The Effects of Blood Usage Shortly after Open Heart Surgery

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Abstract

Cardio- pulmonary bypass affects the homeostatic system of the body through the effect of heparinization, hemodilution and hypothermia,which represent the major challenges on the homeostatic system.Other factors, like pre-operative aspirin use, old age and CPB time, also affect the homeostatic system. The aim of the study is to find factors which are related to excessive blood loss following open-heart surgery, and to study blood transfusion practice in these patients. The importance of FB transfusion, especially autologous blood, in open-heart surgery was also studied. Forty-eight adult patients, who underwent open-heart surgery over the period of 3 months, were studied. Data were collected from these patients to study their effects on the degree of post-operative blood loss. Thirteen patients (27%) had excessive blood loss (blood loss of >= 1000 ml within the first 24 hours post-operatively). The incidence of excessive blood loss was related to the number of units of FB which were given to the patients post-operatively. It was also found that blood loss can be related to patient's age, CPB bypass time, type of surgery and pre-operative aspirin use.Two complications of blood transfusion were noted; allergic and pyrogenic reactions .

Keywards: Cardio- pulmonary bypass , Fresh bood transfusion , Post operative blood loss

الخلاصة

تروية القلب والرئة الصناعية اثناء عملية القلب المفتوح تأثر بشكل مباشر على نظام حفظ السوائل الحركية في جسم الانسان من خلال استخدام عقار الهيبارين المسيل للدم و تخفيف سوائل الجسم مع انخفاض في درجة حرارة جسم الانسان والتي جميعها تعتبر من العوامل الفاعلة الكبيرة في التأثير على نظام حفظ السوائل الحركية لدى الانسان بالإضافة الى عوامل اخرى مثل استخدام عقار الاسبرين المسيل للدم قبل العملية و عمر المريض مع الفترة الزمنية في استخدام تروية القلب والرئة الصناعية اثناء عملية القلب المفتوح . الهدف من الدراسة هو ايجاد العوامل التي تؤثر و التي لها علاقة مع زيادة النزف وفقدان الدم ما بعد عملية القلب المفتوح مع دراسة تأثيرات نقل الدم بأشكاله واهمية استخدام الدم الطازج بشكل عام و الدم المستخدم من نفس المريض بشكل خاص وعلاقته مع النزف ما بعد هذا النوع من الجراحة المعقدة ولهذا تم أجراء دراسة استعادية في مستشفى ابن البيطار لجراحة القلب في بغداد تسلط الضوء على النتائج الجراحية ل 48 مريض أجروا عمليات قلب مفتوح تمت احالتهم من اقسام الباطنية لمدة ثلاثة أشهر وللفترة من 01 \ 01 \ 2016 ولغاية 01 \ 4 \ 2016 تبين من خلالها ان (13) مريض تعرض لفقدان دم ونزف كثير (فقدان دم اكثر ما يساوي او يزيد عن 1000 مليميتر خلال 24 ساعة بعد اجراء الجراحة) وامكانية حدوث هذه الشكلة كان له علاقة مع عدد اكياس الدم الطازج التي اعطيت لكل مريض و عمر المريض والوقت الزمني في استخدام التروية الصناعية للقلب والرئة بالإضافة الى نوع العملية و استخدام عقار الاسبرين قبل العملية علما ان هم مضاعفات نقل الدم التي تم ملاحظتها هي الحساسية مع ارتفاع درجة حرارة الجسم .

الكلمات المفتاحية :- تروية القلب والرئة الصناعية , نقل الدم الطازج , فقدان الدم بعد العملية .

Abbriavations

CPB : cardio-pulmonary bypass.**CABG :** coronary artery bypass graft.**DVR :** double valve replacement. **MVR :** mitral valve replacement. **LA :** left atrium **AVR :** aortic valve replacement. **ASD :** atrial septal defect. **FB :** fresh blood **FFP:** fresh frozen plasma **RBC:** red blood cells. **ICU :** intensive care unit.

Introductions

Cardio–pulmonary bypass (CPB) imposes extremes on the physiological condition system. Despite efforts aimed toward rising biocompatiblity, the CPB surface is mostly perceived as foreign by systemic blood components, That decides to clot it and rejects it by mounting an inflammatory attack [Lawernce *et al.*, 2011].

