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Original Article

The effect of "patient blood management" education on the number of red blood cell transfusions in patients undergoing cardiac surgery: a 5-year retrospective study

Kardiyak cerrahi geçiren hastalarda "hasta kan yönetimi" eğitiminin kırmızı kan hücresi transfüzyon sayısı üzerine etkisi: 5 yıllık retrospektif çalışma

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ABSTRACT

Aim: Red blood cell transfusion may be inevitable in cardiac surgery due to both blood loss and hemodilution secondary to cardiopulmonary bypass. Transfusion strategies may change over time owing to technological advances. The aim of this study was to evaluate the effect of the patient blood management education applied to healthcare staff on the number of red blood cell transfusions and clinical outcomes of the patients undergoing cardiac surgery.

Material and Methods: Patients were included to the study if they had undergone coronary artery bypass grafting and/or heart valve surgery at the cardiovascular surgery clinic of tertiary training and research hospital during the five-year period between January 1, 2013 and December 31, 2017. Age, sex, number of RBC transfusions, Euroscore II, type of surgery, duration of mechanical ventilation, length of intensive care unit (ICU) stay, length of hospital stay, and in-hospital mortality of the patients were recorded. As the intervention, a patient blood management course was held for anesthesia and intensive care unit staff the department of cardiovascular surgery in December 2015. Patient blood management program was started as of 1st January of 2016 during perioperative period in cardiac surgery patients. Patients were divided into two groups as those undergoing cardiac surgery before January 2016 (Group I, the control group) and those having the surgery after January 2016 (Group II, the intervention group). The groups were compared in terms of sex, age, Euroscore II, duration of mechanical ventilation at intensive care unit, length of stay at intensive care unit and hospital, and in-hospital mortality.

Results: A total of 691 patients were found to meet inclusion criteria. The patients in Group I and Group II were statistically similar in age, sex, and Euroscore II. Mean number of RBC transfusions were 3.55 ± 1.49 in Group I and 2.77 ± 1.64 in Group II ($p<0.001$). The duration of mechanical ventilation in Group I (6.56 ± 1.18 days) was significantly longer than that in Group II (5.93 ± 14.1 days), ($p<0.001$). There was no statistically significant difference between the groups in terms of length at ICU and hospital ($p=0.255$ and $p=0.823$, respectively). The mortality rate was 3.0% in Group I and 3.5% in Group II, where the difference was not statistically significant ($p=0.736$).

Conclusion: The training of healthcare personnel about current "patient blood management" protocols was associated with reduced number of perioperative RBC transfusions and partially improved clinical outcomes in patients undergoing cardiac surgery.

Keywords: cardiac surgery; red blood cell; transfusion training, mortality.

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ÖZ

Amaç: Kardiyak cerrahide hem kan kaybı hem de kardiyopulmoner baypas uygulamasına bağlı hemodilüsyon nedeniyle kırmızı kan hücresi transfüzyonu zorunlu hale gelebilir. Teknolojik gelişmeler sayesinde transfüzyon stratejileri zaman içinde değişiklik gösterebilir. Bu çalışmanın amacı kardiyak cerrahi geçiren hastalarda, güncel bilgilerin kullanılması ile kırmızı kan hücresi transfüzyon yaklaşımındaki değişikliklerin ortaya konmasıdır.

Gereç ve Yöntemler: Üçüncü basamak eğitim ve araştırma hastanesi kardiyovasküler cerrahi kliniğinde 1 Ocak 2013 ile 31 Aralık 2017 tarihleri arasında 5 yıllık periyotta koroner arter baypas greftleme ve/veya kalp kapak cerrahisi geçiren hastalar çalışma kapsamına alındı. Tüm hastaların yaş, cinsiyet, kırmızı kan hücresi transfüzyonu sayısı, Euroscore II, ameliyat tipi, mekanik ventilasyon süresi, yoğun bakım ünitesinde yatış süresi, hastanede yatış süresi, hastane içi mortalite durumu kaydedildi. Aralık 2015'te kalp ve damar cerrahisinde çalışan anestezi ve yoğun bakım çalışanlarına "hasta kan yönetimi" kursu düzenlendi. 1 Ocak 2016 tarihinden itibaren hasta kan yönetimi programı, kardiyak cerrahi uygulanan hastalara perioperatif dönemde uygulanmaya başlandı. 1 Ocak 2016 dan önce (Grup I) ve sonra (Grup II) kardiyak cerrahi geçiren hastalar iki gruba ayrıldı. Hastaların karakteristik özellikleri yanı sıra yoğun bakım ünitesinde mekanik ventilasyon süresi, yoğun bakım yatış süresi, hastanede yatış süresi ve hastane içi mortalite durumu açısından bu iki grup karşılaştırıldı.

