

State of the Art Blood Management in Cardiac Surgery

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Blood has been described as the most precious and personal substance in the world (1), and caregivers focused on cardiac surgery issues now know that the current direction today in cardiac surgery is to actively move away from transfusing donor “allogeneic” blood products, and towards improved methods of keeping and saving the patient’s own autologous blood. Quite simply allogeneic blood products are not as good for a patient as is their own (autologous) whole blood. Nothing else even comes close to the natural healing abilities and homeostasis that your own blood offers and no substitute whether it is human or artificial will ever work as well.

Although the tainted blood scandals of the 1980s and 1990s are largely over thanks to improved blood donor screening tests for diseases such as AIDS and hepatitis C, much discouraging news still abounds almost daily. News reports garner a great deal of press today and commonly feature severe blood shortages and research that documents newly recognized transfusion risks such as how older stored blood can put heart surgery patients at increased risk (2) and others that point to the morbidity and mortality associated with its use (3). In response, the medical community has moved to better manage blood usage by minimizing the exposure of donated blood and instead saving as much as possible and reinfusing the patient’s own autologous blood that would might otherwise be mismanaged or lost during surgery and this is by far the best choice for patients.

Factors reinforcing the avoidance of allogeneic blood product transfusions (4)

- *Improved Patient Outcomes*
- *Reduced overall costs*
- *Immunosuppression*
- *Skyrocketing acquisition costs*
- *Transfusion-transmitted Infections*
- *Transfusion-transmitted Viruses*
- *ABO compatibility transfusion reactions*
- *Transfusion-associated immunomodulation*
- *Dissemination of malignant cells*
- *Negative effects of the storage lesions*
- *Dwindling blood supplies*
- *Increasing cost of hemovigilance*
- *Motivation for more discriminating transfusion practice*
- *Health care team satisfaction*
- *Accommodating patient preference*
- *Religious belief*
- *Increasing Litigation*

Blood conservation, blood salvaging, bloodless surgery, and blood management are just some of the terms used to describe this new trend in cardiac surgery. In today’s healthcare, the

avoidance of blood transfusions is not only motivated by patients with religious beliefs, but also by informed consumers and cutting edge clinicians working closely with hospitals to improve their status within their respective healthcare markets. Why change transfusion practice: one, because the benefits of improved patient outcomes are easy to show and two, the savings are enormous to the bottom line of everyone involved.

Cardiovascular heart disease still rates as the leading cause of death in the USA, with over a thousand people each day in the U.S. having heart surgery to help combat this statistic. The heart surgery number is now approximately 400,000 procedures annually. Blood salvage has been used extensively in cardiac surgery which historically has been a major user of the nation's blood supply. We are now at a crossroad of supply and demand for blood. Over 50% of patients having heart surgery receive at least one transfusion of donor blood and the over-all use of donor blood in heart surgery is between 15-20% of the nation's blood supply, each year (5). This trend shows no signs of slowing down unless better communications and team dynamics in cardiac surgery become more focused on the avoidance of transfusion.

Cardiac surgery, with the use of cardiopulmonary bypass, can be routinely performed without the administration of allogeneic blood products with the use of several combined team strategies. Every effort should be made to treat each patient exactly the same as if they were a small body surface area (BSA) of the Jehovah's Witness faith and cannot receive any allogeneic blood products.

Optimal patient care through better blood management is a team (Multidisciplinary) effort with many players involved and the use of many tools (Multimodality). This approach is required to accomplish the goal of avoiding donor blood products and maximizing all options in the conservancy of the patients own blood and avoiding unnecessary wastage (6, 7).

This coordinated multidisciplinary multimodality approach is integral to this success of a comprehensive blood conservation program in cardiac surgery and should include all phases of treatment, from weeks before admission and the preoperative period all the way through to hospital discharge. One major initiative starting to take hold in many hospitals is delaying surgery on all non urgent cases for as much as a month and "optimizing the patient medically" to build up a satisfactory red cell mass prior to admission.

