Cardiovascular Topics

Creating blood conservation for a cardiothoracic surgical hospital: when you have to start from scratch!

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Abstract

Background: This improvement report presents a hospital blood-management programme, a hospital-specific model that differs from patient blood managment and was aimed at improving operational standards of transfusion. We identified the challenges of the transfusion process and suggest practical strategies for improving them. The aim of this article was to investigate the effect of the programme on the transfusion of blood components.

Methods: In January 2019, the programme was started to improve the transfusion process. The data before and after the start of the programme were compared. Frequency distribution was obtained for each variable for statistical analysis and the chi-squared test with continuity correction was used to compare these variables for the years 2018 and 2019.

Results: Transfusion of total blood components decreased by 23.2%, fresh whole blood by 46.7%, fresh frozen plasma by 38.4%, pooled platelets by 14.0% and red blood cells by 9.66%. Autologous transfusion increased 11.7-fold. The emergency department (76.0%) and intensive care unit transfusion rate (9.26%) decreased significantly.

Conclusion: This programme is an example for hospitals where patient blood management cannot be applied. The programme can be considered the first step for blood management and may be applied to blood management in institutions worldwide. The difficulty of blood supply and increased cost will increase the importance of hospital blood-management programmes in the coming years.

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Transfusion of blood components is associated with complications and high costs, which have introduced concerns about this therapy.[1,2] Decisions about transfusion are determined by guidelines, physicians' habits and hospital transfusion policies, which have not incorporated these issues.[3-6] Patient blood management (PBM), a patient-centred approach, is a multidisciplinary, evidence-based, patient-personalised approach with known clinical results.[7-10]

Implementation of PBM often faces difficulties in healthcare services and from clinicians' resistance. In this article we ask: What can be done if implementing PBM meets significant resistance? How can the transfusion processes be improved? Does a transfusion quality-improvement programme affect blood-component use in a hospital?

On 1 January 2019, we instituted a programme called hospital blood management (HBM), which was created to meet our needs. It was directed towards quality improvement, patient safety and awareness of transfusion costs and adverse events.

There is no hospital blood management keyword in the literature. We have used this concept to focus on hospital staff performance, not patient transfusion requirements, with strict application of defined methodology. The aim of this article was to present the results from implementation of this programme in our hospital.

Methods

Kosuyolu High Specialization Training and Research Hospital is a tertiary-care facility with 465 beds. The hospital specialises in thoracic and cardiovascular procedures and has performed the second highest number of heart and lung transplantations in Turkey.

This study was a retrospective review of the results of the transfusion quality programme, introduced in 2019, compared with transfusion data from 2018. Institutional ethics committee approval was received on 8 May 2020, with the number 2020.4/04 304.

On 1 November 2018, a programme was presented to the hospital management to improve blood-component management at our centre. A core team was set up that was responsible for holding didactic presentations, training, data monitoring and auditing the programme. The team included a cardiovascular surgeon, an anaesthesiology/critical care doctor, a transfusion doctor, and haemovigilance nurses.

For the HBM programme, first, transfusion characteristics in the emergency service, intensive care unit (ICU) and operating room were determined. Data were recorded at hours when transfusion requests were heaviest. The use of autologous blood, habits of transfusion of fresh frozen plasma (FFP), fresh whole blood (FWB) and other blood components, and donation of pre-operative blood components were tabulated. Proposals for solutions to problems identified were addressed through shared wisdom.

In January 2019, a model of transfusion processes was developed as a quality-improvement project. The data collected before and after the start of the programme were compared.

We first reviewed transfusion-related workflow step by step to detect problems in the process (Fig. 1).[11,12] We created an acceptable standardised transfusion threshold, ranging from a more restrictive to a more liberal threshold, depending on the patient populations. The core team observed physicians' transfusion practice and decision making.

The pre-operative quantity of blood components prepared were three units of packed red blood cells (PRBC), two units of FWB and two units of FFP. For every FWB and PRBC unit ordered, a cross-match was made. Two units of FFP were routinely administered concomitantly with protamine at the end of cardiopulmonary bypass (CPB). FFP was the most-often requested blood component in the emergency department (ED). Patients with international normalised ratio (INR) values of > 4.5 received FFP transfusion routinely because of the high risk of bleeding.