Bulgular: Toplam 691 hasta çalışmaya dahil edildi. Grup I'deki (kontrol grubu) hastalar ile Grup II'deki (çalışma grubu) hastalar istatistiksel olarak yaş, cinsiyet, Euroscore II açısından benzer idi. Transfüzyon yapılan kırmızı kan hüresi sayısı Grup I de 3.55 ± 1.49 iken Grup II'de 2.77 ± 1.64 idi (P<0.001). Mekanik ventilasyon süresi Grup I'de (6.56± 1.18 gün) Grup II'ye (5.93 ± 1.14 gün) göre daha uzun idi (P<0.001). Hem yoğun bakımda hem de hastanede yatış süresi açısından iki grup arasında istatistiksel olarak fark yoktu (P=0.823). Mortalite oranı Grup I'de %3 iken Grup II'de %3.5 idi ve bu fark istatistiksel olarak önemli değil idi (P=0.736).

Sonuç: Sağlık personelinin mevcut "hasta kan yönetimi" protokolleri hakkındaki eğitimi, kalp cerrahisi geçiren hastalarda perioperatif kırmızı kan hücresi transfüzyonlarının azalması ve kısmen iyileşmiş klinik sonuçlarla ilişkili bulunmuştur.

Anahtar kelimeler: kardiyak cerrahi; kırmızı kan hücresi; transfüzyon eğitimi, mortalite.

Introduction

In cardiac surgery, a high rate of allogeneic blood transfusion is performed conventionally. In a multi-center study involving 82,446 cases undergoing on-pump coronary artery bypass grafting (CABG), use of red blood cell (RBC) transfusion was reported to vary from 7.8% to 92.8% [1]. Such wide range of RBC transfusion rate suggests no standardized strategy of RBC transfusion. The primary goal of RBC transfusion is to maintain a normal level of oxygen delivery to the tissues and thus provide adequate tissue oxygenation. If an adequate tissue perfusion can be achieved with fewer number of RBC transfusions, a lower target of hemoglobin level may be considered. This may facilitate improved patient outcomes and reduced costs. Allogenic blood transfusions may be associated with such complications as hemolytic transfusion reactions, graft-versus-host disease, circulatory overload, anaphylaxis, and post-transfusion purpura [2]. For this reason, it is necessary to appropriately determine whether a patient really needs blood transfusion. Reducing unnecessary use of blood components will reduce the risks associated with transfusion. In recent years, some reports have been published on strategies to reduce perioperative use of blood products, including perioperative iron therapy, intraoperative tranexamic acid treatment, cell salvage, maintenance of lower target hemoglobin levels, and combinations thereof.

In patients undergoing cardiac surgery, those who were managed with restrictive hemoglobin transfusion strategy were reported to receive less RBC transfusion and have lower incidence of transfusion-associated adverse events compared with that in those managed with liberal hemoglobin transfusion strategy [3]. However, information on optimal blood transfusion management is scarce. Therefore, "patient blood management" guideline was developed and associated training programs were planned [4,5]. Studies so far reported

widely varying target hemoglobin levels, where the number of RBC transfusions also showed variations between centers [6-9]. Unfortunately, there is still controversy about how much RBC transfusion should be done. Furthermore, the clinical implications of providing healthcare staff with patient blood management training are also not known.

The aim of this study was to determine whether the number of RBC transfusions and clinical outcomes were changed by training healthcare staff about patient blood management training in patients who underwent cardiac surgery and subsequently managed in the intensive care unit (ICU).

Material and methods

After the local ethics committee approval of the study, the patients who underwent CABG and/or heart valve surgery in the cardiovascular surgery clinic of tertiary training and research hospital during the 5-year period between January 1, 2013 and December 31, 2017 were included in the study. Data on patients' age, sex, number of RBC transfusions, Euroscore II, type of surgery, duration of mechanical ventilation, length of stay at ICU, length of hospital stay, and in-hospital mortality were collected from institutional database of medical records. The patients who had ≥10 RBC transfusionsor preoperative lung disease were excluded from the study.