The biggest message for Perfusionists is that you are not alone. The entire surgical experience leads to hemodilution and the resultant coagulopathy in the perioperative time period (8). Blood components are preserved with meticulous surgical techniques, and by not diluting the patient's blood volume to the point of a dilutional anemia or coagulopathy. Recent papers on reducing cardiopulmonary bypass circuit primes, to enhance hematocrit and oncotic pressure, describe improvement of patient outcomes and avoidance of allogeneic blood products. Circuit modification is a trade-off and a fine line that we walk to decrease ECC volumes and maintain safety, economically (9). We do not want to fail to protect the patients and ourselves by pushing the line of safety too far. In efforts to reduce prime volumes we should not lose sight of the cardinal rules of perfusion to keep it simple and avoid air, especially systemic micro-air emboli (10).

Traditionally the finger has been pointed at the Perfusionist as the culprit in hemodilution. Industry is pushing Perfusionists out on a limb to reduce their CPB circuits to the point of jeopardizing patient care. Condensing circuits safely down to primes of 1000-1400mls and then autopriming both sides (RAP, VAP) of the circuit with the help of anesthesia and the surgeon, will accomplish little change in the patients Hct level and will afford all the safety necessary with no added expenses.

Avoiding dilution is not just a "one discipline" effort; the responsibility *cannot* be placed only on Perfusion to carry the burden. Blood management must be multidisciplinary and can only be successful with effective communication (8,11). Anesthesia and other members of the team as well as ICU care givers contribute much to the dilution of patients and need to be part of the solution (12). Hypotension is not always hypovolemia, and pushing the Starling curve is not always the right answer. Keeping the systemic vascular resistance (SVR) within normal limits (800-1200) as tolerated by the cardiac index will help avoid unnecessary heavy handed crystalloid hemodilution that leads directly to a dilutional anemia and dilutional coagulopathy. This, in turn, leads to organ edema and the associated organ dysfunction (13). Techniques should be employed that maximize the patient's red cell mass and plasma constituents, and then safely increase the vascular resistance while monitoring cardiac output and index, and, of course, judicious microsampling (7). Teams need to work meticulously on not losing blood in the first place and avoiding and then reversing hemodilution so that the patient doesn't require allogeneic blood products.

Transfusion triggers should also be reevaluated. Current reviews of the literature suggest that a nadir hematocrit on CPB of 21-22% in cardiac surgery is safe and effective in preventing morbidity and mortality (14,15). A restrictive transfusion trigger (hemoglobin = 8 gm/dL) postoperatively is comparable to a liberal transfusion trigger (hemoglobin = 10 gm/dL) with regard to patient outcomes (16). A hematocrit of 24% appears to be more than enough in the post-operative setting.

Most importantly we should not to be washing away all the viable plasma cell and protein fractions to a waste bag on the side of a cell washer. With insufficient platelets and clotting factors, patients bleed and require transfusion with red cells and other expensive and scarce blood components. The old standard of washing away viable platelets and plasma proteins must be reevaluated. Washing away blood components and wasting these important blood constituents is counter intuitive to sound ethical and medical practices, and is not in the best interest of the cardiac surgery patient and blood conservation in general.

In response to this ongoing concern about this wastage and the safety of the blood supply, whole blood ultrafiltration has emerged as a process that conserves blood containing not only the red blood cells, but all of the other constituents that are washed away by cell washers. Ultrafiltration allows for the salvage, concentration and re-infusion of the patient's own whole blood containing platelets, clotting factors, important plasma proteins, as well as red blood cells. This technique helps to stabilize fluid shifts at the microcirculatory capillary level in heart surgery patients and help prevent bleeding.

A recent paper in the Journal of Extracorporeal Technology (JECT) reports how an online waste calculator can be used to estimate the cost of blood wastage seen with the traditional cell washer technology most commonly used during heart surgery to salvage the patient's own blood. (17). Such wastage can require transfusions of increasingly costly allogeneic blood components the very type of riskier transfusion that blood salvage machines were designed to prevent in the first place. The calculator exposes how this previously unknown wastage can cost billions of dollars each year in cardiac surgery in the USA alone.

Cardiac surgery is changing yet again, but now its focus is on the best way to get through a safe operation without allogeneic products and the optimal use of the patients own precious resource. There is a saying that goes, "You can't start saving blood Until you actually start saving blood!" There is nothing better for a patient than to receive their own fresh concentrated whole blood when they need it the most in the surgical setting (18)

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