation of China's guidelines on massive blood transfusion (draft for recommendation), we have made the multicenter retrospective research analysis on a large number of medical records for massive blood transfusion in 20 Class III general hospitals located in different regions of China. This study reported the application of blood constituents in 1,601 transfusion patients, aiming to understand the application status of blood constituents of surgical massive blood transfusion patients during blood transfusion in our nation.

## Methods

This study has been approved by the ethical committee of the Third Affiliated Hospital of Medical College of Xi'an Jiaotong University. The subject's informed consent was obtained from each of the participants.

### *Collecting data*

Distribute 2000 copies of Massive blood transfusion Survey Table (Herein referred to as

"Survey Table" to 20 Class III comprehensive hospitals in the northwest, southwest, central south, north and northeast of China. Members of National Massive blood transfusion Current Status Investigation Coordination Group (Herein referred to as "Coordination Group") are responsible for collecting data from these hospitals and filling in Survey Table. Data on case history of inpatients who received massive blood transfusion during surgery in 20 Chinese hospitals from January 2009 to December 2010 were collected. Materials were collected during June 2010-January 2011.

*Determination of study subject*

Inclusion criteria: Patients transfused ≥10 U RBC (1 U is 200 mL whole blood, similarly hereinafter) within 24 h were part of the observation group; those transfused less than 10U within 24 h as control group. Disease entity under investigation: trauma transfusion, cardiac surgery transfusion, obstetrics transfusion, other common surgeries (orthopedics, chest surgery, general surgery, urinary surgery, hepatobiliary surgery and neurosurgery etc.) transfusion. Exclusion criteria: coagulation disorder caused by hematological diseases, hepatic failure and bleeding due to deficiency of coagulation factors caused by other medical diseases. Study grouping: according to red blood cell transfusion volum within 24 or 72 hours, they are divided into 0-4 U, 5-9 U, 10-14 U, 15-19 U, 20-24 U, 25-29 U, 30-39 U and 40 U-group.

*Investigation procedure*

The directors of Transfusion Department of the above mentioned 20 hospitals design the Survey Table through topic discussing, experts consulting and referring to massive domestic and foreign materials based on the principle of equality, voluntariness and mutual benefits. The launching meeting of investigation was held and 35 experts of clinical transfusion, surgery, anesthesia, gynaecology and obstetrics, hematological disease and medical statistics discussed the plan, the investigation staffs were trained.

Survey Table is divided into 4 parts: 1. General conditions and characteristics of patients: name, gender, age, weight, blood group, ethnicity, hospital number, department, main diagnosis, secondary diagnosis, pathological diagnosis, operation, vital signs on admission etc; 2. Event: Surgery, transfusion within 24 hours, transfusion after 24 hours, total transfusion volume, pre-operation and intraoperation condition. 3. Examination results before transfusion (including blood RT, coagulation, liver function, kidney function, kidney function ion blood gas analysis); Examination results within 24 hours after transfusion (including blood RT, coagulation, liver function, kidney function, kidney function ion blood gas analysis); Examination results after 24 hours post transfusion (including blood RT, coagulation, liver function, kidney function, kidney function ion blood gas analysis); 4. Adverse events ( Massive blood transfusion risk).

*Quality control*

Small pre-investigation was conducted by Shaanxi Provincial People's Hospital using Survey Table. The Survey Table was revised and finalized it according to pre-investigation results and experts' comments.

Examination data such as blood routine, coagulation, liver function, kidney function, kidney function ion blood gas analysis etc. were from lab examination index of surgical inpatients of 20 Class III hospitals with Massive blood transfusion. Each lab conducts internal quality control and participates in external quality assessment organized by Clinical Test Center of Ministry of Health.

*Statistical analysis*

Statistical analysis was conducted using SPSS software (SPSS 18.0. Chicago, IL: SPSS Inc.). Comparison of the means of two samples which were normally distributed continuous variables used t test and U test for larger sample. Categorical variables were analyzed by chi-square test, and Bonferroni method was applied as post-hoc tests for analyzing the differences between groups which were statistically significant. Survival analysis and multivariate logistic regression analysis were also used.

