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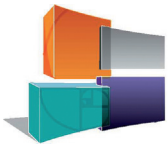

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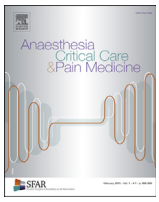

Original Article

Predictive factors for homologous transfusion during paediatric scoliosis surgery

Claire Dupuis [a,d], Daphné Michelet [a,d], Julie Hilly [a,d], Thierno Diallo [a,d], Christophe Vidal [c,d], Honorine Delivet [b,e], Yves Nivoche [a,d,g], Keyvan Mazda [c,d], Souhayl Dahmani [a,d,f,*]

[a] Department of Anaesthesia and Intensive care, Robert-Debré University Hospital, Paris, France
[b] Department of Pain Management, Robert-Debré University Hospital, Paris, France
[c] Department of Paediatric Orthopaedic Surgery, Robert-Debré University Hospital, Paris, France
[d] Paris Diderot University, Paris VII, PRES Paris Sorbonne Cité, Paris, France
[e] Paris Descartes University, Paris V, PRES Paris Sorbonne Cité, Paris, France
[f] DHU PROTECT, Inserm U1141, Robert-Debré University Hospital, Paris, France
[g] EA 7334 REMES, Paris Diderot University, Paris VII, PRES Paris Sorbonne Cité, Paris, France

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ABSTRACT

Introduction: Blood saving strategies during paediatric spinal surgery often include recombinant erythropoietin (rEPO) and antifibrinolytic therapy (AFT). The goal of this study was to investigate additional preventive factors involved in the risk of blood transfusion.
Methods: This prospective study was designed with the aim of identifying factors associated with the perioperative (defined as the intraoperative and the first postoperative day) probability of homologous red cell transfusion during scoliosis surgery in children operated during a one year period in our institution. The predictors analysed were: age, weight less than the 3rd percentile ($W_{<3P}$), indication for spinal surgery (idiopathic or neuromuscular), Cobb's angle, ASA status, preoperative haemoglobin, number of levels fused, duration of surgery, intraoperative fluid intakes, sacral fusion and thoracoplasty. Statistical analyses were performed using a multivariate logistic regression model.
Results: One hundred and forty-seven patients were included in the analysis. Multivariate analysis found the following variables to be independent predictors for an increased risk of homologous blood transfusion: $W_{<3P}$, neuromuscular scoliosis and duration of surgery $>$ 255 minutes. ROC analysis for the latter model found an area under the curve of 0.9 (95% confidence interval: 0.8–0.97). The accuracy of the model was 92.3% (97.4% for non-transfusion and 69.2% for transfusion). Multivariate sensitivity analysis excluding patients with no preoperative administration of EPO found similar results.
Conclusion: The current results indicate that optimising nutritional status might prevent allogenic blood transfusion and requires further investigation.

1. Introduction

Spinal surgery in children is a high-risk procedure associated with many postoperative adverse issues [1]. First, up to 10% of patients have neuromuscular diseases or cerebral palsy, conditions increasing postoperative cardiovascular, respiratory and infectious complications [1–3]. Second, spine surgery has been shown to exhibit specific postoperative complications such as hyponatremia that can cause devastating effects, such as cerebral oedema [4]. Finally, spinal surgery is classically associated with extensive blood loss and haemodynamic instability that can impair postoperative rehabilitation and contribute to the occurrence of the complications quoted above [5]. In addition, perioperative transfusion (whether autologous or homologous) has been shown to induce many specific complications such as bacterial infections, acute immunological incompatibility reactions and long-term immunological effects (infections, tumour recurrence) [6,7]. Consequently, many blood saving strategies have been studied and introduced in order to decrease the incidence of blood transfusion and its related complications [8–10].

During the last decade, the use of blood saving strategies such as recombinant erythropoietin (rEPO) and antifibrinolytic therapy

* Corresponding author. Department of Anaesthesia and Intensive Care, Robert-Debré Hospital, 48, boulevard Sérurier, 75019 Paris, France. Tel.: +33 1 40 03 41 83; fax: +33 1 40 03 20 00.
E-mail address: souhayl.dahmani@rdb.aphp.fr (S. Dahmani).

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(AFT), during scoliosis surgery, has been associated with a reduction in perioperative blood transfusion (autologous and homologous) both in adults and children [10–13]. These strategies are easier to perform, less subject to contraindications and less associated with acute and long lasting immunological-related effects as compared to transfusions. These blood saving techniques are more often used by physicians than preoperative blood donation. The available literature indicates previously studied factors as being associated with homologous blood transfusion, including these bloods saving strategies as co-factors, and found them as major predictors of the studied outcome. However, given their large diffusion, it seems interesting to focus on updating knowledge on this topic. The goal of this study was to investigate factors predicting the probability of homologous red cell transfusion during the perioperative period.

2. Material and methods

The study is a prospective analysis of perioperative data for patients operated in our institution from January 2012 to December 2012. This study was approved by our institutional review board (*Comité d'Évaluation de l'Éthique des projets de Recherche Biomédicale [CEERB] Paris Nord; No. 12-021)*. Informed written consent was obtained from all patients (when allowed by their neurological status) and/or parents.

All patients undergoing scoliosis surgery during the above quoted period were included in this study.

