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Original Article

Total knee arthroplasty: indication of blood transfusion according to hematimetric variation and clinical symptoms of hypoperfusion^{☆,☆☆}



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ABSTRACT

Objective: To analyze the relationship between hematimetric variation and the presence of clinical symptoms of hypoperfusion for indicating blood transfusion in patients undergoing total knee arthroplasty.

Methods: A retrospective analysis was conducted on data gathered from the medical files of 55 patients with a diagnosis of gonarthrosis, who underwent total knee arthroplasty at a hospital orthopedics and traumatology service between February 2011 and December 2012. The patients studied presented unilateral joint degeneration and fitted into the indications for surgical treatment. All the patients underwent a preoperative cardiologic evaluation, presenting a pattern of ASA I–III and absence of blood dyscrasia, and preoperative hemoglobin measurements were made. However, no minimum hematimetric value was established for the surgical treatment; there were only clinical criteria for blood perfusion.

Results: Among the 55 patients, 35 were female and 20 were male, and the mean age was 68 years. Six patients underwent homologous blood transfusion, because of their clinical condition of tissue hypoperfusion, persistent hypotension, loss of consciousness, sweating and coercible vomiting. They presented postoperative hemoglobin of 7.5–8.8 g/dL.

Conclusion: For patients with falls in hemoglobin counts greater than 20% and values lower than 9 g/dL after the surgery, there is a possible need for blood transfusion, which should only be indicated when accompanied by major symptoms of tissue hypoperfusion.

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Artroplastia total do joelho: indicação de transfusão sanguínea de acordo com a variação hematimétrica e os sintomas clínicos de hipoperfusão

R E S U M O

Palavras-chave:

Hemoglobina
Perda sanguínea cirúrgica
Articulações
Artroplastia
Hipovolemia

Objetivo: Analisar a relação entre a variação hematimétrica e a presença de sintomas clínicos de hipoperfusão para a indicação de transfusão sanguínea em pacientes submetidos a artroplastia total do joelho.

Métodos: Fez-se uma análise retrospectiva dos dados coletados nos prontuários de 55 pacientes com diagnóstico de gonartrose submetidos a artroplastia unilateral total do joelho feita pelo serviço de ortopedia e traumatologia de um hospital de fevereiro de 2011 a dezembro de 2012. Os pacientes estudados apresentaram degeneração articular unilateral e se enquadraram na indicação para o tratamento cirúrgico. Todos foram submetidos a avaliação pré-operatória cardiológica e manteve-se um padrão correspondente a ASA-I até III, ausência de discrasia sanguínea e mensuração de hemoglobina pré-operatória. Porém, não foi estabelecido valor hematimétrico mínimo para o tratamento cirúrgico, apenas critérios clínicos de perfusão sanguínea.

Resultados: Dos 55 pacientes, 35 do sexo feminino e 20 do masculino, com média de 68 anos, apenas seis foram submetidos a transfusão sanguínea homóloga, decorrente do quadro clínico de hipoperfusão tecidual, hipotensão persistente, perda da consciência, sudorese e vômitos coerçíveis e apresentaram hemoglobina pós-operatória entre 7,5 e 8,8 g/dL.

Conclusão: Pacientes com queda acima de 20% na contagem de hemoglobina e valores abaixo de 9 g/dL após a cirurgia sugerem uma possível necessidade de transfusão sanguínea, que só deve ser indicada quando acompanhada de sintomas maiores de hipoperfusão tecidual.

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Introduction

Total knee arthroplasty (TKA) is one of the surgical procedures most indicated for treating osteoarthritis,¹ which is a disease of inflammatory and degenerative nature that causes destruction of the knee joint cartilage and leads to joint deformity.² TKA is an increasingly common procedure,³⁻⁶ but it is associated with major postoperative blood losses that may reach quantities greater than or equal to 1.5L. In such cases, transfusion becomes inevitable.^{7,8} The bleeding occurs mainly after removal of the tourniquet.^{9,10}

It is understood that in cases of trauma and in large-scale surgical procedures like TKA, in which there is acute blood loss, oxygenation is the main indicator regarding blood volume replacement. This is a decisive moment, at which replacement should be performed using blood or blood components, rather than by means of acellular solutions alone. Thus, transfusions can be done using homologous blood donated by another person, or using autologous blood, in which the donor and recipient are the same person. In most cases, transfusion using homologous blood is done more often.¹¹

However, if the indications for transfusions are analyzed, it is seen that there is no consensus regarding what the minimum acceptable value for the hemoglobin level would be, for adequate tissue perfusion to be maintained. Discrepant values have been reported, ranging from levels as low as 1.8 g/dL to normal levels like 12 g/dL.¹²

The present study had the aim of analyzing the relationship between the hematimetric variation and the presence

of clinical symptoms of hypoperfusion, for indicating blood transfusion in patients undergoing TKA.