## Results

*General data description of the study subject*

A total of 1,753 pieces of the *Survey Form* were retrieved from 20 hospitals participating in the survey. The retrieving rate was 87.65%

**Table 1.** Baseline data of 1,601 transfusion patients

| | <10 | ≥10 | *P* |
|---|---|---|---|
| Demograhics | | | |
| Number of patients, n | 553 (34.5) | 1048 (65.5) | |
| Age, yr (±SD) | 46.5±18.2 | 44.9±16.7 | |
| Males, n | 300 (300/553), | 402 (400/1048) | |
| Weight, kg (±SD) | 56.6±13.9 | 58.5±11.4 | |
| Number of patients (1)[a], n | 81 (30.2) | 187 (69.8) | |
| Number of patients (2)[b], n | 116 (30.3) | 267 (69.7) | |
| Number of patients (3)[c], n | 335 (38.2) | 541 (61.8) | |
| Number of patients (4)[d], n | 21 (28.4) | 53 (71.6) | |
| Clinical data (before transfusion) | | | |
| R, n/min (±SD) | 20.3±3.5 | 20.5±3.6 | 0.043* |
| P, n/min (±SD) | 94.1±69.8 | 92.5±54.3 | 0.452* |
| RP, mmHg (±SD) | 113.5±24.7 | 112.8±30.2 | 0.020* |
| T, °C (±SD) | 36.6±1.0 | 36.5±0.7 | 0.319* |
| RBC, ×1012/l (±SD) | 3.8±1.0 | 3.8±1.1 | 0.323* |
| Hb, g/l (±SD) | 114.3±30.2 | 117.4±43.2 | 0.213* |
| Hct, % (±SD) | 21.2±17.7 | 16.6±17.6 | 0.834* |
| PLT, ×109/l (±SD) | 179.5±91.5 | 175.6±98.9 | 0.324* |
| PT, s (±SD) | 13.7±6.0 | 14.1±5.8 | 0.173* |
| APTT, s (±SD) | 33.6±11.7 | 36.3±24.2 | 0.006* |
| TT, s (±SD) | 17.1±12.8 | 17.5±7.1 | 0.529* |
| INR | 1.3±2.1 | 1.2±1.1 | 0.041* |
| FIB (g/l) (±SD) | 11.3±44.4 | 11.0±46.6 | 0.801* |
| Clinical data (after transfusion) | | | |
| Days of stay, d (±SD) | 24.9±14.3 | 29.8±23.9 | 0.000* |
| Stay in ICU, d (±SD) | 3.8±3.5 | 8.7±23.4 | 0.006* |
| Operation time | 2.5±3.2 | 3.7±3.9 | 0.000* |
| pRBC in 24 h (U) | 9 | 25 | 0.000** |
| FFP in 24 h (U) | 8 | 20 | 0.000** |
| PLT in 24 h (U) | 10 | 6 | 0.009** |
| pRBC in 72 h (U) | 20 | 18 | 0.202** |
| FFP in 72 h (U) | 14 | 13 | 0.499** |
| PLT in 72 h (U) | 8 | 8 | 0.873** |

*Values are mean ± SD. **values are medians. *Analysis of Variance was used. **Kruskall-Wallis test was used; [a,b,c,d]stands for patients who suffered from trauma, cardiopathy diseases, general surgery and obstetric condition respectively.

