Autologous blood donation in total knee arthroplasties is not necessary

Urs Müller[1], Christoph Röder[1], Markus Pisan[2], Rene Orler[3], Amer El-Kerdi[1] and Stefan Eggli[3]

[1]Institute for Evaluative Research in Orthopaedic Surgery, University of Bern, CH-3008 Bern, Departments of Orthopaedic Surgery, [2]Kantonsspital Winterthur, CH-8400 Winterthur, [3]Inselspital, University of Bern, CH-3000 Bern, Switzerland
Correspondence: UM umueller@memced.org
Submitted 02-10-26. Accepted 03-05-01

Background **This study intends to prove the hypothesis that preoperative autologous blood donation in total knee arthroplasties (TKA) is dispensable.**

Patients and methods **The study comprises a prospective analysis of 81 consecutive TKA without preoperative autologous blood donation (AB-donation). Guidelines for blood retransfusion were used. Surgery, as well as the pre- and postoperative procedures were identical for each patient. In the analysis of the data, the consecutive TKAs were divided into patients who were eligible for preoperative autologous blood donation (group 1, n = 46) and those with relevant risk factors not permitting preoperative autologous blood donation (group 2, n = 35).**

Results **None of the patients in group 1 needed a blood transfusion. 14 of 35 patients in group 2 needed an allogenic blood transfusion.**

Interpretation **Total knee arthroplasty can be managed without preoperative AB-donation if it is performed using a tourniquet, if a postoperative collection and direct retransfusion system is used for the wound blood, and if the transfusion algorithm is defined according to compulsory and practical guidelines.**

The efficiency of preoperative autologous blood (AB) donation in reducing allogenic blood (HB) exposure is undisputed (Spahn and Jamnicki 1998). The current discussion focuses on cost effectiveness versus potential risks of preoperative autologous blood donation, and on transfusion criteria for autologous versus allogenic blood. The cost effectiveness of AB-donation may indeed be low mainly due to the high percentage of units discarded (Etchason et al. 1995, Bengtson and Bengtson 1996, Thomas et al. 1996). Potential risks (Popowsky et al. 1995) or errors in donation (Goldmann et al. 1996, Linden and Kruskall 1997) during retransfusion should be considered before retransfusion.

However, patients who are considered for preoperative autologous blood donation usually belong to a healthy population in whom lower hemoglobin values are less critical. Therefore, we started a prospective study to determine whether primary total knee arthroplasties (TKA) can be managed without preoperative autologous blood donation or increasing the risk of cardiovascular complications or a higher rate of allogenic blood transfusions.

Methods

We analyzed a consecutive and prospective primary knee arthroplasty group with no autologous blood donation before surgery. The surgical intervention as well as the pre- and postoperative procedures were identical in all patients. The patients were extensively informed about the design of the study and they gave their written consent to take part in it. The study was done in a public medium-sized public hospital with a mixed rural and urban patient population.

From October 1999 until September 2000, 81 consecutive TKAs were performed in a technically

Table 1. Demographic variables in the entire material

Number of patients	81
Age (range)	76 (61–90)
Gender: women / men	63 / 18
Total no. patients with relevant risk factors	35
Risk factors	
Age above 80 years	25
Cardiac disease ≥ NYHA II	23
Kidney insufficiency	1
St. a. cerebrovascular insult	3
Severe pulmonary disease	2
Preoperative hemoglobin < 110 g/L	0

identical manner. The patients' mean age was 76 (61–90) years and no patient was excluded from the study group. The operations were performed using a femoral tourniquet. For postoperative blood salvage, a wound drainage system (Handy Vac, Maersk Medical, Allerod, DK) was installed in all patients. This method permitted us to filter and retransfuse the postoperative wound blood. We used comprehensive guidelines for the indications and donations of blood transfusion (Figure). All necessary data were documented employing a protocol where all relevant risk factors concerning the patient, preoperative platelet count, duration of surgery, changes in hemoglobin and hematocrit, as well as in fluids (loss of blood, transfusion of blood, colloids, NaCl etc.) were documented. The key criteria that permitted preoperative AB-donation were age below 80 years, absence of restricting cardiovascular diseases < NYHA II, hemoglobin above 110 g/L, no previous cerebrovascular insult and no kidney disease.