Materials and methods

A retrospective analysis was conducted on data gathered from the medical files of 55 patients who underwent unilateral TKA, performed at the orthopedics and traumatology service of a hospital between February 2011 and December 2012. Among these patients, 35 (63.63%) were female and 20 (36.36%) were male, and the mean age was 68.3 years (range: 45–86), as can be seen in [Fig. 1](#).

All the procedures were performed by a team of surgeons with experience of the surgical technique of unilateral TKA.

As inclusion criteria, the patients needed to present primary gonarthrosis with an indication for TKA, undergo a preoperative cardiological assessment, remain within categories I–III of the American Society of Anesthesiology (ASA), present absence of blood dyscrasia and have preoperative

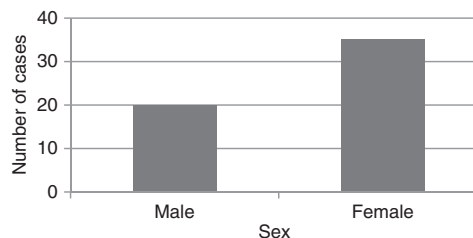


Fig. 1 – Number of cases according to gender.

hemoglobin measurements available. No minimum hematimetric value was established for the surgery: only clinical criteria for blood perfusion. Patients who were regularly using medications with the potential to alter their coagulation were advised to suspend their use ten days before the surgical intervention, and all of the patients presented normal coagulograms on the day of the procedure. Any intraoperative or postoperative complication was considered to be an exclusion criterion.

The antibiotic cefazolin was used as a single dose of 1 g intravenously, to induce anesthesia. Prevention of venous thromboembolism followed the guidance of the venous thromboembolism prevention committee, with subcutaneous administration of 40 mg of enoxaparin per day, starting 6 h after onset of the anesthetic block and continuing for ten days. In all the patients, the anesthesia consisted of a locoregional block and the criterion for transoperative and immediate postoperative volume replacement was restrictive, comprising crystalloid infusion at the rate of 10 mL/kg/h. Asepsis and antisepsis were performed, with application of specific topical solutions, and placement of appropriate surgical fields.

During the surgical procedure, a pneumatic tourniquet with a pressure of 375 mmHg was used. This was positioned at the root of the thigh, which was protected with orthopedic cotton wool and a crepe bandage. The conventional technique for total knee arthroplasty was followed, by means of a median access route and medial parapatellar arthrotomy, eversion of the patella, disturbance of the knee extensor mechanism, joint dislocation and extensive violation of the soft tissues surrounding the joint.¹³⁻¹⁵ All the patients received a cemented prosthesis, which is used more frequently for technical and economic reasons.¹⁶

After the pneumatic tourniquet had been released, hemostasis was performed and a one-way vacuum suction drain was placed inside the joint, with its outlet in the lateral distal region of the femur. Suturing was performed in layers, with complete flexion-extension movements made after closing each layer. Dressings were applied from the inguinal region to the foot, consisting of successive layers of compressive bandages and orthopedic cotton wool, followed by a plaster-cast splint extending from the inguinal region to the malleolus.

Volume replacement with crystalloids was performed in the ward, with observance of a ration of 3:1 for the blood losses collected through the vacuum drain and the estimated daily loss into the dressings. Hemoglobin control was applied 24 h after the end of the surgical procedure, given that this is the ideal time, since it corresponds to the time of greater volume drained through the drain collector system. After this time, the volume becomes insignificant.¹⁷

The length of hospital stay was three days. Isometric and isotonic exercises were performed on the entire lower limb, beginning on the first postoperative day and continuing until discharge from hospital. The aims were to achieve active flexion of at least 90°, complete extension and walking with partial weight-bearing, with the aid of a walking frame.

Results

In evaluating the hemoglobin levels after 24 h, it was observed that the mean loss was 3.33 g/dL (24.78%), with a range from 0.5

Table 1 – Number of patients according to the postoperative hemoglobin assay value.

