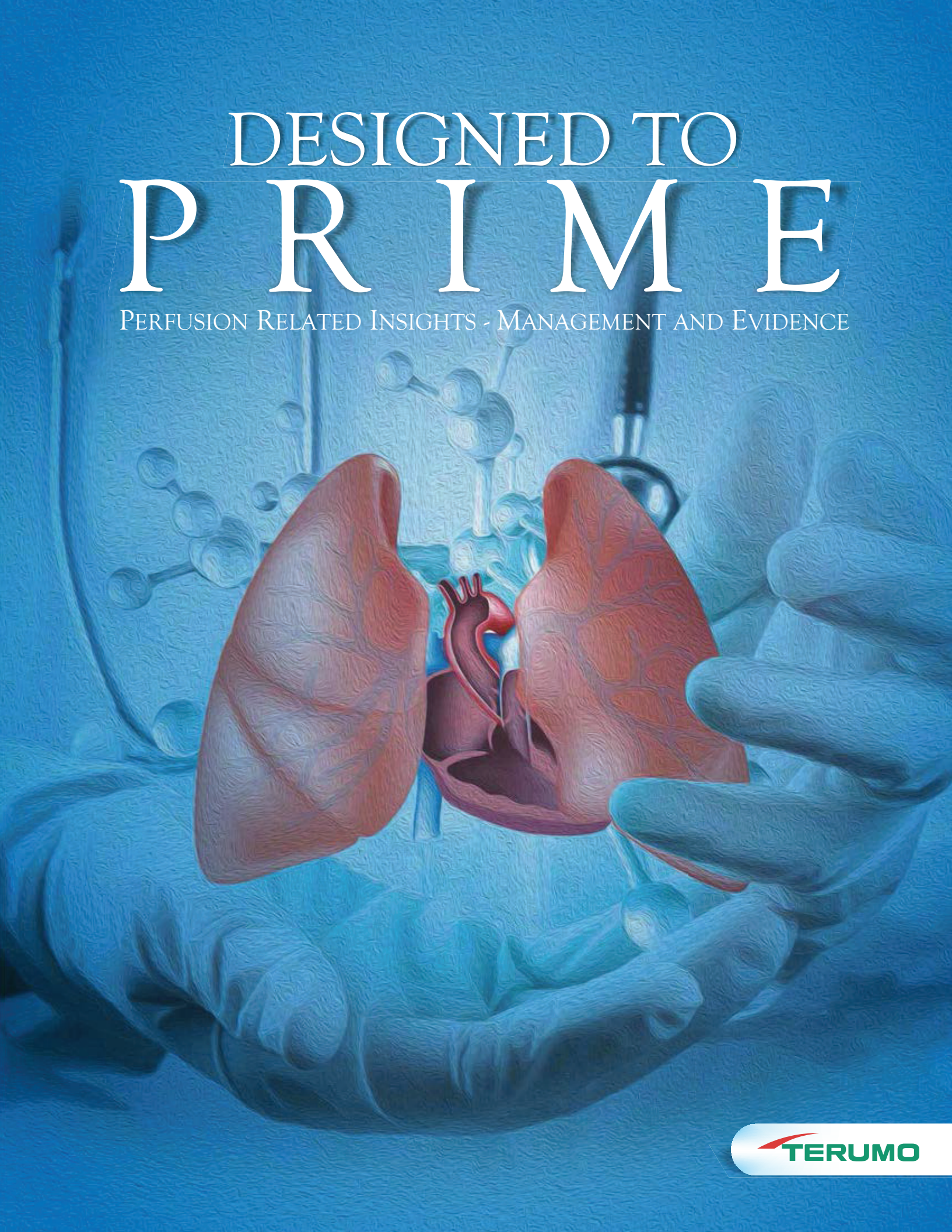
DESIGNED TO PRIME

Perfusion Related Insights - Management and Evidence



TERUMO

List of Editorial Board

Editorial Letter

Dear Readers,

PRIME – '**P**erfusion **R**elated Insights - **M**anagement and **E**vidence' is a scientific newsletter published every quarter with the help of our editorial board members and includes latest reviews, guidelines and expert experiences in relation to perfusion strategies.