In December 2015, anesthesia and intensive care staff in the cardiovascular surgery department of tertiary training and research hospital were given a 1-hour course of patient blood management training by an anesthesiologist according to most up-to-date clinical guidelines and other evidence-based materials [3,4,10]. Beside restrictive transfusion strategy, the course endorsed recommendations about administering iron treatment if preoperative iron deficiency was present, or using tranexamic acid as systemic hemostatic agent and hemostatic sealants and anti-fibrinolytic agents as topical hemostatic agents in the intraoperative period [11,12]. The patients were divided into two groups in order to compare outcomes before and after 1 January 2016. While Group I (control group) consisted of those undergoing heart surgery between January 1, 2013 and December 31, 2015; Group II (intervention group) consisted of those undergoing heart surgery between 1 January 2016 and 31 December 2017. Local ethics committee approved the study and informed consent was obtained from participant(s)

Statistical Analysis

All analyses were performed through IBM SPSS Statistics for Windows [13]. While describing the data in each study group, we reportedmean ± standard deviation (median, minimum - maximum) for continuous variables and frequency (%) for categorical variables. We applied Shapiro-Wilk and Levene's tests to check normality and variance homogeneity assumptions, respectively. Independent t-test was used to compare the study groups with respect to continuous variables. Pearson Chi-square test was utilized for comparison of the study groups in terms of categorical variables. A two-sided p-value ≤ 0.05 was considered as statistically significant.

Results

A total of 691 patients were found to meet inclusion criteria between January 2013 and December 2017. While 432 patients who had undergone heart surgery were in Group I, remaining 259 patients with heart surgery between 1 January 2016 and 31 December 2017 were included to the Group II. Mean age of the patients in Group I (57.1± 12.8 years) and Group II (58.0 ± 10.8) were similar (p=0.324). The percentages of male patients in Group I (72.2%) and Group II (74.1%) were also similar (p=0.585). Mean Euroscore II did not differ between Group I and Group II (1.49 ± 0.71 and 1:46 ± 0.67, respectively; p=0.624), (Table 1).

Table 1. Characteristics of study groups.

		Group I (n=432)	Group II (n=259)	P-value
Age (years)		57.1± 12.8 (58, 17- 85)	58.0± 10.8 (59, 19- 83)	0.324[a]
Sex	Female	120 (27.8)	67 (25.9)	0.585[b]
	Male	312 (72.2)	192 (74.1)	
EuroScore II		1.49 ± 0.71 (1.23, 0.63 - 5.84)	1.46 ± 0.67 (1.23, 0.78 - 3.88)	0.624[a]

Note: Results were demonstrated as mean ± standard deviation (median, min - max) for continuous variables and as frequency (%) for categorical variables.a, b: p-values are obtained via independent t-test and Pearson Chi-square test, respectively.

Mean number of RBC transfusions were 3.55 ± 1.49 in Group I and 2.77 ± 1.64 in Group II (p<0.001). The duration of mechanical ventilation in Group I (6.56 ± 1.18 days) was significantly longer than that in Group II (5.93 ± 14.1 days),(p<0.001). There was no statistically significant difference between the groups in terms of length of stay at ICU (p=0.255). The groups were also similar

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for length of hospital stay (p=0.823).The in-patient mortality rate was 3.0% in Group I and 3.5% in Group II, where the difference was not statistically significant (p=0.736), (Table 2).

Table 2. The variables regarding intensive care unit.

		Group I (n=432)	Group II (n=259)	P-value
Duration of mechanical ventilation, hours		6.56± 1.18 (6, 2 - 11)	5.93± 1.14 (6, 1 - 9)	<0.001a
RBC, n		3.55 ± 1.49 (4, 0 - 9)	2.77 ± 1.64 (3, 0 - 8)	<0.001a
Length of stay at ICU, hours		43.3 ± 11.9 (40, 30 - 72)	44.4 ± 12.0 (40, 30 - 74)	0.255a
Length of stay at hospital, days		5.78 ± 0.98 (5, 5 - 8)	5.76 ± 0.96 (5, 5 - 8)	0.823a
Mortality	**Deceased**	13 (3.0)	9 (3.5)	0.736[b]
	Alive	419 (97.0)	250 (96.5)	

Note: Results were demonstrated as mean ± standard deviation (median, min - max) for continuous variables and as frequency (%) for categorical variables.a, b: p-values are obtained via independent t-test and Pearson Chi-square test, respectively.