(1,753/2,000). With the exclusion of the forms for missing items, 1,601 (people) pieces of medical records of surgical massive blood transfusion that can be used for the statistical processing were acquired. Among 1,601 massive blood transfusion patients, the mortality was 10.31% of patients infused with RBC≥10 U and 4.34% of patients infused with RBC<10 U within 24 hours. A total of 268 cases were under trauma and the mortality was 12.69%, 383 cases were under cardiac surgery and the mortality was 13.84%, 876 cases were under general surgery and the mortality was 4.79%, 74 cases were under obstetrics and the mortality was 4.05%. 4) When RBC≥10 U was infused within 24 hours, the death rate of the patients under the four departments was sequenced as: cardiac surgery (18.4) > trauma (14.4%) > obstetrics (5.7%) > general surgery (5.4%); when RBC<10 U was infused within 24 hours, the death rate sequence was trauma (8.6%) > general surgery (3.9%) > cardiac surgery (3.4%) > obstetrics (0%). The baseline data of 1,601 transfusion patients were shown in **Table 1**.

*Application of red blood cell suspension, platelet suspension, frozen plasma and cryocepitate among 1,601 transfusion cases*

Platelet suspension, frozen plasma and cryocepitate were also used among 1,601 transfusion cases. When 6 units of RBC are infused among 1,601 transfusion cases, a total of 1,545 cases used RBC. Meanwhile, 54.24% of them used plasma, 2.46% of them used platelet and 3.11% of them used cryocepitate. **Figure 1** showed the distribution of the cases infused with other blood constituents when RBC was infused in different units within 24 hours. **Figure 2** showed the virtual average infusion volume of other blood constituents when RBC was infused in different units within 24 hours.

We found that red blood cell suspension and plasma volume used by patients in the death

