Sepsis
Second Edition

Guillermo Ortiz-Ruiz, MD
Professor of Pulmonary and Critical Care Medicine
Universidad del Bosque
Bogotá, Colombia

Marco A. Perafán, MD
Professor of Cardiology and Critical Care Medicine
Fundacion Clinica Shaio
Bogotá, Colombia

Eugen Faist, MD
Professor, Department of Surgery
Klinikum Grosshadern, University of Munich
Munich, Germany

Carmelo Dueñas Castell, MD
Professor of Pulmonary and Critical Care Medicine
Hospital Bocagrande
Cartagena, Colombia

Editors

Springer
Preface

The mortality of severe sepsis (infection-induced organ dysfunction or hypoperfusion abnormalities) and septic shock (hypotension not reversed with fluid resuscitation and associated with organ dysfunction or hypoperfusion abnormalities) remains unacceptably high. Similar to an acute myocardial ischemic attack and an acute brain attack, the speed and appropriateness of therapy administered in the initial hours after the syndrome develops likely influence the outcome.

The care of critically ill patients in a modern intensive care unit (ICU) results in a large societal burden in terms of both manpower and monetary cost. The high cost of critical care can largely be attributed to high overhead costs (e.g., need for experienced staff and expensive equipment), and high demand for ICU services. With the continued increase in healthcare costs, there is an increasing need to establish whether new therapies are not only effective, but also cost-effective. Although this is true throughout medicine, the issue of cost-effectiveness is especially important in critical care medicine. ICU costs in the United States exceed $150 billion, representing up to one third of all hospital costs. Furthermore, attempts to reduce ICU costs by other mechanisms, such as reduction in lengths of stay, have proven to be difficult.

The concern over the financial effect of new therapies in the ICU is so intense that scrutiny begins even before therapies are approved by the Food and Drug Administration (FDA). Before ever gaining approval, the antiendotoxin monoclonal antibody HA-1A stimulated considerable furor and debate not only in the medical literature, but also in the national media over its anticipated cost. Currently, the FDA does not explicitly consider cost when evaluating new therapies. However, infections have placed pressure on the agency. It is perhaps as a consequence of this pressure that many recent antisepsis biologic therapies have been burdened with proving their ability to decrease mortality to gain FDA approval. This burden is greater than that faced by many less expensive therapies (e.g., antibiotics).

This book provides both a summary of this expanding field and a practical approach for clinicians to treat patients with sepsis syndrome and its complications in the critical care unit. The focus of this effort is to provide a clinical approach to specific at-risk populations who present with sepsis. This approach,
rather than an organism-directed organization, has been used because of our firm belief that one must consider the clinical and epidemiological picture of the patient before one can consider a specific microbial cause for a sepsis syndrome. This clinical approach must have a firm scientific foundation.

This book begins with a scientific review of the Latin American epidemiological approach to sepsis syndrome. It provides the principles for clinical assessment of different kinds of clinical complications as well as therapeutic strategies in this clinical field. This book is edited by four physicians with experience and interest in different aspects of the critical care point of view: three experts in the field from Colombia, as well as the international perspective of Dr. E. Faist from Germany. In this way, we believed that we could identify and recruit authoritative authors for each chapter. We are grateful to our contributing authors for all of their efforts toward this project.

Guillermo Ortiz-Ruiz
Marco A. Perafán
Carmelo Dueñas Castell
Eugen Faist

Bogotá, Colombia
Munich, Germany
## Contents

1. When to Transfuse Septic Patients ........................................... 1  
   **Carmelo Dueñas Castell**

2. Sepsis Occurrence and Its Prognosis in Latin America ............ 11  
   **Fabián Jaimes and Rodolfo J. Dennis**

3. Novel Therapies in Critically Ill Septic Patients ................. 25  
   **Jean-Louis Vincent, Carla Marie Clausi, and Alejandro Bruhn**

4. Dissemination Control of the Antimicrobial Resistance in the Intensive Care Unit ....................................................... 33  
   **Carlos Arturo Alvarez and Jorge Alberto Cortés**

5. Diaphragmatic Dysfunction in Intensive Care ...................... 47  
   **Guillermo Ortiz-Ruiz**

6. Myocardial Depression in Sepsis and Septic Shock ............... 55  
   **Justin Wong and Anand Kumar**

7. Toward a Consensus on Intraabdominal Hypertension ............. 74  
   **Manu LNG Malbrain, Michael Sugrue, Michael Cheatham, and Rao Ivatury**