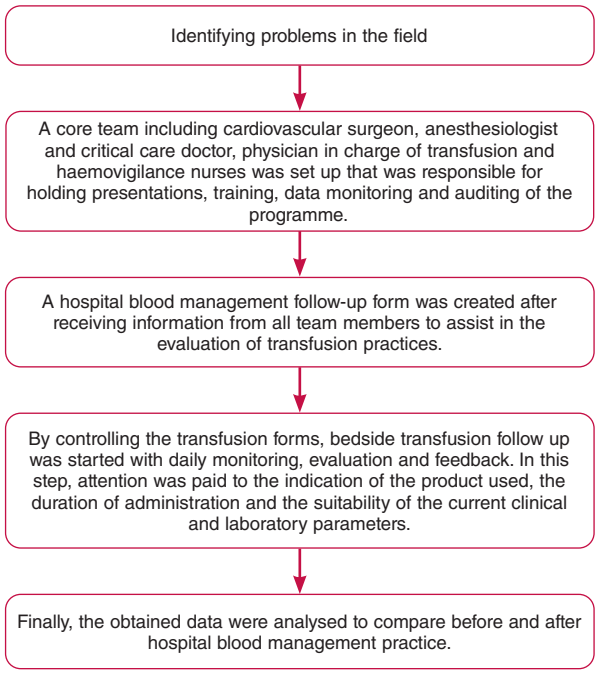

Fig. 1. Stages of the transfusion programme model

Cryoprecipitate transfusions were administered without measuring fibrinogen values, except with massive transfusions. Platelets were ordered for postoperative patients who had continued bleeding, and platelets were routinely administered to patients with platelet counts of < 100 000 cells/mm^3.

Peri-operative autologous blood collection was rare. Use of cell recovery (Cell Saver®) was limited. One-third of all blood-component orders was made during the 17:00 shift change of the ICU.

Initially, all surgeons, anaesthesiologists and internal medicine physicians, then perfusionists, anaesthesiology technicians and nurses were given training on the risks, benefits and alternatives of blood transfusion. The training modules were tailored to the transfusion steps for which each professional was responsible. Blood component usage, approach to transfusion reactions, transfusion policies of our centre and our plans were explained, with examples taken from our daily clinical practice. Reminders were provided through e-mail and hospital-informed pop-up windows. Use of FWB and FFP transfusions was high and for numerous indications, therefore, emphasis was placed on reducing the number of FWB and FFP transfusions.

Two units of PRBC were prepared for pre-operative patients. Also, orders for FFP were not permitted before operations. FWB orders were limited to situations where FWB was felt necessary, such as massive transfusions or high INR due to warfarin usage or liver failure.

Clinicians determined the PRBC transfusion threshold to be a haemoglobin (Hb) value of 9 g/dl. Physicians were encouraged to evaluate the patient's haemodynamic status, electrocardiogram, and arterial blood gas values before giving transfusions, rather than transfusing based on Hb value alone. Teams responsible for elective operations and invasive procedures were asked to reschedule if their patients had INR values > 1.8.

Clinicians caring for extracorporeal membrane oxygenation, intra-aortic balloon pump and left ventricular assist devices were allowed more liberal transfusion. FFP given for high INR was most frequently given in the ED. The use of FFP for high INR is common in our institution, but it is not recommended. A flow chart for FFP was prepared, based on current guidelines.[8,13-16] Patients with bleeding risk or active bleeding were transferred to the ICU before transfusion unless the bleeding was critical.

The use of peri-operative autologous blood by anaesthesiologists was increased through training and practice. Autologous blood was stored in the operating rooms at room temperature for up to six hours. The practice of routinely transfusing two units of FFP immediately after protamine injection at the end of CPB was discontinued. Cryoprecipitate was transfused as part of massive transfusions and/or bleeding with fibrinogen values < 100 mg/dl.

At the end of evening (17:00) rounds, a senior physician reviewed the blood transfusions given to haemodynamically stable patients, and the staff was given feedback when inappropriate transfusions occurred.