Discussion

In this study, the "patient blood management" education was shown to be associated with a 22% lesser number of perioperative RBC transfusions (p<0.001) and about 10% shorter duration of postoperative mechanical ventilation (p<0.001) in patients who underwent heart surgery. No statistically significant difference was detected in terms of length of ICU or hospital stay, or in-patient mortality after the intervention compared to the baseline. Despite numerous studies regarding RBC transfusion strategy in heart surgery, no consensus has been achieved yet. It is important to follow up most up-to-date information and to support healthcare professionals with training activities according to the evidence-based medicine principles. The effectiveness of these trainings and their reflection on clinical outcomes should also be measured.

Target hemoglobin levels show variation in studies where the efficacy of restrictive transfusion was investigated in patients undergoing cardiac surgery. Shehata et al.[14] reported that they targeted intraoperative hemoglobin as 7 g/dL and postoperative hemoglobin as 7.5 g/dL in cardiac surgery.On the other hand, Slight et al. [8] determined a target hemoglobin rangeof 7.2 to 8.5 both in intraoperative and postoperative setting. Lilly et al. [15] reported to choose the target 7 g/dL for both intraoperative and postoperative hemoglobin. Bracey et al. [6] reported that they determined postoperative hemoglobin target to be 8 g/dL. Mazer et al. [16], in their multi-center randomized study of 5243 patients who underwent cardiac surgery, reported intraoperative target hemoglobin level as 7.5 g/dL in the restrictive transfusion group. These studies suggest that a definite hemoglobin target value in the restrictive transfusion strategy is still controversial. In our study, we recommended the participants to use a hemoglobin threshold value of 7.5 g/dL for RBC transfusion in both intraoperative and postoperative periods as part of the patient blood management training.

Koch et al. compared patients who did and did not receive RBC transfusion among 11,963 patients who underwent CABG. They reported prolonged ventilatory support (OR, 1.79; 95%CI, 1.72-1.86; p<0.0001) in the RBC transfusion group [17]. The study by Mazer et al. included cardiac surgery patients, where median duration of postoperative mechanical ventilation was 0.38 days (interquartile range, 0.22 to 0.75) in the restrictive RBC transfusion strategy group compared to 0.36 days (interquartile range, 0.22 to 0.71) in the liberal strategy group with a hazard ratio of 94% (0.89-1.00) [16]. On the contrary, we found the duration of mechanical ventilation as 6.56 ± 1.18 hours before the intervention and 5.93 ± 1.14 hours after the intervention, which constituted a statistically significant difference (p<0.001).

In their study of 8598 patients undergoing cardiac surgery, Murphy et al. reported that the length of stay at ICU and hospital were about 30% and 35% shorter, respectively, in patients who were not transfused RBCs compared to that in those receiving RBC transfusions (p<0. 0001)[18]. Mazer et al. reported that there was no difference of length of ICU or hospital stay between patients in whom a restrictive or liberal RBC transfusion strategy was applied in the study involving cardiac surgery patients [16]. Similarly, Hajjar et al. reported no difference between patients receiving restrictive or liberal RBC transfusions in terms of length of stay at ICU or hospital (p=0.45) [9]. The groups in our study also did not differ according to the intervention in terms of duration of stay at ICU or hospital.

Murphy et al. reported 6-fold higher 30-day mortality in cardiac surgery patients who received RBC transfusion compared to those who were not RBC-transfused [18]. Several other studies were also published, comparing liberal and restrictive transfusion strategies in patients who underwent heart surgery. Some of these studies reported no statistically significant difference in mortality between these two strategies [6,7,9]. We also did not find any significant difference of mortality between the study groups. On the contrary, there were also studies reporting reduced mortality by restrictive RBC transfusion compared to that by liberal approach [18,19].

In recent years, studies have been carried out on the development of various RBC transfusion protocols. Obtaining information about new transfusion guidelines is a very critical issue in this manner. Not only hematologists, but also physicians and other healthcare personnel from different disciplines should also follow new transfusion protocols. Institutional continuous training activities should be organized for clinicians, medical residents, and medical students about updated transfusion guidelines. By translating this information into clinical practice, blood transfusion reactions can be reduced and improved patient outcomes can be achieved.

The limitation of the study is that no further detailed data could be obtained due to its retrospective design.

In conclusion, the number of perioperative RBC transfusions in patients undergoing cardiac surgery was reduced by a training about current patient blood management protocols. While the duration of postoperative mechanical ventilation was shortened by the training, the mortality rate remained unchanged.

Declaration of conflict of interest

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