8. Resuscitation Goals in Severe Sepsis and Septic Shock .......... 92  
   **Fernando Pálizas**

9. Coagulation Disorders in Critically Ill Septic Patients .......... 103  
   **Marcela Granados**

10. Vasopressors in Sepsis: Do They Change the Outcome? .......... 121  
    **Marco A. González and Christiaan D. Ochoa**
Contents

11. Lactic Acidosis in Critically Ill Septic Patients ............... 126
    Daniel De Backer

    Timothy D. Girard and E. Wesley Ely

Index ................................................................. 151
List of Contributors

CARLOS ARTURO ALVAREZ, MD
Chief, Infectology Unit, Hospital Universitario San Ignacio; Department of Internal Medicine, Pontificia Universidad Javeriana, Bogotá, Colombia

ALEJANDRO BRUHN, MD
Department of Intensive Care, Erasme Hospital, Free University of Brussels, Belgium

CARMENO DUEÑAS CASTELL, MD
Professor of Medicine, Universidad de Cartagena; Intensive Care Unit Director, Hospital Bocagrande; Intensive Care Director, Clinica Madre Bernarda, Cartagena, Colombia

MICHAEL CHEATHAM, MD, FACS, FCCM
Director, Surgical Intensive Care Units, Orlando Regional Medical Center, Orlando, FL, USA

CARLA MARIE CLAUSI, MD
Department of Intensive Care, Erasme Hospital, Free University of Brussels, Belgium

JORGE ALBERTO CORTÉS, MD
Infectology Unit, Hospital Universitario San Ignacio; Department of Internal Medicine, Pontificia Universidad Javeriana, Bogotá, Colombia

DANIEL DE BACKER, MD, PhD
Department of Intensive Care, Erasme University Hospital, Free University of Brussels, Belgium

RODOLFO J. DENNIS, MD, MSc
Professor of Medicine, Pontificia Universidad Javeriana; Department of Internal Medicine, Fundacion Cardioinfinatil, Bogotá, Colombia
E. WESLEY ELY, MD, MPH  
Division of Allergy, Pulmonary, and Critical Care Medicine, Vanderbilt University School of Medicine; Veterans Affairs Tennessee Valley Geriatric Research, Education, and Clinical Center, Nashville, TN, USA

EUGEN FAIST, MD  
Professor, Department of Surgery, Klinikum Grossharern, University of Munich, Munich, Germany

TIMOTHY D. GIRARD, MD  
Division of Allergy, Pulmonary, and Critical Care Medicine, Vanderbilt University School of Medicine, Nashville, TN, USA

MARCO A. GONZÁLEZ, A., MD  
Department of Critical Care Medicine, Medellín Clinic and Universidad Pontificia Bolivariana, Medellín, Colombia

MARCELA GRANADOS, MD, FCCM  
Director, Fellowship Program in Critical Care, Section of Critical Care Medicine, Universidad Del Valle, Cali, Colombia

RAO IVATURY, MD  
Professor, Department of Surgery, Director, Trauma, Critical Care and Emergency Surgery, Virginia Commonwealth University Medical Center, Richmond, VA, USA

FABIÁN JAIMES, MD, MSc, PhDc  
Assistant Professor of Medicine and Clinical Epidemiology, Universidad de Antioquia, Medellín, Colombia

ANAND KUMAR, MD, FRCPC  
Associate Professor of Medicine, Section of Critical Care Medicine, Health Sciences Center, University of Manitoba, Winnipeg, Canada; Associate Professor of Medicine, Division of Cardiovascular Diseases and CCM, Cooper Hospital/University Medical Center, University of Medicine and Dentistry, New Jersey, Camden, New Jersey, USA

MANU LNG MALBRAIN, MD  
Director, Intensive Care Unit, ZiekenhuisNetwerk Antwerpen, Antwerp, Belgium

CRISTHIAAN D. OCHOA, MD  
Research Fellow, Pulmonary and Critical Care Unit, Department of Medicine, Massachusetts General Hospital and Harvard Medical School, Boston, MA, USA
GUILLERMO ORTIZ-RUIZ, MD
Professor, Pulmonary and Critical Care Medicine, Universidad del Bosque; Chief, Intensive Care Unit, Hospital Santa Clara, Bogotá, Colombia