Postoperative hemoglobin (g/dL)	Number of patients
>12	7
11-12	11
10-11	13
9-10	13
8-9	9
7-8	2
<7	0

Table 2 – Total number of patients and number of transfused patients according to the percentage decrease in hemoglobin level after the operation.

Decrease in hemoglobin (%)	Total number of patients	Number of transfused patients
0-10	4	0
10-15	2	0
15-20	10	0
20-25	14	1
25-30	12	1
30-35	4	1

to 6.3 g/dL. The postoperative hemoglobin assay ranged from 7.5 to 12.7 g/dL, and most of the patients (67.27%) presented levels between 9 and 12 g/dL (Table 1).

To view the data presented in Table 1 better, a histogram of frequencies of numbers of patients was constructed according to the postoperative hemoglobin assay values (Fig. 2).

The percentage reduction in hemoglobin level ranged from 5.55% to 40.91%. Most of the patients (36) presented a decline, which ranged from 15% to 30%. All the patients who received transfusions presented percentages greater than 20%. However, 39 patients presented percentage losses greater than 20% and only six (15.38%) received transfusions, as shown in Table 2.

The total number of patients and number of transfused patients according to the percentage decline in hemoglobin levels after the operation can be seen in Fig. 3.

Six patients (10.9%) underwent exclusively homologous blood transfusion, because they presented symptoms of tissue hypoperfusion, such as persistent hypotension, loss of consciousness, cold sweating, coercible vomiting and mental confusion. The criteria of hematimetric variation were not determinants for the transfusions. However, in analyzing the values, we observed that all the transfused patients

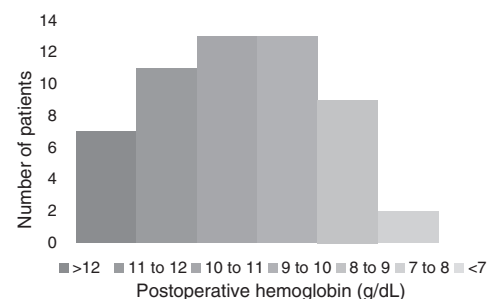


Fig. 2 – Number of patients according to the postoperative hemoglobin assay values.

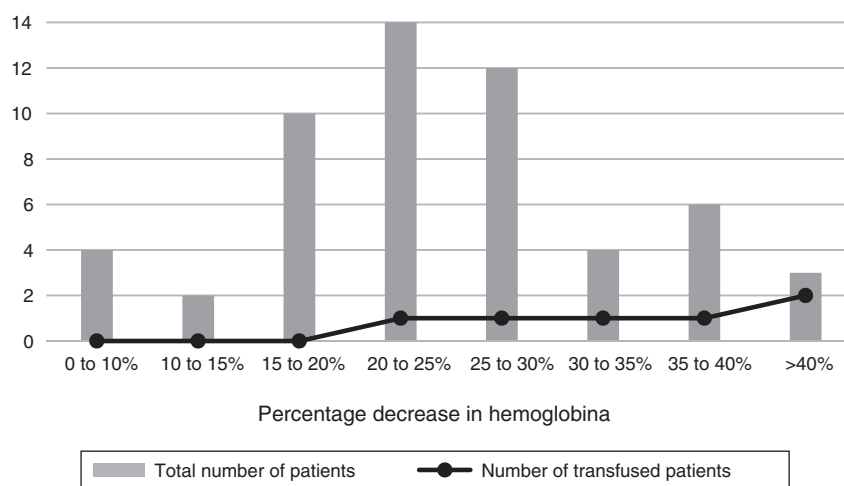


Fig. 3 – Total number of patients and number of transfused patients according to the percentage decrease in hemoglobin value after the operation.

presented postoperative hemoglobin counts that ranged from 7.5 to 8.8 g/dL (Table 3). It should be emphasized that other patients with postoperative hemoglobin counts lower than 8.8 g/dL did not have the need for transfusion, since they did not present clinical symptoms of hypoperfusion (Table 1).

Discharge from hospital was delayed by one day for the patients who underwent transfusions. However, no other complications were observed.

The behavior of the patients who underwent blood transfusion, regarding their pre and postoperative hemoglobin levels and the percentage reductions, can be seen better in Fig. 4.

Discussion

Blood loss during TKA may lead patients to the need to undergo transfusion. However, there is no consensus in the pertinent literature regarding the indications for transfusion according to hemoglobin levels.

It is worth recalling the observation made by Vuille-Lessard et al.¹⁸ that doctors do not have definitive indications or support guidelines for the need for blood transfusion after orthopedic surgery, which ultimately results in a diversity of levels used in transfusion practice.