Ideally, complete arrest of clotting and inflammation would be maintained throughout the bypass amount, then separation from CPB would be associated with the total come back of clotting perform. In reality, the clotting arrest achieved by current medical care technique is partial, and also the sequent restoration of clotting is often suboptimal, resulting in large blood loss and the use for blood transfusion and its products [Hirsch and Fuster, 2003] .

There are three major challenges imposed on homeostatic system during CPB [Lawernce *et al.*, 2011 2011] : -

1-Heparinization: which represents the obligatory main alteration in clotting by CPB. Anticoagulant binds to systemic antithrombin and causes a conformational modification that accelerates its binding to and inactivation of three essential clotting factors: coagulase, factor Xa, and issue IXa. Anticoagulant has both direct and indirect antiplatelet effects, and despite of the post-CPB neutralization, residual anticoagulant might contribute to post- CPB hemorrhage. Among its antiplatelet actions, the anticoagulant binds to Von-Willebrand issue - blood platelet| thrombocyte| protoplasm| living substance} interaction website and might impair initial platelet rolling and adhesion to the subendothelium.

2-Hemodilution: owing to the massive volume of the circuit, that should be set with blood – compatible fluid, hemodilution is the next obligatory challenge on the physiological condition system. The degree of hemodilution varies with the establishment, kind of CPB circuit and size of the patient. Clotting factors may be diluted to twenty to four-hundredth of traditional values before symptoms of hemorrhage area unit manifested or coagulation times area unitprolonged. Similarly, most conventional blood platelet counts may be halved with no rise in tendency to bleed. Therefore, the anticoagulant medication result of hemodilution is usually gentle.

3-Hypothermia: hypothermia inhibits blood platelet {thrombocyte protoplasm living substance} activation and also the platelet aggregation in response to thrombi. additionally, physiological condition might adversely have an effect on the dynamics of the activity cascade and might even impair the power of native vasculature to constrict in response to hemorrhage.

There are, also, some other factors which contribute to post-open heart surgery bleeding. These may include, pre-operative aspirin use, old age, increased CPB time,type of the surgery and excess protamine dose [Despotis *et al.*, 2011 2011].

Patients and methods

In this study, 48 adult patients, who underwent open-heart surgery at Ibn Al-Bitar Cardiac Center over the perioed of three months (Janury- March 2016), were studied. The age of the patients range from twenty to fifty years.Variable operations had been studied ; including GABG, DVR, MVR, AVR, ASD repair and excision of LA myxoma (Table 1). Usage of blood and its products within the first 24 hours post- operatively was studied. The data used in the study were : patient's age, blood group, CPB time, number of units of FB,

banked blood and blood products, which were given to the patients, and their complications.The total drainage of the tube drains within the first 24 hours post-operatively was collected from each patient; and excessive post-CPB blood loss was considered if patient's drain was equal to or more than 1000 ml in the first 24 hours post-operatively. Pre-operative aspirin use, and the time of its stoppage before the date of surgery, were also studied.

Results

In this study, the most common blood group found is O+ ve followed by B+ve, and the least common was A-ve (Table 2). All patients had FB transfusion post-operatively, and about half of them (26 patients) had banked blood transfusion. The total number of FB units used was 81 units, an average of 1.68 unit per patient.The total number of banked blood units used were 54 units, an average of 1.12 unit per patient (Table 3).The total number of FFP units used were 187 units, an average of 3.89 unit per patient.The total number of platelets used were 179 units, an average of 3.72 unit per patient.The total number of cryoprecipitate used were 10 units, an average of 0.2 unit per patient.

Thirteen patients (27%) had total drainage of >= 1000 ml within the first 24 hours post-operatively (excessive blood loss). Ten of them received only one unit of FB (only one needed reexploration which revealed no surgical bleeding). The other three patients received two units of FB (only one needed reexploration which revealed a surgical bleeding), as it is shown in Table 4.Of these thirteen patients with excessive bleeding, seven of them were males and six were females. A relation between type of the surgery and the amount of post-operative blood loss had been identified. It was shown that about half of patients who had excessive blood loss post-operatively, underwent DVR, which is usually associated with long CPB time (Table 5). Patient's age was also related to excessive post-operative blood loss, as did CPB time. Of the thirteen patients who had excessive blood loss, seven patients (53.8 %) aged 40 years and more, and nine patients (69.2 %) were exposed to CPB time of 165 minutes or more.