Within the first 48 hours postoperatively, the indication for allogenic blood transfusion was decided by the anesthesiologist in charge of the case, using these guidelines (Figure). After this, the need for a transfusion was determined by the operating orthopedic surgeon, using the same guidelines. In case of severe cardiac morbidity (NYHA ≥ II), the anesthesiologist could set individual hemoglobin limits as an indication for blood transfusion to avoid cardiac complications. The level of the hemoglobin limits was based on the personal judgment of the responsible physician.

Before surgery, the consecutive primary TKA patients were divided according to the risk factors into patients who would have been eligible for preoperative autologous blood donation (group 1) and into those with relevant risk factors not permitting preoperative AB-donation (group 2) (Table 1). The study was blinded since neither the involved anesthesiologists nor the orthopedic surgeons knew about the distribution of the patients into group 1 and group 2.

We used the Clopper-Pearson (1934) method for the statistical analysis to estimate the probability of allogenic blood substitution in the TKA population.

Results

46 patients in group 1 had no compromising risk factors, that would have been eligible for preoperative AB-donation (Table 2). All were willing to undergo surgery without preoperative autologous

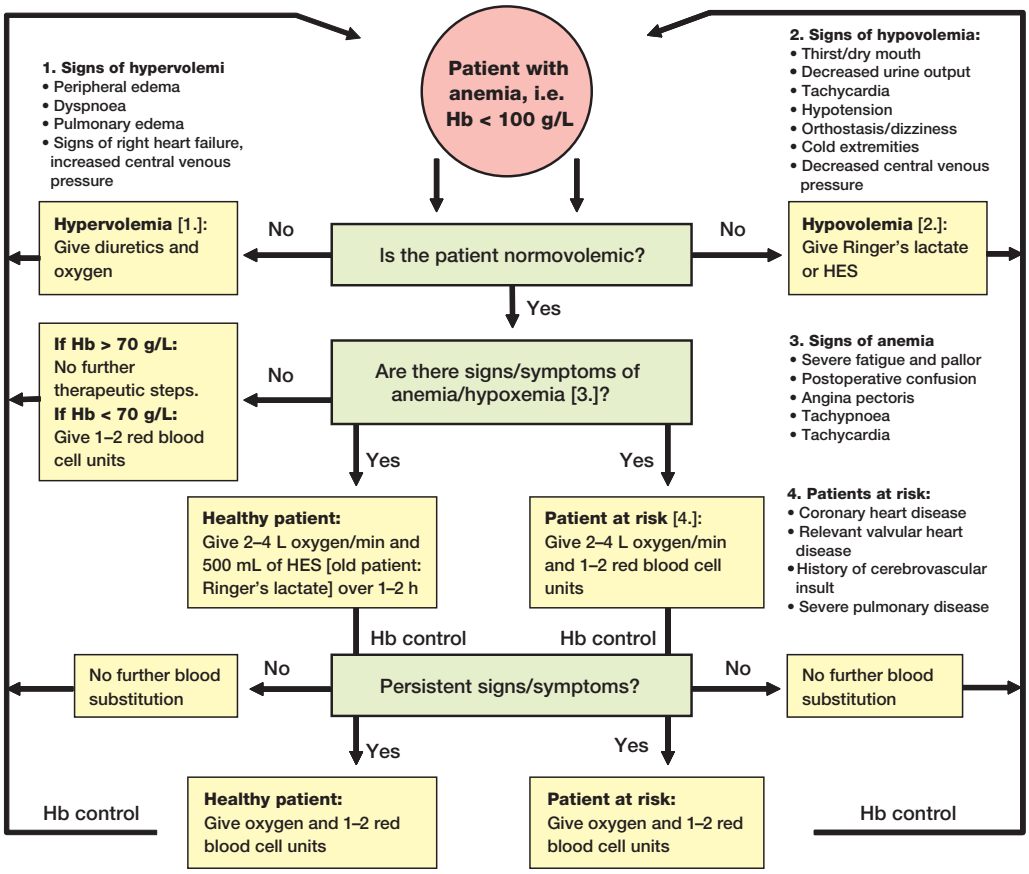
Table 2. Comparison of some patients who would have been eligible for preoperative AB donation and those who were not considered for blood donation because of risk factors

