A Multi-Strategy Approach to Controlling Inflammatory Response

Terumo Introduces the Optimizing Blood Management Relationship Browser. For the full interactive experience, visit www.terumo-cvs.com/optimizingbloodmanagement
Optimizing Blood Management™

Beyond the Economics of Transfusion…

According to Timothy Hannon, M.D., President and Founder of the blood management consulting firm, Strategic Healthcare Group: “In 2008, everyone was talking about [blood management]. In 2009, everyone wants to do it.¹

Indeed, as the cost of donor blood has risen in recent years and supplies have dwindled, interest in reducing blood transfusions has increased substantially. Hospital administrators have been scrutinizing their use of blood products and encouraging clinicians to adopt blood management programs. As an economic issue, blood management has attracted attention outside the clinical community; the topic has been reported on in such far-reaching non-clinical publications as the Wall Street Journal. ²

While much of the renewed attention to blood management may be driven by economic concerns, clinicians have long recognized the clinical benefits associated with minimizing the use of donor blood. Transfusions have been linked to a number of negative outcomes, including the single biggest cause of morbidity and mortality after cardiac surgery – inflammatory response. ³⁴⁵⁶

… To a Multi-Strategy Approach for Cardiopulmonary Bypass

For decades, surgeons, anesthesiologists and perfusionists have studied the causes and effects of inflammatory response in attempts to minimize the negative consequences of cardiopulmonary bypass (CPB).

In doing so, they have identified four important blood management strategies to control inflammatory response:

- **Control hemodilution**
- **Control the blood/foreign surface interface** ⁶⁷⁸
- **Control microemboli** ⁹
- **Reduce activated leukocytes**

Each of these strategies can be addressed, at least partly, through the conduct of CPB, where the incremental adoption of new technologies and techniques can help reduce the incidence of inflammatory response.
About the Optimizing Blood Management™ Relationship Browser

For clinicians interested in reducing blood transfusions, the Optimizing Blood Management Relationship Browser is an interactive exploration of the causes and effects of inflammatory response in cardiac surgery – and how some perfusionists are using Terumo technologies to control it.

It explores relationships between:

**Strategies**
Blood management strategies to control inflammatory response that are within the perfusionist’s control

**Outcomes**
Clinical or financial outcomes that are addressed by controlling inflammatory response

**Studies**
Peer reviewed studies in which the authors discuss products or protocols as part of their blood management strategies.

*Note: The studies’ conclusions about a product represent the authors’ findings and are not necessarily performance claims about the product. Refer to the instructions for use for the intended use of this product.*

**Features**
Features of perfusion products that studies have shown to be effective in addressing blood management strategies

**Products**
Products manufactured or distributed by Terumo Cardiovascular Systems that have those features (see Features)

Relationships between objects are defined by arrows:
- is addressed by
- is referenced by
- is associated with

Where Product, Protocol and Information Intersect

Terumo has long been an advocate for combining perfusion technology with techniques to achieve optimal clinical results. This is particularly true in a multi-strategy approach to controlling inflammatory response. The perfusion community has at its disposal a myriad of protocols – from retrograde autologous priming to sequestering cardiotomy suction blood and more – that are considered best practice and can be employed in any of these blood management strategies.

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Of these four strategies to limit inflammatory response, controlling hemodilution has been attracting the most attention.

In one of the most significant recent publications on the subject, Perioperative Blood Transfusion and Blood Conservation in Cardiac Surgery, authors for the Society of Thoracic Surgeons (STS) Workforce on Evidence-Based Surgery write, “A great deal is known with regard to blood transfusion risks yet little is known of its benefits.”

The authors cite a number of clinical risks associated with blood transfusion, the most common of which are febrile nonhemolytic transfusion reactions, bacterial infection, leukocyte-related target organ injury, and transfusion-related acute lung injury.

Their evidence-based review of all published literature – that were available at the time of writing – results in a set of guidelines and recommendations that address blood conservation strategies, many of which can be addressed by the perfusionist during the conduct of cardiopulmonary bypass.
In a landmark study conducted more than 25 years ago, John Kirklin blamed the heart-lung machine for causing inflammatory response, authoring one of the first studies to associate the blood’s contact with a foreign surface with inflammatory response. Other clinicians have since substantiated the association; none have disproven it.

In the decades that followed, clinicians and industry have worked to reduce the inflammatory consequences created by the interface between the blood and foreign surfaces, including air, tubing, membranes, and filter media.

They now consider several techniques that minimize the interface as best practice for CPB, including the careful administration of negative pressure when using vacuum-assisted venous drainage and reducing excessive use of cardiotomy suction.
Whether comprised of gas, fat, or other particulate matter, microemboli in the blood can lodge in the capillary beds, contributing to inflammatory response in two ways. The emboli acts as a foreign surface to activate neutrophils, complements, and cytokines in the vascular tissue. In addition, the embolus can strip cells from the endothelial lining, creating leaks and edema in the interstitial space. The ensuing irritation of the endothelial lining initiates an inflammatory response that can ultimately result in an occluded vessel and subsequent organ damage.

Cardiac teams can employ a combination of techniques to reduce microemboli during CPB, including: taking precautions during placement and suturing of venous cannulae; taking precautions while drawing samples or injecting drugs or other fluids into the circuit, and isolating cardiotomy suction blood.
While the cardiac surgery community concurs that activated leukocytes create an inflammatory response, the means to remove them from the extracorporeal circuit remains controversial.

According to the STS Workforces’ Guidelines on Perioperative Blood Transfusion and Blood Conservation in Cardiac Surgery, many of the harmful effects of CPB can be traced to leukocyte activation during extracorporeal perfusion.

However the guidelines do not endorse leukocyte filtration to remove activated leukocytes; while the authors cite evidence that the filters are effective in leukocyte removal and evidence that there are a number of beneficial effects associated with the use of the filters, they note that none of these effects consistently translates into clinical benefit. They also note evidence that leukocyte depletion may activate white cells.

Yet, a number of more recent studies have associated the use of leukocyte reducing filters, particularly among higher risk groups, with a reduction in inflammatory response and other clinical benefits, including a reduction in post-operative atrial fibrillation and platelet preservation.
References


Studies Referenced in the Optimizing Blood Management Relationship Browser


Gunaydin, S. Clinical evaluation of minimized extracorporeal circulation in high risk coronary revascularization: impact on air handling, inflammation, hemodilution and myocardial function. Perfusion 2009, 24(3) 153-162.


