

Use of the cell saver in blood management

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Cell savers are often used during cardiac surgery, and the recent guidelines of the American Society of Thoracic Surgeons and Society of Cardiovascular Anesthesiologists recommend their use during cardiac surgery [1]. However, we should be aware that these devices have been introduced into clinical practice in advance of clearly demonstrated advantages.

As the name implies, cell savers are used to “save” red blood cells of the patient that would otherwise be lost. The reasoning is that by this “saving”, the exposure of the patients to allogeneic red blood transfusions is reduced. As we know that transfusion of allogeneic red blood cells is “bad”, we think that we do a good job by using intra-operative cell saving. Is this true?

To answer this question we have to take into account several items such as:

- What are the disadvantages of allogeneic blood transfusion?
- What is the population that we consider for cell salvage?
- Do we intend to reduce the number of patients who receive allogeneic blood cell transfusions or to save on overall red blood cell transfusions?
- In what time frame is cell salvage used and measurements made?
- What is the quality of the retrieved and processed blood?
- Does the type of cell saver influence the results?

Disadvantages of allogeneic blood transfusion

There used to be emphasis on the chance of contracting severe infections such as Hepati-

tis C or HIV after transfusion of allogeneic blood cells. Due to better laboratory and screening procedures in recent years this chance is nowadays negligible with a reported incidence of about 1:1000000 [2]. As such, the allogeneic bank blood is safe, but errors in the administration of allogeneic bank blood still present a problem. In the United Kingdom the study group for serious hazards of transfusion (SHOT) reported that in about 40% of the reported cases of adverse events the wrong blood was transfused to the wrong patient or that errors in handling and storage were present [3].

More important however, may be the long-term clinical implications of blood transfusion. Koch et al. performed a database study in the United States on 10289 patients undergoing coronary artery bypass grafting (CABG). They found that even by correcting for demographics, co-morbidities and operative factors the transfusion of allogeneic red blood cells was associated with a reduced short and long term survival [4].

Population

It has been demonstrated in a recent Cochrane meta-analysis that cell salvage is more effective in orthopaedic surgery than in cardiac surgery [5]. However, it should be realized that in the majority of cell salvage procedures in orthopaedic surgery postoperative autotransfusion of unwashed wound blood was studied. This is less the case during cardiac surgery.

The majority of cell salvage studies in cardiac surgery are limited to CABG procedures. The results of cell salvage may be different during valve surgery or in combined procedures, as

peri-operative blood loss and transfusion rates are higher in these procedures. More important may be in which patients we want to use cell salvage. It has been demonstrated that intra-operative cell salvage is not effective in cardiac surgery with a low risk (defined as a EuroSCORE less than 10 and with additional exclusion criteria for increased risk for bleeding) [6]. The size of most studies does not permit a conclusion regarding, for example age, sex or preoperative haemoglobin content. Questions whether the use of a cell saver would be more effective in older patients, women, or anaemic patients remain to be answered.

Do we intent to reduce the number of patients that receive allogeneic blood cell transfusions or to save on overall red blood cell transfusions?

In a recent meta-analysis of intra-operative cell salvage during cardiac surgery Wang et al. found that the use of cell salvage resulted in a small but significant reduction in the number of patients that were transfused, and in a general saving on blood products of about one unit [7]. Considering the long term effects of allogeneic blood cell transfusions as discussed above [4], the main advantage of using intra-operative cell salvage is in a reduction in the number of patients that receive allogeneic blood cell transfusions.

There is also a trend to gradually lower the transfusion threshold for red blood cells in cardiac surgery. Spiess et al. demonstrated that a restrictive intra-operative transfusion policy reduced the peri-operative myocardial infarction rate, compared to a more liberal transfusion strategy [8]. This may reduce the effect of cell salvage as due to a lower transfusion threshold fewer patients are being transfused.

The time frame that cell salvage is used and measurements are made.

The procedure of cell salvage is not standardized and dependent on institutional traditions, leading to all possible combinations of intra- and postoperative use. Intra-operative

or postoperative or combined, during cardiopulmonary bypass or not, using residual heart lung machine blood or not. This may be important as these differences between the studies may well influence the results. Currently, most evidence suggests that an extended intra-operative use of cell salvage is most effective [7]. That means that cell salvage should be used for shed blood, cardiomy suction blood and for residual heartlung machine blood. From many studies on cell salvage it is not clear what the measurement window is for the effect. Is it only intra-operative allogeneic blood transfusion, transfusion in the first 24 hours, transfusion during the complete hospital stay? This is important as the effect of intra-operative cell salvage diminishes over time due to blood transfusions given in the ward. This may be considerable and supports the notion that intra-operative cell salvage can only be part of a multimodal hospital blood conservation programme.