	Group 1	Group 2
Number of patients	46	35
Age (range)	71 (61–80)	82 (71–90)
Gender: women / men	34 / 12	27 / 8
Patients over 80 yr	0	25
Patients with relevant risk factors (except age)	0	29
Mean preoperative Hb (g/L) (range)	137 (117–165)	132 (110–162)
Patients with preoperative AB-donation	0	0
Mean loss (mL) of blood during surgery (range)	285 (100–800)	298 (100–1200)
Mean postoperative Hb (g/L) (range)	103 (66–121)	101 (65–129)
Autoretransfused blood after surgery [a] (range)	471 (220–850)	503 (250–1050)
Number of units transfused allogenic blood	0	26

[a] Handy Vac

Guidelines for the perioperative management of volume status

- Peri- and postoperative management of volume status does not simply refer to red blood cell transfusion, rather it needs a careful evaluation of clinical signs and symptoms.
- Distinguish between hypovolemic or hypervolemic patients and normovolemic patients with signs and symptoms of anemia.
- **Asymptomatic patients** with normovolemic anemia **do not need blood transfusions** if the hemoglobin level is above 70 g/L.



Note: High risk patients need special thresholds for red blood cell transfusion

Indication for blood transfusion in normovolemic patients:
- Syncope
- Dyspnoea
- Tachycardia
- Hypotension
- Angina pectoris
- Transient ischemic attack

Relative indication for blood transfusion:
- Fatigue and weakness in patients with anemia

No indication for blood transfusion:
- General well-being in patients with anemia
- Prophylactic substitution in general
- Use as a volume expander. First replace intravascular volume with crystalloids/HES

Note: differential diagnosis to hypo-/hypervolemia and anemia:
- Heart failure
- Angina pectoris
- Pulmonary embolism
- Pneumonia
- Pleural effusion
- Infections of all kind, etc

Management in hypovolemic patients:
- 500–1000 mL Ringer's lactate over 2–4 h, in healthy patients 500 mL HES over 2–3 h [don't give HES in case of allergies]
- 2–4 L oxygen/min

The guidelines for blood component therapy based on principles published by the American Association of Anesthesiologists (Stehling 1996) and the ICU Book (Marino 1998).

blood donation. In group 2, 35 patients had limiting risk factors (Table 1). 1 patient, who insisted on undergoing preoperative AB-donation, was rejected by the Red Cross (the responsible institution for AB-donation), because of compromizing risk factors. Therefore this patient is listed in group 2 of the study.

In 14 of 81 patients, 26 allogenic blood units were used for substitution, which is the equivalent of 1.8 units per patient (Table 2). All of these patients belonged to risk-group 2 who would not have been qualified for preoperative AB-donation. The indications for transfusion were tachycardia in 5 cases, dyspnea in 1 and hypotension in 1 normovolemic patient. In the other 7 patients with severe cardiac co-morbidities (NYHA ≥ III), the hemoglobin level fell below the previously defined safety Hb-value and a transfusion was therefore given.

None of the patients in group 1 needed an allogenic blood transfusion. Moreover, none of them suffered any clinical consequences of the low hemoglobin values such as angina pectoris, abnormal fatigue or dizziness.

The statistical analysis showed a binominal distribution of allogenic blood transfusion in group 1 (n = 46). With zero events of blood transfusion, the 95% confidence interval lies between 0 and 0.08, using the Clopper-Pearson method.

Discussion

Our aim was to determine whether primary TKA can be performed without preoperative autologous blood donation unless there is an increase in the risk of an allogenic blood transfusion postoperatively. The data were collected prospectively and consecutively. Before surgery, they were divided into two groups according to their risk profile. The physicians involved were blinded as to the allocation of the patients into the groups.

The two groups were comparable as regards the distribution of gender, preoperative hemoglobin values, intraoperative blood loss and direct autoretransfusion, using the Handy Vac System. Due to the requirement of age above 80 years as a risk factor, the average age of patients in group 2 was higher than in group 1. No patient was excluded from this consecutive sample. Therefore the patient material represents a standard TKA population of a medium-sized public hospital.

We found that none of the patients in group 1, who were theoretically eligible for autologous blood donation, needed an allogenic blood transfusion and none of them had any blood-related complications such as angina pectoris, abnormal fatigue or dizziness.