FERNANDO PÁLIZAS, MD
Intensive Care Unit Director, Clinica Bazterrica, Buenos Aires, Argentina

MARCO ANTONIO PERAFÁN C., MD
Professor of Cardiology and Critical Medicine, Chief, Intensive Care Unit, Fundacion Clinica Shaio, Bogotá, Colombia

MICHAEL SUGRUE, MD
Director of Trauma, Liverpool Hospital, University of New South Wales, Sydney, Australia

JEAN-LOUIS VINCENT, MD, PhD, FCCP
Professor, Department of Intensive Care, Erasme Hospital, Free University of Brussels, Belgium

JUSTIN WONG, MD, FRCPCH
Fellow, Section of Critical Care Medicine, Health Sciences Center, University of Manitoba, Winnipeg, Canada
1

When to Transfuse Septic Patients

Carmelo dueñas Castell

Patients who enter the intensive care unit (ICU) frequently have anemia and 70% to 95% of patients in ICU have a hemoglobin count lower than normal.1–4

Why Critical Patients Have Anemia

The cause of anemia is multifactorial:

1. Hemodilution. Generally due to crystalloid infusions to keep the hemodynamics parameters.
2. Increased blood loss: There are many reasons for critical patients’ blood loss:
   a. Bleeding: Digestive, trauma, loss because of procedures, etc.2–4
   b. Phlebotomies.3–4 Pioneer studies reported a blood loss from phlebotomies from 60 to 70 cc/day.5 Recent publications have established some minor losses that are the result of technological advances and a more rational use of the blood.6
   c. Reduction of half-life of the red cells: Not much is known about the half-life of the red cells in critical patients. However, the red cell destruction can be mediated by the systemic inflammation, activation of the complement, and the macrophages.7 Anemia of chronic disorders or anemia by inflammation reduces the half-life of the red cells to less than 90 days.8,9
3. Decrease or alteration in blood production: Chronic inflammatory disorders lead to a reduction in the production of red cells.10 More than 90% of critical patients have low levels of serum iron and capacity to bind the iron2,11 with high levels of ferritin,5,12 although the levels of erythropoietin are only slightly increased with little evidence of response from the reticulocytes to the endogen erythropoietin.3 There are at least four contributing factors to the erythropoietin levels2,13–15:
   a. Direct inhibition to the erythropoiesis by circulating inflammatory mediators, among them interleukins 1, 6, and tumor necrosis factor.
   b. Reduction of available iron.
c. Unsuitably low levels of erythropoietin.
d. Poor response of the precursor cells of the red cell to erythropoietin.2

Others: Deficiency of folic acid has been found in 25% of critical patients.2

How Much Blood Is Transfused in ICU?

More than half of the patients in ICU receive red blood cell transfusion during their stay in intensive care3,4,16 and it can be up to 85% of patients who stay more than 1 week in ICU.17

Paradoxically, many patients tolerate hemoglobin levels near 7 without complications.1–4 A liberal transfusion strategy of red blood cells, in which a transfusion is made to keep the hemoglobin above 10 g/dL, has been associated with deplorable clinical outcomes.2–4,16

The transfusion in clinical practice has been subjected to multiple careful examinations in the past 20 years.2–4,18,19 But transfusion methods have not changed in the past century.20,21

Sepsis and Transfusion

The frequency of sepsis has increased 139% from 1979 to 1987.22 It is estimated that 18 million people per year suffer from sepsis.22 With a mortality of approximately 30%, sepsis is considered the leading cause of death worldwide.23 In Table 1.1 the epidemiologic studies that evaluate sepsis are shown. From them, the importance of this pathology in critical patients can be seen.