The relation between pre-operative aspirin use and excessive post- operative blood loss was clear. Of the thirteen patients who had excessive post-operative bleeding, eight patients received pre-operative aspirin (Table 6). Of these eight patients, six of them stopped aspirin 2-3 days before the date of surgery, and the other two patients stopped aspirin 10 days before the date of surgery.

Two complications of blood transfusion were identified in the study; allergic and pyrogenic reactions. Most of the allergic reactions and all pyrogenic reactions were secondary to banked blood transfusions (Table 7).

Table 1 : Number and Percentage of the operations

	DVR	CABG	MVR	AVR	ASD Repair	LA myxoma excision
Number of operations	14	12	11	5	5	1
Percentage	(29.1%)	(25%)	(22.9%)	(10.4%)	(10.4%)	(2.08%)

Table 2 : The Percentage of blood groups

	O+ve	B+ve	A+ve	AB+ve	O-ve	A-ve
Number of patients	16	15	9	5	2	1
Percentage	33.3%	31.2%	18.7%	10.4%	4.1%	2%

Table 3 : Blood transfusion in this study

	4 units	3 units	2 units	1 unit	zero
Patients who received FB	-	-	33	15	-
Patients who received banked blood	2	8	6	10	22

Table 4 : Relation between excessive posto-perative blood loss (n=13) and number of FB units given to the patients

	2 F.B. usage	1 F.B. usage
Patients with excessive blood loss	3 (23 %)	10 (76.9 %)
Patients who needed re-exploration for excessive blood loss	1 surgical bleeding found	1 no surgical bleeding found

Table 5 : Relation between excessive post-operative blood loss and type of the surgery

	DVR	CABG	MVR	AVR	ASD repair
Number of patients with excessive blood loss (n=13)	6 (46.15%)	3 (23.07%)	2 (15.38%)	1 (7.69%)	1 (7.69%)

Table 6: Relation between pre-operative aspirin use and excessive post operative blood loss

	Excessive blood loss (n=13)
Patients who received aspirin pre- operatively (n=18)	8 patients (61.5 %)
Patients who didn't receive aspirin pre- operatively (n=30)	5 patients (38.4 %)

Table 7 : Complications of blood transfusion

	Allergic reactions	pyrogenic reactions
Patients who received banked blood (n=26)	3 patients	3 patients
Patients received FB (n=48)	1 patient	non

Disscusion

The post-perfusion syndrome is characterized by a diffuse whole body inflammatory reaction with elements of increased capillary permeability, extravascular extravasation of plasma, increased interstitial fluid, leucocytosis, fever, peripheral vasoconstriction, breakdown of RBC and a diffuse body diathesis [Despotis *et al.,* 2011]. Some risk factors for an adverse clinical response to CPB have been identified . In most adults, the probability of structural or functional damage seems to increase as the perfusion time extends beyond three hours [GusVlahakes, *et al.,* 2016]. Another risk factor is age. The susceptibility to organ dysfunction after CPB appears to increase in neonates. The very elderly patients also seem to be less tolerant to the damaging effects of CPB, particularly in the presence of pre-existing renal dysfunction [Despotis *et al.,* 20112011].

Other factors undoubtedly interact, including the type of oxygenator, the composition

of the perfusate, the perfusion flow rate, the presence or absence of pulsatile flow and patient's temperature [Despotis *et al.*, , 2011].

High blood conservation techniques and the useage of autologous blood transfusion have decrease the average suffer from the allogeneic transfusions of blood [Herbert *et al.*, 2002]. A study of transfusion practices was recently performed in six Canadian ICU [Herbert *et al.*, 2002]. In overall, 28% of the patients received banked blood transfusion, with a mean of 0.95 unit per patient. In our study, banked blood transfusion practices reached 54%, with a mean of 1.12 unit per patient. Another study [Lawrence *et al.*, 2011], stated that higher than 35% of suffered from having surgery of cardiac type requiring CPB, bled more than 1 liter in the first day post-operatively, with factors such as female sex and pre-operative aspirin use correlated with bleeding . In our study, 27% of patients bled 1 liter or more in the first 24 hours post-operatively, with no obvious sex relation. Pre-operative aspirin use correlated well to excessive post-operative blood loss, as eight patients of those who received pre-operative aspirin had excessive post-operative blood loss, and most of these eight patients, stopped aspirin two to three dayes before surgery. This emphasizes the importance of stoppage of aspirin at least 10 days before the date of surgery, so that the dysfunctioned platelets get enough time to regain their normal function. No preoperative hematologic factors truly identified suffers at bleeding risk [Lawrence *et al.*, 2011].