We are happy to present the 1st issue of PRIME to you.

The 'Review Article' section in this issue includes an important publication on the use of prescriptive patient extracorporeal circuit and oxygenator sizing during adult cardiac surgery. In this article, Bronson SL, *et al.* discusses how the use of the 'right-sized' circuit algorithm may be useful in eliminating allogeneic blood transfusions in cardiopulmonary bypass..

This publication also includes two expert experiences shared on 'Cardiopulmonary bypass during pregnancy' and 'Perfusion strategies in arch repair', from two of our editorial board members.

The first contribution showcases two cases in the second trimester of pregnancy undergoing mitral valve replacement, in which the fetal heart rate and umbilical artery flow velocity were continuously monitored by transvaginal ultrasonograpy and analyzed in relation to the events of the cardiopulmonary bypass.

The second contribution presents the procedure of arch repair on low flow bypass or total circulatory arrest with intermittent perfusion.

The 'Guidelines' section touches upon the 'Development of Institutionally based Protocols', as advised by the AmSECT Standards and Guidelines for Perfusion Practice, 2013. This guideline by ICEBP aims to provide a framework to guide the safe and effective practice of cardiopulmonary bypass in adult patients.

We hope PRIME will create an awareness among perfusionists and will serve the purpose of being a publication alert for the experts. We are looking forward to hear from you for your valuable feedback, comments and suggestions.

Dr. Sandeep Arora
Head Medical Affairs
Terumo India Pvt. Ltd.
On behalf of editorial board members

SECTION 1

REVIEW ARTICLE

Use of prescriptive patient extracorporeal circuit and oxygenator sizing during adult cardiac surgery

Introduction

The current quality improvement project is aimed at reducing the prime volume of the cardiopulmonary bypass (CPB) circuit by matching oxygenators, reservoirs, and arterio-venous (A-V) loops to patients, on the basis of patient blood flow requirements during CPB. A hypothesis was made that by decreasing the prime volumes for smaller body surface area (BSA) patients, the hemoglobin (Hgb) nadir would increase, which would help to reduce allogeneic red blood cell (RBC) and blood product transfusions.

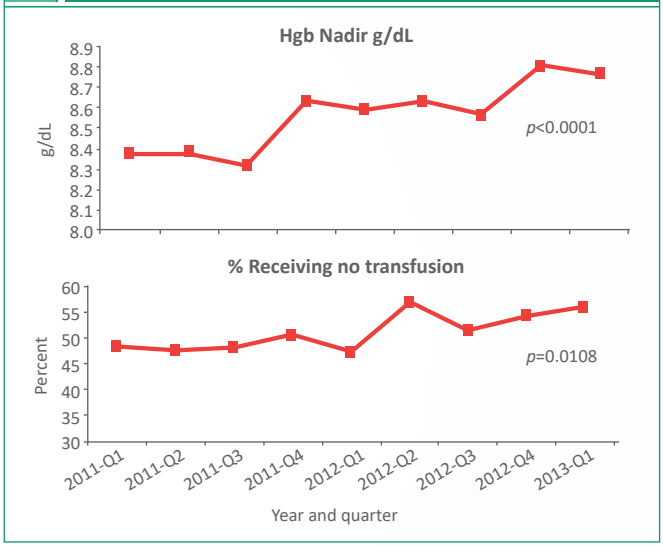
Methods

An observational analysis of 3,852 adult cardiac surgical patients who underwent CPB in an institution (between January 1, 2011 and March 31, 2013) was used for this quality initiative. Using a sizing algorithm - derived from manufacturers' recommendations - individualized "right-sized" extracorporeal circuits was created, based on the patients' BSA, cardiac index and target blood flows.