The quality of the retrieved and processed product

In fact little is known about the quality of processed cell saver blood. Most data are available for haemoglobin, haematocrit and platelet content. Gu et al. demonstrated that the red blood cells in the processed cell saver blood had a reduced deformability and a reduced 2,3-DPG content, but these findings should not impair the patient as these effects could not be demonstrated in the patients blood after retransfusion [9]. There is still debate about the activation of leukocytes after processing. It is known that processed cell saver blood contains microorganisms, despite careful processing. This may be demonstrated in up to 30% of the processed units [10]. On the other hand it has been demonstrated that the processed blood also has reduced pro-inflammatory cytokines such as interleukin-6 and TNF- α [11].

Several machines have different washing programmes, but the effects on the quality of the processed blood are unknown. There

may also be concern about the quality of processed blood when large quantities have been processed. Is the quality of the last portion equal to the quality of the first run? This may not be completely the case as shown by Vermeijden et al. [12].

In conclusion there is evidence that supports the use of intra-operative cell salvage by a reduction in the number of patients that receives peri-operative allogeneic blood transfusion. However, there are still many questions to be resolved and therefore there is still need for large scale well designed randomized trials that address the issues mentioned above.

References

1. Ferraris VA, Ferraris SP, Saha SP et al. Perioperative blood transfusion and blood conservation in cardiac surgery: the Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists clinical practice guideline. *Ann Thorac Surg* 2007; 83: 27-86
2. Goodnough LT, Brecher ME, Kanter MH, AuBuchon JP. Transfusion medicine. First of two parts – blood conservation. *N Engl J Med* 1999; 340: 438-47
3. Taylor C, Cohen H, Mold D et al. On behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2008 Annual SHOT Report. 2009
4. Koch CG, Li L, Duncan AI, Mihaljevic T, Loop FD, Starr NJ, Blackstone EH. Transfusion in coronary artery bypass grafting is associated with reduced long-term survival. *Ann Thorac Surg*. 2006; 81: 1650-57
5. Carless PA, Henry DA, Moxey AJ, O'Connell D, Brown T, Fergusson DA. Cell salvage for minimising perioperative allogeneic blood transfusion. *Cochrane Database of Systematic Reviews* 2010, Issue 4. Art. No.: CD001888
6. Reyes, G Prieto MA, Alvarez P et al. Cell saving systems do not reduce the need of transfusion in low-risk patients undergoing cardiac surgery. *Interact CardioVasc Thorac Surg* 2011; 12: 189-193
7. Wang G, Bainbridge D, Martin J, Cheng D. The efficacy of an intraoperative cell saver during cardiac surgery: a meta-analysis of randomized trials. *Anesth Analg* 2009; 109: 320-330
8. Spiess BD, Ley C, Body SC et al. Hematocrit value on intensive care unit entry influences the frequency of Q-wave myocardial infarction after coronary artery bypass grafting. *J Thorac Cardiovasc Surg* 1998; 116: 460-67
9. Gu YJ, Vermeijden WJ, MD, De Vries AJ et al. Influence of mechanical cell salvage on red blood cell aggregation, deformability, and 2,3-Diphosphoglycerate in patients undergoing cardiac surgery with cardiopulmonary bypass. *Ann Thorac Surg* 2008; 86: 1570-75
10. Bland LA, Villarino ME, Arduino MJ et al. Bacteriologic and endotoxin analysis of salvaged blood used in autologous transfusions during cardiac operations. *J Thorac Cardiovasc Surg* 1992; 103: 582-88
11. Reents W, Babin-Ebell J, Misoph MR et al. Influence of different autotransfusion devices on the quality of salvaged blood. *Ann Thorac Surg* 1999; 68: 58-62
12. Vermeijden WJ, Hagens A, Van Oeveren W, De Vries AJ Do repeated runs of a cell saver device increase the pro-inflammatory properties of washed blood? *Eur J Cardiothoracic Surg* 2008; 34: 350-3