It is evident that blood loss following open-heart surgery is almost a constant finding, for this reason, blood transfusion is very important post-operatively, especially FB transfusion, which contains all the coagulation factors, has increased survival of RBC and has increased oxygen- carrying capacity of hemoglobin [Good nough *et al.*, 2013]. In addition to FB, blood products like FFP, platelets and cryopecipitate are also of importance in reducing the amount of post-operative blood loss [McCoy–Pardington *et al.*, 1990]. There are two sources for providing FB, autologous and allogenic blood. In this study, the type of FB used is allogenic blood. The number of FB units used was related to the degree of post-operative blood loss. Patients who received two units of FB post-operatively had less incidence of excessive blood loss than those who received only one unit of FB (3 Vs 10 out of 13). This indicate the importance of giving more than one unit of FB to the cardiac-surgical patient post-operatively, because it may reduce the amount of blood loss and, thus, reduce the subsequent banked blood usage and reduce its complications.The study also showed that the largest number of banked blood units used is thirty eight units were given to patients who had excessive post-operative blood loss.

Patient's age and CPB time do influence the degree of post-operative blood loss. It was shown that patients aging more than fifty years are usually less able to tolerate the damaging effects of CPB, especially those with pre-existing renal dysfunction [Despotis *et al.*, 2011]. The injurious effects of CPB on blood elements and different body organs also increase as the CPB time increases beyond 180 minutes [Despotis *et al.*, 2011] . Therfore, the incidence of excessive blood loss is high in these two conditions.In this study, similar findings were seen. Patients aged forty years and more were more liable to have excessive post-operative blood loss; and the incidence of excessive post-operative blood loss was high in patients who were exposed to CPB time of 165 minutes and more.

Double valve replacement is usually associated with long CPB time, therefore, the damaging effects of CPB would be more, and the incidence of excessive post-operative blood loss would be high [David and James, 1995]. This fact was clear in our study where about half of patients who had excessive post-operative blood loss, underwent DVR.

Autologous blood is superior to allogenic blood transfusion, because it avoids the risk of transmission of viral and other infectious diseases, it reduces the cost of preparation of blood unit (in USA preparing one unit of allogenic blood costs 200$) and it reduces the complications of blood transfusion [Stover *et al.,* 1998]. Moreover, it has been shown that transfusing autologous blood reduces the subsequent allogenic blood requirements. Yet, the advantage of autologous blood transfusion is limited by the fact that large number of patients who are presented to cardiac surgery are anemic which may increase the risk of autolgous blood transfusion [Stover *et al.,* 1998]. There are, also, other contraindications to donate autologous blood [David and James, 1995] :-

1- Evidence of infection.
2- Patients scheduled for surgery to correct aortic stenosis.
3- Patients who have unstable angina.
4- Patients who have seizure within the last three months of donation.
5- Myocardial infarction or cerebro-vascular accident within the last six months of donation.
6- High grade left main coronary artery disease.
7- Uncontrolled hypertension.

In this study, there was no complete documentation of the use of autologous blood. Thus,its effect couldn't be studied .There are other methods to reduce allogenic blood transfusion. The blood drained into the tube drains is passed through a special cell-saver, so that it can be filtered and cleaned from any particle, and then, can be reinfused to the patient; but the facilities for such technique is not available in our country.

Conclusions

1- Some cases of post-operative bleeding in open-heart surgery, show almost a constant and acceptable finding.
2- Patients aging more than 40 years and those who undergo DVR, are at the risk of excessive bleeding post-operatively.
3- Prolonged CPB time is associated with increased risk of excessive post-operative blood loss.
4- Aspirin should be stopped at least ten days before the date of surgery, otherwise, the risk of excessive bleeding post-operatively would be high.
5- The cardiac surgical patient should receive more than one unit of FB postoperatively,because this may reduce the amount of blood loss and, thus, reduce the subsequent use of banked blood and reduce its complications.
6- Autologous blood transfusion is superior to allogenic FB transfusion, but unfortunately, it is not widely applied in our cardiac surgery centers.
7- Postoperative blood salvage, the use blood drained in to the tube drains and reinfusing it again to the patient, reduces the need for allogenic blood transfusion, but unfortunately, the facilities for such technique is not available in our country.

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