To aid in evaluating the transfusion practices, a hospital blood-management follow-up form was constructed after receiving input from all team members (Fig. 2). With this form and the patients' demographic data, a practical guide was created for decision making on the transfusion of blood components. The form was adapted to fit the features of our centre and was easy to understand and complete.

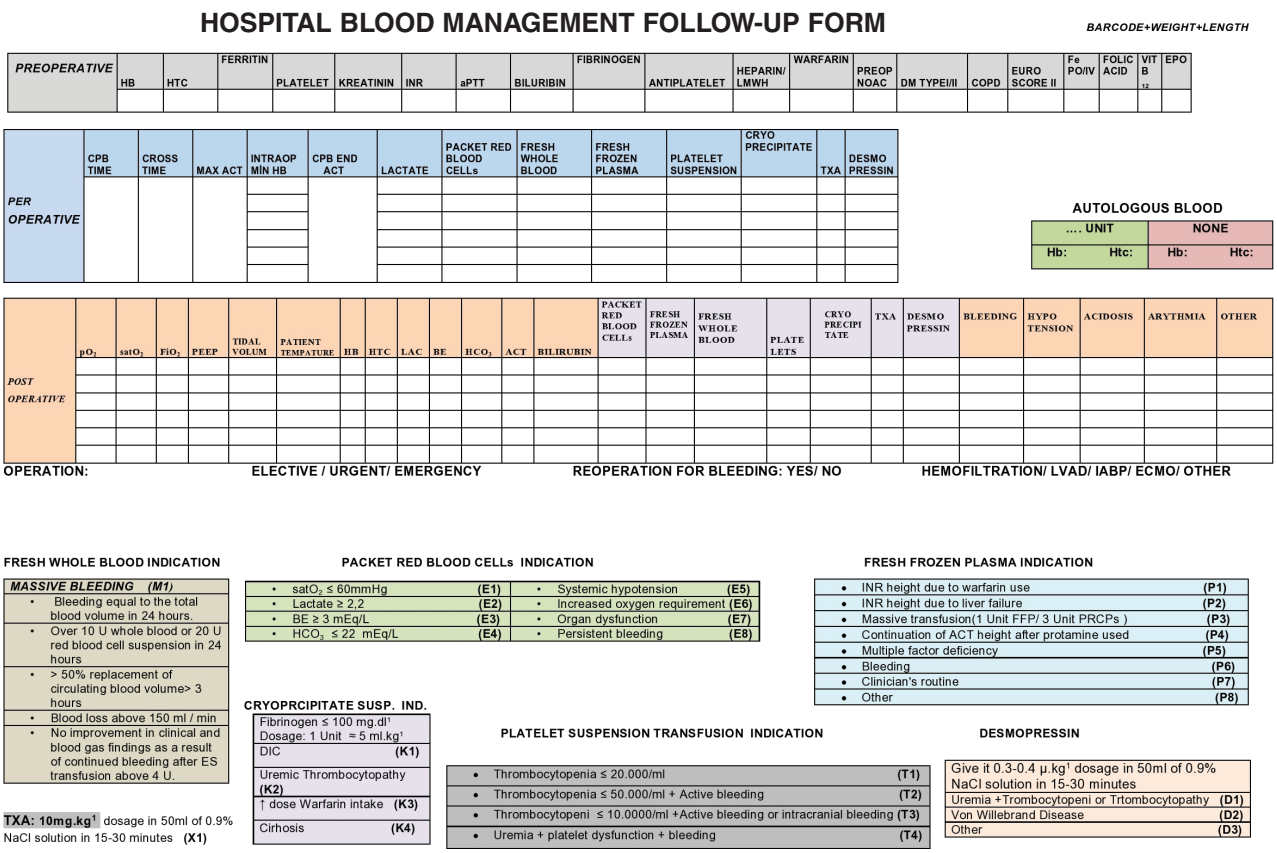

Fig. 2. Hospital blood-management follow-up form.

Statistical analysis

IBM SPSS 15.0 was used in the statistical analysis. The frequency distribution for each variable was compared between the two years. The chi-squared test with continuity correction was performed. A p-value < 0.05 was considered statistically significant.