2.1. Perioperative anaesthesia and blood saving management

Preoperative anaesthesia and surgical preparation included standardized recombinant erythropoietin (rEPO, Eprex®, JANSSEN-CILAG, Issy-Les-Moulineaux, France) administration. The latter was administered if haemoglobin concentration, determined 24 hours before the scheduled date of injection, was strictly below 15 g/dl. Erythropoietin therapy consisted of the subcutaneous administration of 600 U/kg of rEPO weekly, starting at 4 weeks before the scheduled date of surgery, and was systematically associated with iron supplementation. Antifibrinolytic agent administration begins after anaesthesia induction; it consists of tranexamic acid (Exacyl®, Sanofi-Aventis, Paris, France) given as a 50 mg/kg bolus, plus a continuous intraoperative administration of 10 mg/kg/h. At skin closure, this agent was discontinued in order to respect its maximal dose (4 g/d). Intraoperative blood salvage was used in all patients (Haemonetics Cell Saver 5, Haemonetics Corporation, Braintree, MA, USA) using the standard salvage program in order to ensure blood transfusion with an optimal haemoglobin levels (haematocrit of 55%).

Anaesthesia was standardized according to our local protocols. All patients underwent three minutes of preoxygenation. Induction was performed using sevoflurane (6% in a mixture of O_2/N_2O 50%/50%) or intravenous propofol (5 to 7 mg/kg). Anaesthesia maintenance was performed using sevoflurane (0.8 MAC) or propofol given according to plasma target concentrations determined by the Marsh model. Intraoperative analgesia was performed by sufentanil boluses (0.2 μg/kg when heart rate or mean arterial pressure increased by 20% over preoperative values) and spinal morphine (0.5 μg/kg after incision performed by the surgeon). All patients were intubated and a non-depolarizing muscle relaxant was systematically given in order to facilitate both intubation and the surgical procedure (muscle relaxation was systematically reversed at the end of surgery). Patients were operated in a prone position performed on a Jackson frame. Two venous lines were systematically inserted and intraoperative crystalloids consisted of Ringer Lactate solution (RL) given at 2 ml × kg^{-1} × h^{-1} plus vascular filling according to haemodynamic monitoring. Intraoperative haemodynamics were assessed by oesophageal Doppler and intravenous fluid loading (10 ml/kg) was guided in order to maximize the indexed stroke volume – a decrease of stroke volume greater than 15% indicated a fluid load using 10 ml/kg of crystalloid (RL) or colloid solution (hydroxyethylstarch 130/0.4, Voluven®, FRESENIUS KABI FRANCE, Sevres, France). The indication for colloid therapy was the failure of two consecutive 10 ml/kg crystalloid loadings. Arterial pressure and heart rate were maintained within 20% ranges of preoperative values using vasopressor agents (neosynephrine 50 μg per bolus: in case of decreased arterial pressure) and vascular filling or sufentanil boluses (in case of increased arterial pressure). All patients received intrathecal morphine (5 μg/kg) during the surgical dissection.

Transfusion was managed according to intraoperative and postoperative haemoglobin measurements maintained above 8 g/dl for idiopathic or congenital scoliosis. This target was increased to 10 mg/ml in case of neuromuscular scoliosis or in patients with ASA status > 2. This was achieved by autologous transfusion (intraoperative cell saving) and homologous transfusion if necessary. Fresh frozen plasma and platelets were administered if perioperative prothrombin time was below 50% and platelet count was less than 50,000 elements/mm^3, respectively. Finally, all patients were given intravenous iron therapy (3 mg/kg) twice during the postoperative period (during the PACU stay and 48 hours later).

2.2. Surgical management [14–17]

Hybrid constructs that included sublaminar bands in the thoracic spine, auto-stable pediculo-supralaminar claws (Instinct, Zimmer Spine, Bordeaux, France) at the two proximal levels and pedicular screws (Shiraz, Zimmer spine, Bordeaux, France) at lumbar levels were placed into patients undergoing posterior correction and fusion for adolescent idiopathic scoliosis.

Fusion levels were selected according to the same criteria during the entire study period. The 2 rods were adjusted to the desired sagittal profile and connected with 2 transverse connectors before placement. The rods were first introduced in the pedicle screws, and lumbar correction was performed. Thoracoplasty was performed by the posterior method according to the patient's cosmetic concern. Spinal cord function was monitored by means of somatosensory/motor-evoked potentials. Patients with neuromuscular deformities were operated with the same technique, but the pelvic fixation was performed using intrasacral rods, as described in the modified Jackson's technique.

Patients with congenital scoliosis (hemivertebrae or unilateral unsegmented bar) were treated by circumferential convex epiphysiodesis, combining posterior instrumented arthrodesis (2 levels above and 2 levels below) and anterior epiphysiodesis.

2.3. Data collected

The data collected and analysed consisted of: age, weight (less than 3rd percentile according to patient's age: $W_{<3P}$), indication for spinal surgery (idiopathic scoliosis, neuromuscular scoliosis: neuromuscular disease or cerebral palsy, congenital scoliosis: including hemivertebrae or unilateral unsegmented bar), Cobb's angle, ASA status, preoperative and postoperative haemoglobin concentration, blood saving technique (rEPO, AFT), the number of levels fused, thoracoplasty, sacral fusion, duration of surgery, intraoperative volumes of colloids and crystalloids administered and volumes of homologous blood transfused during the perioperative period including: the intraoperative period and the first postoperative day.