The recommendations and present practices to use blood components to treat sepsis are based on the extrapolation of results of heterogeneous groups of critical patients, from studies in noncritical patients and from consensus guides.29 In an

<table>
<thead>
<tr>
<th>Author, year (reference)</th>
<th>Countries</th>
<th>Number of ICU entries evaluated</th>
<th>Incidence</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberti, 200224</td>
<td>6 European countries, Canada, Israel</td>
<td>14,364</td>
<td>21.1%</td>
<td>22.1% vs. 43.6%</td>
</tr>
<tr>
<td>Padkin, 200325</td>
<td>England, Wales and, Northern Ireland</td>
<td>56,673</td>
<td>27.1%</td>
<td>35% vs. 47%</td>
</tr>
<tr>
<td>Annane, 200326</td>
<td>France</td>
<td>100,554</td>
<td>8.2%</td>
<td>60.1%</td>
</tr>
<tr>
<td>EPISEPSIS, 200427</td>
<td>France</td>
<td>3,738</td>
<td>14.6%</td>
<td>35% vs. 41.9%</td>
</tr>
<tr>
<td>Finfer, 200428</td>
<td>Australia and New Zealand</td>
<td>5,878</td>
<td>11.8%</td>
<td>26.5% vs. 32.4%</td>
</tr>
</tbody>
</table>
1. When to Transfuse Septic Patients

In an observation study in the United States, 11% of the patients with a diagnosis of sepsis entry had hemoglobin < 8.21 The optimum hemoglobin for patients with sepsis is uncertain. This is an essential aspect, as the hemoglobin in patients with sepsis varies between 8 to 10 g/dL.29 The hemoglobin reduction in septic patients is related to different factors, as discussed above, and frequently presents in this type of patient29: (1) ineffective erythropoiesis, and (2) hemodilution, a reduction of 1–3 g in hemoglobin is expected during the reanimation from septic shock with crystalloids and colloids.29

In the majority of patients, this grade of anemia is tolerated well as the reduction in the viscosity decreases the afterload, increases the venous return, and increases the beating volume and the cardiac output.29 The reduction in the blood viscosity can compensate for other rheological changes of the septic patients, making the microvascular flow easy. However, different factors can affect the capacity of the patient to tolerate the reduction in the hematocrit and these should be taken into account:

1. The cardiac disorder, when presented in the septic patient, because it can limit the compensation of the cardiac output as a result of reduced viscosity.29
2. In hypermetabolic stages, the increase in the cardiac output may not be enough to compensate the reduction in the oxygen-carrying capacity caused by the anemia.
3. The incapacity to extract oxygen related to anatomic anomalies, such as coronary illness or physiological changes due to sepsis, which can cause major oxygen dependence.30,31

The transfusion risks are well described and should be similar in septic patients. However, secondary immunosuppression to transfusion can be particularly important in septic patients. Thus, an increase of nosocomial infection with poor prognosis in transfused patients has been reported.30–36

It is not easy to establish a causal association between transfusion and clinical outcomes due to the factors of confusion and because of the design of the studies.37,38 However, the literature suggests an increase in mortality in transfused patients.29–38 Later we will review the complications caused by red blood cell transfusion.

What Is the Appropriate Hemoglobin Level at Which to Transfuse Red Blood Cells in Patients with Sepsis?

The optimal level of hemoglobin in severe sepsis has not been investigated specifically. For this reason the final decision must be based on wise and reasonable analysis of the risks and benefits of the anemia compared to the risks and benefits of the transfusion.

It is believed that red blood cell transfusion increases the oxygen-carrying capacity, benefits the tissues, and minimizes or prevents ischemia. The transfusion effects in septic patients have been evaluated in different studies (see Table
From these studies it can be surmised that red blood cell transfusion obviously improves the hemoglobin level and increases the oxygen-carrying capacity for the tissues, but the changes in the consumption of oxygen are very erratic, the improvement of the tissue oxygenation is not demonstrated, and it has not generated favorable clinical outcomes.39–48

At the same time, transfusion increases the pulmonary vascular resistance and the intrapulmonary shunt, consequences that can be catastrophic in the septic patient.29

The Spanish group also did not find benefit with the use of supranormal oxygen values in 63 patients with severe sepsis and septic shock.49 On the contrary, there was an increase of 13% in mortality in this transfused group.