These guidelines (Figure) played a crucial role in avoiding unnecessary blood transfusions and two basic definitions were fundamental. 1) Action was taken on the basis of clinical findings and not primarily on the hemoglobin or hematocrit values (except in high-risk patients (NYHA ≥ III), where an individual hemoglobin limit was defined as a limitation for transfusion. 2) If the patient had clinical symptoms of anemia, first we increased the amount of fluids. Only if that signs persisted, did we give an allogenic blood substitution. Only in patients with severe effects of anemia—e.g., angina pectoris—was an allogenic blood transfusion immediately given. This procedure, as described by the American Society of Anesthesiologists, proved to be very effective and safe (Stehling 1996, Marino 1998). General hemoglobin or hematocrit values, as an indication for blood substitution, should only be used when a patient has severe risk factors (Marino 1998, Stehling 1996). In all other cases, the rigid application of threshold hematological values leads to an unnecessary increase in allogenic blood transfusions with its well-described risks for the patients (Duffy and Neal 1996, Innerhofer et al. 1999, Sonnenberg et al. 1999).

On the basis of a good preoperative information to the patient, no patient in group 1 wanted to undergo a preoperative blood donation. The obvious advantages for the patients were avoidance of the donation procedure and the possibility of undergoing surgery earlier. This conflicts with the views of Lee (Lee et al. 1998a, b), who stated that patients would prefer to pay for the preoperative AB-donation themselves instead of not having it. The authors of the present study suggest that this mainly reflects a difference in the message given to the patient before surgery.

The wound drainage system (Handy Vac) permitted collection and retransfusion of about 450 mL wound blood per patient. This system proved

to be a cheap and effective way for postoperative autologous blood salvage. Errors in donation become almost impossible because the collected blood is retransfused at the bedside. However, the quality of this blood remains disputed (Jensen et al. 1999).

No competing interests declared.

Bengtson A, Bengtson J. Autologous blood transfusion: preoperative blood collection and blood salvage techniques. Acta Anaesthesiol Scand 1996; 40: 1041-56.

Clopper C S, Pearson E S. The use of confidence or fiducial limits illustrated in the case of the binomial. Biometrika 1934; 26: 21.

Duffy G, Neal K R. Differences in postoperative infection rates between patients receiving autologous and allogeneic blood transfusion: a meta-analysis of published randomized and nonrandomized studies. Transfus Med 1996; 6: 325-8.

Etchason J, Petz L, Keeler L. The cost effectiveness of preoperative autologous blood transfusion. N Engl J Med 1995; 332: 719-24.

Goldmann M, Remyprince S, Trepanier A, Decary F. Autologous donation error rates in Canada. Transfusion 1996; 37: 523-7.

Innerhofer P, Walleczek C, Luz G, Hobisch-Hagen P, Benzer A, Stöckl B, Hessenberger G, Nussbaumer W, Schobersberger W. Transfusion of buffy coat-depleted blood components and risk of postoperative infection in orthopedic patients. Transfusion 1999; 39: 625-32.

Jensen C M, Pilegaard R, Hviid K, Nielsen J D, Nielsen H J. Quality of reinfused drainage blood after total knee arthroplasty. J Arthroplasty 1999; 14: 312-8.

Lee S J, Liljas B, Churchill W H, Popovsky M A, Stowell C P, Cannon M E, Johannesson M. Perceptions and preferences of autologous blood donors. Transfusion 1998a; 38: 757-63.

Lee S J, Liljas B, Neumann P J, Weinstein M C, Johannesson M. The impact of risk information on patients' willingness to pay for autologous blood donation. Med Care 1998b; 36: 1162-73.

Linden J, Kruskall M. Autologous blood: always safer? Transfusion 1997; 37: 455-6.

Mario P. The ICU Book. 2 Ed. Section XI: Blood component therapy. Williams & Wilkins 1998.

Popowsky M, Whitaker B, Arnold N. Severe outcomes of allogenic and autologous blood donation: frequency and characterization. Transfusion 1995; 35: 734-7.

Sonnenberg F A, Gregory P, Yomtovian R, Russell L B, Tierney W, Kosmin M, Carson J L. The cost-effectiveness of autologous transfusion revisited: implications of an increased risk of bacterial infection with allogeneic transfusion. Transfusion 1999; 39: 808-17.

Spahn D, Jamnicki M. Blood-saving techniques with special emphasis on haemodilution. Curr Anaesth Crit Care 1998; 9: 140-5.

Stehling C. Practice guidelines for blood component therapy. Anesthesiology 1996; 84 (3): 732-42.

Thomas M, Gillon J, Desmond M. Consensus conference on autologous transfusion. Preoperative autologous donation. Transfusion 1996; 36: 633-9.