In analyzing blood management in patients undergoing total knee or hip arthroplasty, Bierbaum et al.¹⁹ stated that their study was the first to prospectively assess the role of

hemoglobin according to its levels or specific categories. They evaluated the need for autologous or homologous transfusion based on the initial hemoglobin level. Patients whose preoperative hemoglobin level was 13 g/dL or less would need a homologous blood transfusion, particularly those whose initial hemoglobin level was between 10 and 13 g/dL. Subsequently, Billote et al.²⁰ made a complete review of the manuscript of Bierbaum et al.¹⁹ and disagreed with the original result, with the justification that the category of patients with initial hemoglobin levels from 10 to 13 g/dL presented in that study was very broad, in that it mixed anemic and non-anemic elderly individuals and other eligible donors. Also in Billote et al.,²⁰ Bierbaum et al. replied and stated that from the conceptual point of view, the interval of 10–13 g/dL in their study was based on information from the World Health Organization (WHO). Bierbaum et al.¹⁹ agreed with Billote et al.²⁰ in stating that additional investigations of blood management strategies in these surgical procedures were necessary.

In this regard, Ng et al.²¹ made reference to the studies of Salido et al.²² and Hatzidakis et al.,²³ and stated only that patients with preoperative hemoglobin levels less than 13 g/dL are four to six times more likely to need transfusion than are patients with hemoglobin levels between 13 and 15 g/dL and 15 times more likely than those with a level of 15 g/dL.

In the present study, it was observed that among the patients who underwent blood transfusion, only one of them presented a preoperative hemoglobin level lower than 11 g/dL, while the others (total of five) presented preoperative

Table 3 – Pre and postoperative hemoglobin levels and percentage decreases in patients who underwent blood transfusion.

Transfused patient	Preoperative hemoglobin level (g/dL)	Postoperative hemoglobin level (g/dL)	Decrease in hemoglobin (%)
A	12.6	7.50	40.47
B	12.7	7.60	40.16
C	12.8	8.20	35.94
D	10.9	8.20	24.77
E	11.7	8.40	28.20
F	13.1	8.80	32.82

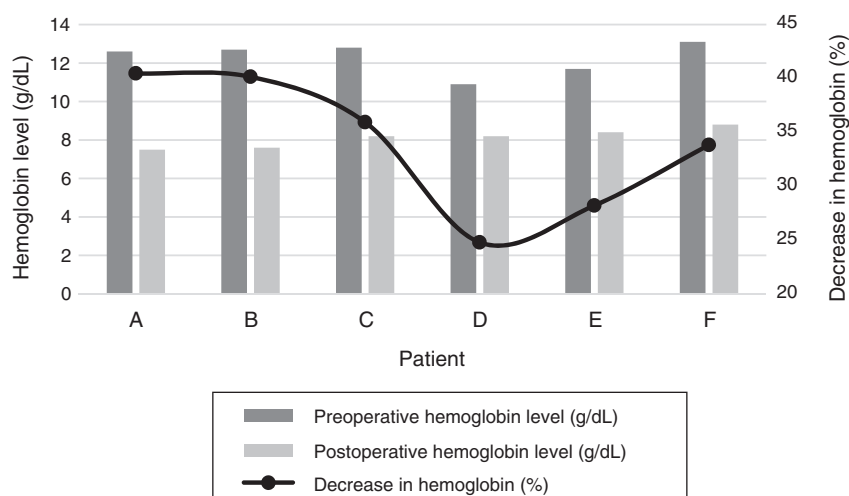


Fig. 4 – Pre and postoperative hemoglobin levels and percentage decrease in patients who underwent blood transfusion.

hemoglobin levels between 12.6 and 13.1 g/dL. This was not the decisive factor for indicating transfusion.

Regarding postoperative hemoglobin levels, in another study²⁴ on the use of tourniquets in TKA cases in two groups of patients (with and without a tourniquet), it was reported that two patients in each group underwent blood transfusion after the operation. One patient underwent transfusion when a hemoglobin level of 8.3 g/dL was presented, accompanied by tachycardia and mild dyspnea, while the other three presented low hemoglobin levels (7.2, 7.6 and 7.7 g/dL). The mean decrease in hemoglobin level for these four patients was 4.1 g/dL.