A possible explanation for the poor results in cellular oxygenation derived from red blood cell transfusion is that the cells have been stored in blood banks. The European and American studies on transfusions demonstrate that the time of storage of the transfused blood was 16 days for the European study and 21 days for the American study.3,21,29,50

A study of septic patients showed that the stored red cells do not improve the oxygen-carrying capacity, have reduced levels of 2,3-disphosphoglycerate, and

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of patients</th>
<th>Transfusion</th>
<th>Hemoglobin change</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gilbert, 1986</td>
<td>17</td>
<td>To get Hb 10–12</td>
<td>8.6 to 10–12</td>
<td>Increase of DO2 and VO2 only in those with high lactate</td>
</tr>
<tr>
<td>Mink, 1990</td>
<td>8</td>
<td>8–10 cc/kg in 1–2 h</td>
<td>10.2 to 13.2</td>
<td>Increase in DO2 but not increase in VO2</td>
</tr>
<tr>
<td>Lucking, 1990</td>
<td>7</td>
<td>10–15 cc/kg in 1–3 h</td>
<td>9.3 to 12.4</td>
<td>Increase in DO2, VO2</td>
</tr>
<tr>
<td>Conrad, 1990</td>
<td>19</td>
<td>591 cc in 4.2 h</td>
<td>8.3 to 10.7</td>
<td>Increase in DO2 but not in VO2</td>
</tr>
<tr>
<td>Steffes, 1991</td>
<td>21</td>
<td>1–2 U in 2 h</td>
<td>9.3 to 10.7</td>
<td>Increase in DO2 and VO2 in normal lactate</td>
</tr>
<tr>
<td>Silverman, 1992</td>
<td>19</td>
<td>2 U</td>
<td>8.4 to 10.6</td>
<td>Increase in DO2 but not in VO2</td>
</tr>
<tr>
<td>Marik, 1993</td>
<td>23</td>
<td>3 U 90–120 min</td>
<td>9.0 to 11.9</td>
<td>Increase in DO2 but not in VO2. Increase in SVR and PVR</td>
</tr>
<tr>
<td>Lorente, 1993</td>
<td>16</td>
<td>800 cc in 90 min</td>
<td>9.6 to 11.6</td>
<td>Increase in DO2 but not in VO2. Increase in SVR and PVR</td>
</tr>
<tr>
<td>Gramm, 1996</td>
<td>19</td>
<td>1–2 U</td>
<td>9.4 to 11.5</td>
<td>Increase in DO2 but not in VO2</td>
</tr>
<tr>
<td>Fernandez, 2001</td>
<td>10</td>
<td>1 U in 1 h</td>
<td>9.4 to 10.1</td>
<td>No improvement of lactate, DO2, VO2, increase in PVR</td>
</tr>
</tbody>
</table>
cannot transport oxygen. Additionally, they have a reduced deformity and can produce splanchnic ischemia. Reaffirming the infrequent use of transfused red blood cells in tissue oxygenation, a recent study of 51 patients with anemia who had cardiovascular surgery demonstrated that red blood cell transfusion only improved the systemic oxygen-carrying capacity, without generating benefits at the cellular oxygenation level. On the contrary, oxygen ventilation at 100% improved not only the systemic oxygen but also the tissue oxygen. On the other hand, improving the cardiac output, with inotropies, for example, can have a better risk/cost/benefit relationship than red blood cell transfusion when looking at tissue oxygenation factors.

In the United States more than 10 million units of red blood cells are transfused each year. Despite great technological and scientific advances, there are still complications derived from red blood cell transfusion:

1. Infectious complications
   a. Infections by the virus that causes acquired immune deficiency syndrome (HIV): The risk for HIV infection per unit of transfused blood has been estimated as 1:676,000 (from 1:200,000–1:2,000,000).
   b. Viral hepatitis: The risk of infection per unit of transfused blood is 1:63,000 for hepatitis B and 1:103,000 for hepatitis C.
   c. Other viruses: Such as parvovirus.
   d. Creutzfeldt-Jakob illness.
   e. Bacterial contamination: This is more frequent for blood platelet transfusion, but it has been described that this can occur in 1 per each million units of red blood cells transfused.

