

Anticoagulation of the blood is reportedly not required because it is defibrinated as a result of coagulation and fibrinolysis occurring within the mediastinum and the joint spaces. If bleeding is brisk, use of an anticoagulant may be necessary. Citrate is the preferred anticoagulant because it is rapidly metabolized and there is less potential for systemic anticoagulation. The suction level usually recommended for closed wounds is up to 100 mmHg, although preferences among devices vary.

The reinfusion of unwashed, shed blood has the potential for a number of complications.^{52,57} Blood collected through the use of an unwashed system has high concentrations of contaminants, including tissue fragments; activated clotting factors; complement proteins; lymphokines; and exogenous materials, such as antibiotics and topical clotting agents.⁵⁸ The presence of these contaminants has led some investigators to recommend limiting the amount of unwashed recovered blood that can be reinfused.³⁸

The most commonly reported complication following unwashed postoperative shed blood reinfusion is a febrile reaction, which can also be seen following allogeneic transfusions, particularly of platelets. Depending upon the study, the rates of febrile reactions following postoperative recovery readministration vary from 4% to 12%,^{51,52,59,60} which is higher than the rate reported following allogeneic transfusions with both leukocyte-reduced and non-leukocyte-reduced RBCs.⁶¹ This complication is generally the only reported complication following readministration of unwashed, shed blood; however, one needs to be careful in coming to this conclusion because all of these reports are small case series.

There are reports of far worse problems following postoperative shed blood reinfusion. Clements et al,⁵¹ in a small series of 16 patients, observed severe hypotension in two patients which resolved upon stopping the shed blood readministration and reoccurred when the blood was started again. A different patient was reported to have delayed hypotension 5 hours after readministration that progressed to death from myocardial infarction. In contrast to the hypotensive events reported by Clements et al,⁵¹ Krohn et al⁶² reported a transient increase in pulmonary vascular and systemic vascular resistance during transfusion of shed blood. This study was performed in cardiac patients in whom mediastinal wound blood was reinfused. One could easily postulate that increases in pulmonary and systemic vascular resistance in a patient with a failing heart could be disastrous from any afterload increase that might result from postoperative shed blood reinfusion. The authors of this guidance document have also

anecdotally seen cases of severe dyspnea requiring intubation and intensive care unit admission following the infusing of large quantities of this type of recovered product.

Theoretically, the contents of an unwashed shed blood product would lead to increases in clot formation, primarily from tissue factor concentration. Again, theoretically, one would think that administration of this product might lead to an increase in postoperative thrombotic complications such as deep venous thrombosis, pulmonary emboli, myocardial infarction, or stroke. No study has been performed that was adequately powered to test this hypothesis.

Washed Systems for Postoperative Recovery

A simple solution to the hazards of the contaminants in unwashed, postoperative cell recovery would be to wash the blood. However, in order to use a traditional cell recovery device, processing would require an individual to operate the machine in a postoperative environment. From a staffing perspective, this is not generally a reasonable option. Two devices to process postoperative recovered blood are sold in the United States—OrthoPat and CardioPAT, both manufactured by the Haemonetics Corporation (Braintree, MA). These breadbox-sized devices are designed to attach to a postoperative drain and process in an automated fashion. While effective at concentrating and washing the blood, the cost of the disposables is high.

STORAGE OF RECOVERED BLOOD

AABB *Perioperative Standards* has defined expiration times for recovered blood products, whether using intraoperative or postoperative collection.²⁸ The standards are based on Food and Drug Administration (FDA) recommendations and are extrapolated from handling of allogeneic blood. Although the requirements in the *Perioperative Standards* are based on best practices, there are few data available to support them, and the topic has generated a considerable degree of controversy.

The current *Perioperative Standards* requires that blood, which has been collected intraoperatively and subsequently processed, should expire 4 hours after completion of processing when stored at room temperature. The time from collection to expiration should be less

than 6 hours for recovered blood that is not processed. Controversy arises when blood collection extends beyond 6 hours from the start of collection. If these recovered products are being held at room temperature, and there is no ongoing blood loss, should collected blood be discarded and a new disposable installed?

Several factors should be taken into consideration when contemplating the safety of storage and handling of this blood product. First, most recovered blood contains some degree of bacterial contamination. While bacterial growth may take place over the period of the storage time, routine antibiotic prophylaxis of the surgical patient should lead to some inhibition of bacterial growth. Additionally, the processing of recovered blood removes sizeable quantities of any bacterial load.⁶³ Third, if a fear of bacterial contamination is significant, the use of leukocyte reduction filters can further reduce contamination.⁶⁴ Lastly, there appears to be little association between bacterial load and subsequent clinical sequelae.⁶⁵⁻⁶⁹ Thus, the approach to handling this blood should be the responsibility of the prescribing physician who can make an informed decision about the risks and benefits of administering the product.

All stored autologous products should be properly labeled and inspected before being administered. The AABB *Perioperative Standards* requires the label include the patient's first and last name, hospital identification number, the date and time of collection, and, if applicable, the time of, or conditions for, expiration. Labeling should conform to all FDA regulations, including bar code labeling as applicable. Each unit shall be labeled "For Autologous Use Only" and "Donor Untested" if applicable.

Before administration of the blood product, it should be inspected for the following elements: appearance as defined by the program, labeling, verification that the storage requirements have been met, and product content.

ADMINISTRATIVE ASPECTS

Blood recovery is only one aspect of a comprehensive blood conservation program that should be coordinated by the transfusion service. The use of red cell recovery devices represents one of the more complex components of autologous transfusion programs that may also include acute normovolemic hemodilution, preoperative autologous blood donation, and conservative transfusion practice.