In the present study, it was observed that all the transfused patients presented postoperative hemoglobin counts of between 7.5 and 8.8 g/dL. However, other patients with postoperative hemoglobin counts lower than 8.8 g/dL did not need transfusion, given that they did not present clinical symptoms of hypoperfusion and the hematimetric variation criteria were not determinant for the transfusions.

Other authors²⁵ who studied transfusions of autologous and homologous blood in TKA surgery cases made comparisons through distributing the patients into two groups: those who received homologous blood transfusions and those who received autologous blood transfusions. They emphasized that the indication for transfusion for both groups was when the patient presented a postoperative hemoglobin level of 8.5 g/dL. They also pointed out that their study had some limitations and explained that although the recommendation from local studies was 8.5 g/dL, this was not always followed by some surgeons, who were still reluctant to apply this because they thought that it was too low.

These authors²⁵ took the view that this was the explanation for higher hemoglobin levels in the homologous transfusion group, which was not seen in the autologous group because the protocol for this was controlled by the technique and the anesthesia by the anesthesiologist.

In the present study, the view taken was that, unlike in the cases of the above authors,²⁵ the patients who underwent homologous blood transfusion received this solely because

they presented symptoms of tissue hypoperfusion. The hematimetric variation criteria were not determinants for the transfusions.

In a comparative study on blood transfusion practice in elective surgical procedures in three hospitals in France, Vuille-Lessard et al.¹⁸ concluded that in general, the patients received transfusions when they presented hemoglobin levels of between 7.5 and 8.0 g/dL. There were significant differences between the hospitals, regarding the distribution of the procedures, hemoglobin levels and blood losses, and also in relation to the decrease in hemoglobin levels and duration of this state. These authors stated that in 85% of the transfusions, only the hemoglobin level was envisaged.

In the present study, the majority of the patients (67.27%) presented postoperative hemoglobin levels between 9 and 12 g/dL, and none of them required transfusion. However, among the 11 patients with postoperative hemoglobin levels lower than 9 g/dL, six (54.54%) required transfusion. In other words, patients with hemoglobin levels lower than 9 g/dL following TKA surgery presented twice as much possibility of needing blood transfusion. This hemoglobin value was shown to be a minimum threshold for possible transfusion, in relation to clinical symptoms.

Also in the present study, the majority of the patients (65.45%) presented percentage decreases in hemoglobin levels ranging from 15% to 30%. However, among the transfused patients alone, the mean percentage was greater (33.84%), with a range from 24.77% to 40.47%.

In total, there were 39 patients with a change of more than 20%, but only 15.38% required transfusion. Thus, it seems that indicating blood replacement according to the percentage hematimetric loss is not an appropriate criterion for use in clinical practice, since no standard that would or would not justify blood transfusion was found.

Conclusion

When patients present declines in hemoglobin count greater than 20% and values lower than 9 g/dL after surgery, this

suggests a possible need for blood transfusion, which should only be indicated when accompanied by greater symptoms of tissue hypoperfusion.

Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES

- Cintra FF, Yepéz AK, Rasga MGS, Abagge M, Alencar PGC. Componente tibial na revisão da artroplastia do joelho: comparação entre fixação cimentada e híbrida. *Rev Bras Ortop.* 2011;46(5):585-90.
- Camanho GL. Tratamento da osteoartrose do joelho. *Rev Bras Ortop.* 2001;36(5):135-40.
- Iamaguchi MM, Helito CP, Gobbi RG, Demange MK, Tirico LEP, Pecora JR, et al. Valor da avaliação radiográfica pré-operatória dos defeitos ósseos no joelho nas revisões de artroplastia. *Rev Bras Ortop.* 2012;47(6):714-8.
- Khatod M, Inacio M, Paxton EW, Bini SA, Namba RS, Burchette RJ, et al. Knee replacement: epidemiology, outcomes, and trends in Southern California: 17,080 replacements from 1995 through 2004. *Acta Orthop.* 2008;79(6):812-9.
- Wells VM, Hearn TC, McCaul KA, Anderton SM, Wigg AE, Graves SE. Changing incidence of primary total hip arthroplasty and total knee arthroplasty for primary osteoarthritis. *J Arthroplasty.* 2002;17(3):267-73.
- Pugely AJ, Martin CT, Gao Y, Mendoza-Lattes S, Callaghan JJ. Differences in short-term complications between spinal and general anesthesia for primary total knee arthroplasty. *J Bone Joint Surg Am.* 2013;95(3):193-9.
- Lotke PA, Faralli VJ, Orenstein EM, Ecker ML. Blood loss after total knee replacement. Effects of tourniquet release and continuous passive motion. *J Bone Joint Surg Am.* 1991;73(7):1037-40.
- Singh VK, Singh PK, Javed S, Kumar K, Tomar J. Autologous transfusion of drain contents in elective primary knee arthroplasty: its value and relevance. *Blood Transfus.* 2011;9(3):281-5.
- Andrade MAP, Campos TVO, Silva BFA, Assis ME, Boechat LC, Biondi LF, et al. Avaliação prospectiva dos pacientes submetidos a artroplastia total do joelho com e sem colocação de dreno de sucção. *Rev Bras Ortop.* 2010;45(6):549-53.
- Burke DW, O'Flynn H. Primary total knee arthroplasty. In: Chapman MW, editor. *Chapman's orthopedic surgery.* Philadelphia: Lippincott Williams & Wilkins; 2001. p. 2870-95.
- Vane LA, Ganem EM. Doação homóloga versus autóloga e substitutos da hemoglobina. In: Cavalcanti IL, Cantinho FAF, Assad AR, editors. *Medicina perioperatória.* Rio de Janeiro: Sociedade de Anestesiologia do Estado do Rio de Janeiro; 2006. p. 291-306.
- Hajjar LA, Auler JOC Jr, Santos L, Galas F. Blood transfusion in critically ill patients: state of the art. *Clinics.* 2007;62(4):507-24.
- Motta Filho GR, Cavanellas N. Artroplastia minimamente invasiva do joelho. *Rev Bras Ortop.* 2007;42(9):269-77.
- Scott RD, Volatile TB. Twelve years' experience with posterior cruciate-retaining total knee arthroplasty. *Clin Orthop Relat Res.* 1986;(205):100-7.
- Malkani AL, Rand JA, Bryan RS, Wallrichs SL. Total knee arthroplasty with the kinematic condylar prosthesis: a ten-year follow-up study. *J Bone Joint Surg Am.* 1995;77(3):423-31.
- Cobra HAAB, Palma IM. Artroplastia total do joelho. SEMCAD/PROATO/SBOT - Sociedade Brasileira de Ortopedia e Traumatologia. Porto Alegre: Artmed/Panamericana; 2008.
- Lopes AIS, Cobra HAAB, Cavanellas NT. Avaliação da perda sanguínea em artroplastia total primária do joelho com drenagem de sucção: estudo prospectivo. *Orto & Trauma: Discussões e Complicações.* 2009;(6):4-6.
- Vuille-Lessard E, Boudreault D, Girard F, Ruel M, Chagnon M, Hardy JF. Red blood cell transfusion practice in elective orthopedic surgery: a multicenter cohort study. *Transfusion (Paris).* 2010;50(10):2117-24.
- Bierbaum BE, Callaghan JJ, Galante JO, Rubash HE, Tooms RE, Welch RB. An analysis of blood management in patients having a total hip or knee arthroplasty. *J Bone Joint Surg Am.* 1999;81(1):2-10.
- Billote DB, Bierbaum BE, Callaghan JJ, Galante JO, Rubash HE, Tooms RE, et al. Analysis of blood management. *J Bone Joint Surg Am.* 2000;82(6):900-1.
- Ng VY, Lustenberger D, Hoang K, Urchek R, Beal M, Calhoun JH, et al. Preoperative risk stratification and risk reduction for total joint reconstruction: AAOS exhibit selection. *J Bone Joint Surg Am.* 2013;95(4):e191-215.
- Salido JA, Marín LA, Gómez LA, Zorrilla P, Martínez C. Preoperative hemoglobin levels and the need for transfusion after prosthetic hip and knee surgery: analysis of predictive factors. *J Bone Joint Surg Am.* 2002;84(2):216-20.
- Hatzidakis AM, Mendlick RM, McKillip T, Reddy RL, Garvin KL. Preoperative autologous donation for total joint arthroplasty. An analysis of risk factors for allogenic transfusion. *J Bone Joint Surg Am.* 2000;82(1):89-100.
- Tai TW, Chang CW, Lai KA, Lin CJ, Yang CY. Effects of tourniquet use on blood loss and soft-tissue damage in total knee arthroplasty: a randomized controlled trial. *J Bone Joint Surg Am.* 2012;94(24):2209-15.
- Sarkanovic ML, Gvozdenovic L, Savic D, Ilic MP, Jovanovic G. Autologous blood transfusion in total knee replacement surgery. *Vojnosanit Pregl.* 2013;70(3):274-8.