2. Noninfectious complications
   a. Hemolytic and alloimmunization reactions: These are less frequent each time. However, they are present in 0.5 to 1.4% of the transfusions. These reactions can cause death in 1:250,000 to 1:1,000,000 transfusions.
   b. Transfusion-related acute lung injury: It is not an usual reported complication despite being the third most frequent cause of death associated with transfusion. It is a disease that generally presents within 4h after the transfusion. It occurs in one out of 5,000 transfusions. If all the blood components have been implicated in this pathology, it is associated more frequently with total blood transfusion, red blood cells, blood platelets, and frozen fresh plasma. For its diagnosis it is necessary to exclude volume overload, sepsis, and cardiogenic pulmonary edema.
   c. Immunomodulation: This refers to the phenomenon in which the allogenic blood transfusion generates an immune response in the host that makes the patient vulnerable to infections, recurrence of malignancy, or reactivation of latent viral infections.
   d. Hypotensive transfused reactions: These are more frequent in patients who receive angiotensin-converting enzyme inhibitors or patients exposed to extracorporeal circulation.
A recent publication states that the frequency of complications associated with transfusion depends on the development index of the country. Thus, in countries with a low index of economic development, the risk of these complications is higher than in countries with a high index of development. Given that increase in risk, it is suggested that in developing countries the level of hemoglobin transfused should be less than the level in developed countries.

The evidence of transfusion effects from several important clinical studies can be summarized from some Canadian studies and from the CCCTG (controlled clinical trial of transfusion in critical care—Canadian Critical Care Trials Group) study, which suggests that a hemoglobin count of 7 to 9 g/dL is adequate for the majority of critical patients and this level is not associated with increased mortality.

However, in favor of transfusion for septic patients the Rivers study proposes a hemoglobin level of 10 g/dL in patients with low oxygen venous saturation during the first 6 h of reanimation of the septic shock and severe sepsis. These studies demonstrated that achieving the previously proposed goals reduced mortality rates. For every six patients who received treatment as proposed by the Rivers study, one life could be saved. Patients who were transfused in those first 6 h and in whom the proposed goals were met received fewer liquids and fewer transfusions. Thus, during the first 6 h of reanimation of a septic patient, specific levels of central venous pressure (CVP), mean arterial pressure (MAP), diuresis, and mixed venous saturation should be achieved. When the mixed venous saturation is low, despite obtaining the goals of CVP (8–12 mmHg) and MAP (65–90 mmHg), the administration of red blood cells and dobutamine should be considered. This has been verified in a recent review from the Society of Critical Care Medicine (SCCM).

From the Rivers study, a metaanalysis from a study in cardiovascular surgery, the literature establishes that only when goals are achieved or are normalized to the maximum early in treatment are clinical outcomes obtained. This would suggest that in the studies where therapy was started too late, the usefulness of treatment has not been demonstrated. Another possible explanation for the studies that have not reported the usefulness of transfusion is that it would require 540 patients in each study group to detect clinically important differences in mortality. Thus, the mortality in sepsis is not reduced by normalizing the maximum oxygen-carrying capacity because:

1. Treatment is given too late.
2. The majority of patients are not able to obtain supranormal values.
3. A cause/effect relationship between normalizing the maximum oxygen delivery and reducing mortality has not been demonstrated.
   a. If a causal effect exists, the association between the two will always be there, but it might not be found.
   b. If a causal effect does not exist, aggressively increasing the contribution of supranormal values could be dangerous.
Short-term physiological studies suggest that flow, tissue, or cellular factors can be more important than the oxygen arterial content in improving tissue oxygenation. Clinical studies to evaluate the long-term physiological effects or the impact on outcomes from transfusions have not been conducted for septic patients. However, Neilipovitz and Hébert suggest that the results of CCCTG are applicable in septic patients.

More than pursuing a magical number of hemoglobin, the reasonable use of laboratory tests to reduce the frequency and amount of phlebotomy, control the hemorrhage quickly, optimize the oxygenation, and guarantee an adequate intravascular volume must be performed before considering red blood cell transfusion.

Some septic patients need a high level of hemoglobin. Thus, the level of transfusion used in septic patients requires individualization and consideration of altered physiological function. Specific group of patients, such as those with myocardial ischemia or severe hypoxemia, require higher levels of hemoglobin, but the effectiveness of transfusion in these patients is inadequately characterized. More studies are required to characterize the course of anemia in sepsis and evaluate the impact of transfusion to define a clear course of action. But while studies continue, experience and clinical judgment define the treatment.

In summary, within the first 6 hours for septic patients, using Rivers’s proposed goals, obtain hemoglobin of 10 g/dL to guarantee mixed venous saturation above 70%. Once the hypoperfusion has been obtained and in the absence of special circumstances such as acute coronary illness or acute hemorrhage, a red blood cell transfusion should be made only when the hemoglobin is under 7 g/dL to keep the hemoglobin between 7 and 9 g/dL.

References