Results

Use of a sizing algorithm led to an increase in the percent of algorithm-recommended smaller oxygenators being used from 39% to 63% ($p<0.01$) and an increase in average Hgb nadir from 8.38 to 8.76 g/dL ($p<0.01$) (Figure 1). The marked increase in the average Hgb nadir helped to decrease the usage of blood in the operating room (OR) and surgical intensive care unit (ICU) (Figure 1). A significant increase was noted in the percent of the patients who did not receive a transfusion over the period of nine quarters.

FIGURE 1 Average OR Hgb nadir over the nine quarters and the % increase in patients receiving no transfusions in the OR and ICU



Because of the usage of right-sized algorithm, patients with similar BSA, who were previously exposed to larger oxygenators, reservoirs, and arterial-venous loops, were now supported with smaller circuits. The algorithm was adjusted for unique cases and procedural situations, including age, gender, and length and type of procedure. Larger heat exchanger surface area oxygenators were used for circulatory arrest procedures, due to requirement for increased heat exchange capability. Reduced transfusion related expenditures and decreased exposure risks justified the use of smaller circuit components, despite its higher costs.

CONCLUSION

Use of the "right-sized" circuit algorithm may be useful in increasing Hgb nadir during CPB and eliminating allogeneic blood transfusions in cases undergoing CPB.

Source: Bronson SL, Riley JB, Blessing JP, Ereth MH, Dearani JA. Prescriptive patient extracorporeal circuit and oxygenator sizing reduces hemodilution and allogeneic blood product transfusion during adult cardiac surgery. *J Extra Corpor Technol*. 2013;45(3):167-72.

Contributed by:

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Case 1: Cardiopulmonary bypass during pregnancy

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Introduction

We report two cases in second trimester of pregnancy undergoing mitral valve replacement, in which the fetal heart rate and umbilical artery flow velocity were continuously monitored by transvaginal ultrasonograpy and analyzed in relation to events of the CPB.

Materials and methods

Case I – A 33-year-old gravida III para II was admitted to our institute at 16 weeks of gestation with acute shortness of breath and palpitation, with a thickened heavily calcified mitral valve and a moderately severe eccentric jet of mitral regurgitation, along with a clot in the left atrial appendage on transthoracic echocardiography.

Case II – A 26-year-old gravida II para I was admitted with complaints of breathlessness on exertion at 17 weeks of gestation, with severe mitral stenosis, moderate tricuspid valve regurgitation, along with moderate pulmonary artery hypotension (PAH).

Surgery was the only option at this stage of gestation in both the patients. During CPB, a high flow rate (2.5 L/min/m^2), perfusion pressure >70 mmHg, normothermia, maternal hematocrit >28%, and pulsatile perfusion were maintained. Umbilical artery flow velocity waveforms were recorded. The pulsatility index (PI) and resistive index (RI) values were calculated.

LEARNING POINTS

>> The most important event during surgery is the transition of circulation from corporeal to extracorporeal; the decrease in mean arterial pressure (MAP) at this stage may have potential deleterious effects on the fetus and should be avoided

>> It is advisable to go initially on partial CPB and then slowly on full CPB, maintaining high MAP and avoiding the use of vasoconstrictors, which may have a profound effect on the placental unit

>> Maternal and fetal monitoring can enable early recognition of potential problems during CPB and timely provision of the required treatment

Contributed by:

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Case 2: Perfusion strategies in arch repair

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Arches are repaired on low flow bypass or total circulatory arrest (TCA) with intermittent perfusion.