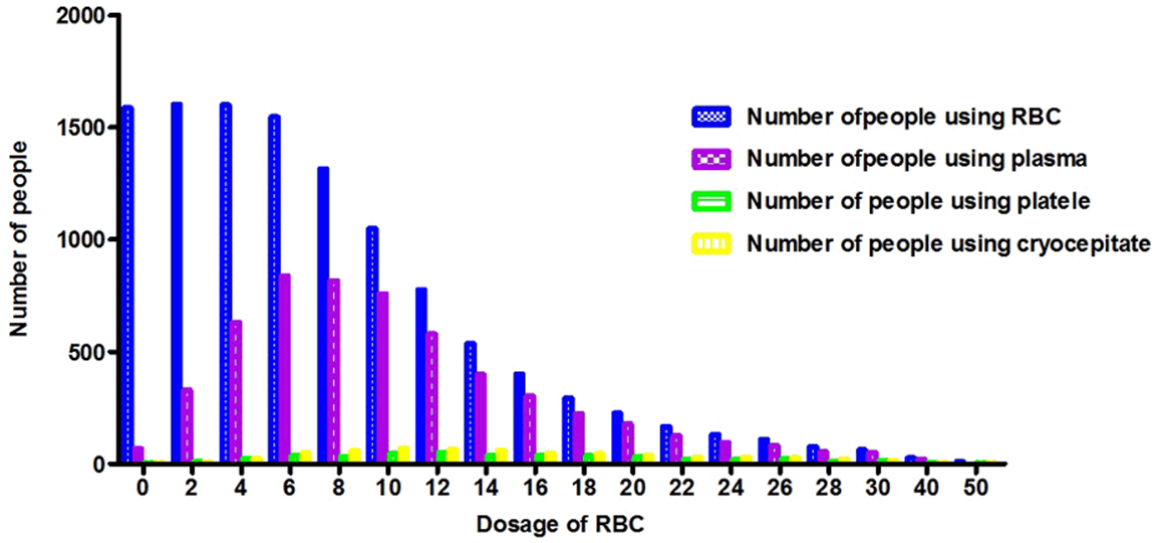


**Figure 1.** Number of cases using different blood constituents under different dosage of RBC.

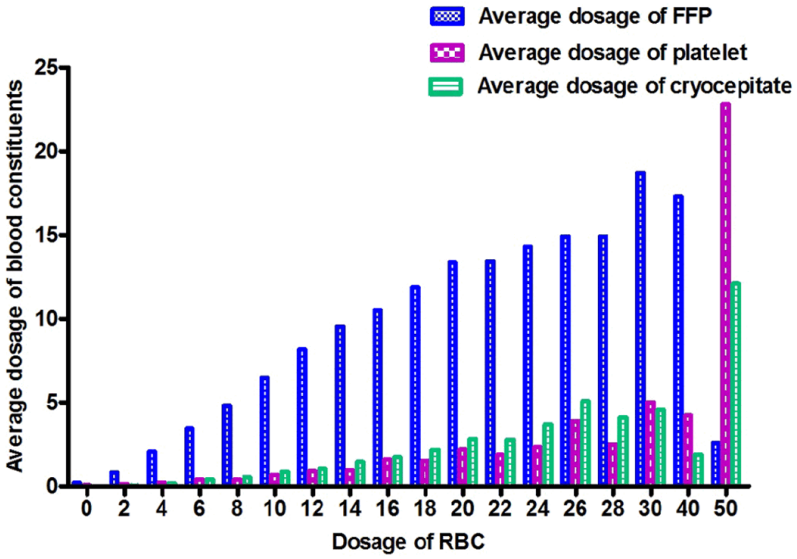


**Figure 2.** Virtual average volume of other blood constituents under different dosage of RBC.

**Table 2.** Basic information of the volume of patients' red blood cells, plasma and cryocepitate input

| | Survived patients (n = 1469) | Dead patients (n = 132) |
|---|---|---|
| Red blood cells (U) | 14 | 23 |
| Plasma (U) | 14 | 23 |
| Platelet (U) | 3 | 2.5 |
| Cryocepitate (U) | 2 | 2 |

group within 24 hours were greater than that used by the survival group (**Table 2**).

## Discussion

Among 1,601 massive blood transfusion cases, 1,048 patients were infused with RBC≥10 U within 24 hours and 108 patients died, 553 patients were infused with RBC<10 U within 24 hours and 24 patients died. When RBC ≥10 U was infused within 24 hours, the death rate sequence of the patients in the four departments was: cardiac surgery (18.4%) > trauma (14.4%) > obstetrics (5.7%) > general surgery (5.4%); when RBC<10 U was infused within 24 hours, the death rate sequence was trauma (8.6%) > general surgery (3.9%) > cardiac surgery (3.4%) > obstetrics (0%). The death rate of massive blood transfusion patients recorded in this study was lower than that reported in the literature [7, 8]. Maybe it is because the 20 hospitals involved in the survey are all large general hospitals located in different regions of China,

which have relatively good rescue conditions or because there are relatively less traumatic medical records and more general surgical medical records in this group of data or because the preoperative preparations are sufficient. These need further study.

Through the analysis of the number of people infused with other blood constituents when RBC are infused in different units within 24 hours in 1,601 blood transfusion medical records, we found that during massive blood transfusion, Chinese clinicians did not pay more attention to the application of platelet and cryocepitate. It is worthy of a deep thinking whether it is maybe related to the supply deficiency of platelet and cryocepitate in China or a problem idea on blood transfusion. Meanwhile, a comparison analysis of the plasma, platelet and cryocepitate dosage corresponding to RBC dosage in different units was made in this study. The results showed that, during massive blood transfusion, the ratio of the dosage of fresh frozen plasma to that of RBC suspension reached 1:1-2, which is consistent with other researches [1, 9-14]. Nevertheless, the dosage of platelet and cryocepitate is very little. During massive blood transfusion, it may reduce the patients' death rate if the ratio of plasma, RBC and platelet remains 1:1:1. Therefore, Chinese clinicians should pay more attention to supplement of platelet in order to reduce the occurrence of massive blood transfusion complications and increase the success rate of rescue.

In conclusion, during massive blood transfusion, clinicians not only should pay more attention to the infusion of fresh frozen plasma while making the infusion of red blood cells, but also should pay more attention to supplement of platelet in order to reduce the occurrence of massive blood transfusion complications and increase the success rate of rescue.

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## Disclosure of conflict of interest

None.

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