Results

Tables 1 and 2 illustrate the numbers of patients seen and the numbers and kinds of blood-product transfusions performed in 2018 and 2019. During 2018 and 2019, there were 22 444 and 22 270 in-patient admissions, respectively; 24 495 and 20 413 catheter procedures, respectively; 3 951 and 4 234 cardiovascular (CV) operations, respectively; and 32 661 and 25 071 units of blood components transfused, respectively. Therefore, the number of blood components decreased by 7 590 units (23.2%) from 2018 to 2019 in conjunction with implementation of the HBM programme. Among individual blood components, the units of PRBC, FFP, pooled platelets and FWB transfused decreased significantly ($p < 0.05$) (Table 1).

From 2018 to 2019, the total number of emergency blood transfusions decreased by about one-third (3 220 to 2 092) ($p < 0.05$) (Table 2), largely because of a decrease in the number of transfusions in the ED (1 243 to 298) ($p < 0.05$). At the same time, the number of ED patients increased slightly (from 69 288

Table 1. The number of catheter procedures, operations, PRBC, FFP, pooled platelets, apheresis platelets, cryoprecipitate, FWB and total blood components in 2018 and 2019.

Variables	*2018*	*2019*	p-*value*
Catheter procedure	24 495	20 413	< 0.05
Operation	3 951	4 234	< 0.05
Packet red blood cells	15 203	13 733	< 0.05
Fresh frozen plasma	13 350	8 218	< 0.05
Pooled platelets	2 116	1 819	< 0.05
Apheresis platelets	61	56	0.381
Cryoprecipitate	889	736	0.130
Fresh whole blood	842	449	< 0.05
Total blood components	32 661	25 071	< 0.05

Table 2. The number of in-patients, emergency patients, in-patients in coronary ICU, peri-operative autologous blood, transfusion reactions, ED transfusions, coronary ICU transfusions, disposed-of components and total emergency transfusions in 2018 and 2019.

Variables	*2018*	*2019*	p-*value*
In-patients	22 444	22 270	< 0.05
Number of emergency patients	69 288	72 193	< 0.05
Number of in-patients in coronary ICU	6 573	6 540	< 0.05
Peri-operative autologous blood	23	271	< 0.05
Transfusion reaction	2	22	< 0.05
Emergency department transfusion	1 243	298	< 0.05
Coronary ICU transfusion	1 977	1 794	< 0.05
Number of disposed-of components	253	1 016	< 0.05
Total emergency transfusion	3 220	2 092	< 0.05

to 72 193) ($p < 0.05$). Another major finding was that the number of peri-operative autologous transfusions increased from 23 units in 2018 to 271 units in 2019 ($p < 0.05$).

Among other findings was an increase in the number of reported transfusion reactions from two in 2018 to 22 in 2019 ($p < 0.05$), and the number of disposed blood components from 253 in 2018 to 1 016 in 2019 ($p < 0.05$). At the same time, the number of cross-matched but not transfused blood components decreased from 9 482 in 2018 to 7 753 in 2019.

A total of 98.6% of transfusions in the ED were administered to the Cardiology Department. Despite the rule mandating that between the hours of 18:00 and 08:00, patients in the ED or in-patient services who required transfusions would be transferred to the coronary ICU, 6 573 patients were transfused with 1 977 units in 2018 versus 6 540 patients transfused with 1 794 units in 2019, a statistically insignificant difference ($p > 0.05$).

The cross-match count was 21 576 in 2019 and 16 045 in 2018, whereas the cross-match/transfusion ratio value (1.53) remained the same. While the number of PRBC units that were cross-matched and not transfused was 9 482 in 2018, this number decreased to 7 753 in 2019 ($p < 0.05$).

Discussion

This work comprehensively reviewed the outcomes of the HBM programme recently established in our hospital. The programme is directed towards patient safety and awareness of transfusion costs and adverse events. Many established but illogical and, frankly, unreasonable transfusion practices were corrected.

The most important outcome was that despite an increase or no significant change in the numbers of in-patients, and ED and ICU patients, the overall use of blood components declined by 23.2% from 2018 (before the HBM was established) to 2019 (after the HBM was established). The greatest reductions were with FFP (38.4%) and FWB (46.7%), which met our target of reducing the unnecessary use of these two blood components. We attribute the improved transfusion data to penetration of guidelines and awareness of the staff of HBM policies.