Procedure

>> After sternotomy and the basic dissection, aortic cannulation is done with a single purse string, with the tip of the cannula just into the lumen of the aorta by 2-3 mm

>> A 14 or 16 Fr straight cannula is used for venous drainage

>> Once bypass is instituted, the flow is maintained at 2.4 liter/kg/min, which translates into a flow rate of about 175-200 ml/kg/min

>> The stringent time frame for core cooling time is 20-30 minutes which is very important to let the bradycardia set in gradually, reduce the metabolism of the heart, maintain no gradient or a gradient of less than 2 degree centigrade between the rectally recorded and peripherally recorded temperatures

>> The ductus is divided; the juxtaductal aortic dissection is completed. The ductus is interrupted and ligated. The descending aorta distal to the ductus is occluded with a spoon clamp, the arch branches are occluded with aneurysm clips, and the arch itself is occluded with an angled clamp, just distal to the innominate. This leaves the arterial cannula perfusing the cerebral and coronary circulations and we reduce the flows to about 50 ml/kg/min

>> The arch reconstruction is started. The ascending aorta is clamped proximal to the cannula, and the heart is arrested with antegrade blood cardioplegia

>> The flows for the arterial cannula are reduced to 30 ml/kg/min for selective cerebral perfusion. Once the arch repair is finished and perfusion is re-established, rewarming is started

>> Once TCA time exceeds 40 minutes, we re-perfuse at low flows, for every 10 minutes of TCA time, we perfuse for 1 minute. At no point does the TCA time extend uninterrupted for more than 40 minutes

>> Rewarming is started, in coordination with the procedure

GUIDELINES

SECTION 3

American Society of ExtraCorporeal Technology Standards and Guidelines for Perfusion Practice (2013): Report from the International Consortium for Evidence-Based Perfusion (ICEBP)

Standard and guideline for checklist

The perfusionist should use checklists for each CPB procedure which should be a part of the patient's permanent medical record in a read-verify manner where the critical steps that needed to be performed should be confirmed. The checklist should be completed by two people out of whom one person should be the primary perfusionist who is responsible for operation of the heart lung machine during the procedure. The checklist should be used during the entire perioperative period. Perfusionist should use the checklist also for other ancillary perfusion services.

Standard and guideline for communication

A patient-specific management plan for the CPB procedure should be prepared and communicated to the surgical team at the time of preoperative briefing or before the start of procedure. The use of cellular telephone technology in the procedure room should be guided by the principles of the ST-59 Statement on use of cell phones in the procedure room written by the American College of Surgeons. Protocol-driven communication should be used to acknowledge the verbal commands, verify the content, and reduce ambiguity. The primary perfusionist should take part in the post-procedure debrief with the surgical team.

NEWS UPDATE

SECTION 4

Attenuating the Systemic Inflammatory Response to Adult Cardiopulmonary Bypass

Numerous approaches have been studied to attenuate the systemic inflammatory response to CPB; however, there is no systematic based review which covers the scope of anti-inflammatory interventions deployed. Thus, an evidence-based review was conducted to capture "self-identified" anti-inflammatory interventions among adult CPB procedures. This review identified 33 different interventions and approaches to attenuate the systemic inflammatory response. But very few papers (35 of 98) showed any clinical improvement to one or more of the predefined outcome measures.

Interventions at level A evidence included off-pump surgery, minimized circuits, biocompatible circuit coatings, leukocyte filtration, complement C5 inhibition, preoperative aspirin, and corticosteroid prophylaxis. Interventions at level B evidence for minimizing inflammation included nitric oxide donors, C1 esterase inhibition, neutrophil elastase inhibition, propofol, propionyl-Lcarnitine, and intensive insulin therapy.

A secondary analysis showed that suppressing at least one inflammatory marker is necessary, but not sufficient to confer clinical benefit. The most effective interventions were those which targeted multiple inflammatory pathways.

There is a need of further research to evaluate whether combinations of interventions which target multiple inflammatory pathways are capable of synergistically reducing inflammation and improving outcomes after CPB.

Source: Landis RC, Brown JR, Fitzgerald D, Likosky DS, Lesserson LS, Baker RA, *et al*. Attenuating the systemic inflammatory response to adult cardiopulmonary bypass: A critical review of the evidence base. *JECT*. 2014;46:197-211.

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