The cost-effectiveness of this HBM programme has been studied in detail. We determined that the economic savings with this programme were approximately 15%.[17]

Many improvements in our transfusion policies were likely responsible for the reduction in blood-product use. One of these was the institution of the 9-g/dl Hb threshold for transfusions. Although this threshold is still high according to guidelines,[7,14] it was low enough to prompt changes in clinician behaviour. An even lower threshold was not chosen to avoid possible resistance to implementing the new policy by clinicians who were accustomed to transfusing patients at Hb values of 10–11 g/dl. Clinicians followed the one-unit transfusion rule and carefully reviewed their transfusion orders.

A second policy improvement was a 12-fold increase in peri-operative autologous blood use. The most important explanation for this achievement was the designation of anaesthesiologists.

FFP was the most-often ordered blood component in the ED and coronary ICU, and it was routinely administered to reverse high INR. A flowchart that could easily be implemented in the ED, called 'the approach to a high INR patient', was prepared, and its use was frequently reviewed.[18,19]

The number of transfusions in the ED decreased by 76.0% after enactment of the rule requiring transfer of patients to the ICU for transfusions. Despite this rule, the number of transfusions given in the ICU did not increase, rather, it decreased by 9.26%. In addition, FFP transfusions were discouraged in patients other than those who needed massive blood transfusions or had elevated INR, and the practice of transfusing two units of FFP with protamine after stopping CBP was discontinued.

The busiest time and service for blood-component orders was in the surgical ICU at 17:00 during the change of shift; about one-third of all transfusions was administered after this visit. Therefore, a practice was instituted that the ICU clinician reviewed the decision to transfuse after the visit ended. This practice became routine and decreased the review workload of the blood bank. The number of cross-matches also decreased significantly with the HBM programme, which further reduced the blood centre's workload.

An unexpected but worthwhile outcome of this study was an increase in reported transfusion reactions from 2018 to 2019. We suspect that this difference reflected an increased vigilance and reporting of the transfusion enterprise after institution of the HBM programme.

This report on our HBM programme reflects some unique characteristics of our insitution and practices. We did not consider prohibiting FWB transfusions because of concern that such a policy would incite clinicians' resistance to the entire programme. During this project, the new policies were accepted by our clinicians, except for a few who had 25 to 30 years of experience in the field and resisted many changes initially, but gradually came on board. The support of the hospital management played an important role in the success of this project.[20]

The HBM programme contrasts in several ways with PBM, which is a multidisciplinary, evidence-based, patient-centred approach to blood management.[7-10,21] In contrast to PBM, HBM is not a patient-specific method; it is a healthcare worker-orientated programme. Correction of pre-operative anaemia is not its primary goal, as it is with PBM. HBM aims to improve transfusion practice through evidence-based clinical pathways. Implementation of PBM often faces clinicians' resistance.

Despite dissimilarities beween HBM and PBM, our programme resulted in blood conservation (over 20%), which was in line with the 10–15% achieved with PBM programmes in CV surgery around the world.[22] We acknowledge, though, that our HBM programme is not an alternative to PBM; the HBM programme can be considered a first step for PBM implementation.

Our study has limitataions. First, it has been tested in only a single institution. Nonetheless, it has features, such as emphasis on quality improvement, patient safety and awareness of transfusion costs and adverse events that may be broadly applicable to blood-product utilisation. Second, the HMB has been tested during one year only; the sustainability of the programme needs to be ascertained over a longer period. Third, pre-operative anaemia protocols have not been integrated into our system, but they should be in future research.

Conclusion

HBM is a dynamic programme with significant benefits. A multidisciplinary, evidence-based approach to blood-component

transfusion reduced the use of blood components by more than 20% in our hospital. The programme can be adjusted to meet the individual requirements of departments, and unit and target blood components. The programme is a practical way to avoid transfusions while achieving significant savings that may be applicable to other tertiary-care hospitals and non-tertiary hospitals as well.[23]

This is the first description of a hospital blood managment programme that we are aware of. Limited blood supplies and the expense of blood-product transfusions will increase the importance of applying HBM programmes in the coming years and in a variety of care institutions.

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