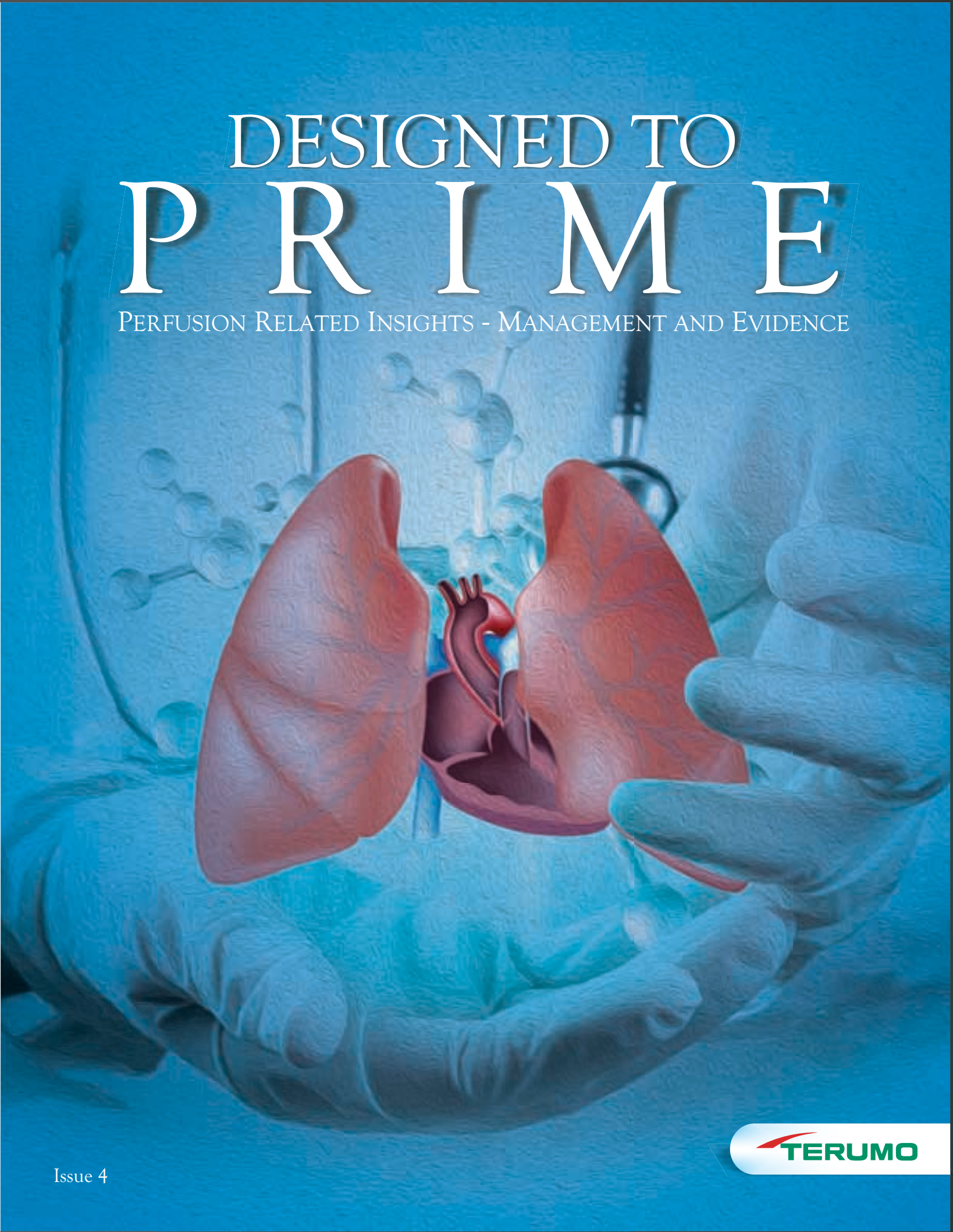
DESIGNED TO PRIME

Perfusion Related Insights - Management and Evidence



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Issue 4

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Editorial Letter

Dear Readers,

This issue of PRIME – '**P**erfusion **R**elated **I**nsights - **M**anagement and **E**vidence' focuses on the use of cardiopulmonary bypass in lung transplantation, and interesting clinical cases on autologous umbilical cord blood usage in neonatal cardiac surgical patients and extracorporeal membrane oxygenation (ECMO) support for a neonate post Takeuchi procedure. The articles shared here are stimulating to implement this knowledge in clinical practice.

The potential application of regenerative therapies with pluripotential stem cells to reduce the burden of heart disease and its sequelae is growing. Interest continues to grow regarding the therapeutic potential for umbilical cord blood therapies. This cord blood is a rich source of multiple populations of non-embryonic stem cells. Many congenital defects requiring postnatal surgical correction are now diagnosed antenatally. A significant number of these babies will require blood transfusion. Autologous cord blood is becoming the standard of care for use in hematologic and oncologic disorders.

Extracorporeal membrane oxygenation is a supportive therapy instituted to maintain respiratory and/or cardiac support, and to allow time for intrinsic recovery of the lungs and heart. Extracorporeal membrane oxygenation helps in unloading the distended and poorly contractile heart by decreasing the ventricular wall stress and myocardial workload.

The 'Guidelines' section focuses on 'gas exchange' from the American Society of Extracorporeal Technology Standards and Guidelines for Perfusion Practice, 2013. The 'News Update' section throws light on early and long-term results of cardiac surgery with extracorporeal circulation and concomitant malignancy.

We hope that PRIME continues to serve by updating perfusionists of the most recent developments in the field. We look forward to your continued support and suggestions to add value to the forthcoming issues.

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SECTION 1

REVIEW ARTICLE

Use of Cardiopulmonary Bypass in Lung Transplantation

Background

A controversy surrounds the use of cardiopulmonary bypass (CPB) in lung transplantation (LTx) surgeries. In an attempt to resolve it, Mohite and colleagues evaluated and compared outcomes after LTx surgeries employing different CPB strategies — elective CPB vs. off-pump vs. off-pump with unplanned conversion to CPB.

Methods

The investigators studied 302 LTx surgeries performed over 7 years and divided them as follows:

- 'Off-pump' group (n = 86)
- 'Elective on-pump' group (n = 162)
- 'Conversion' group (n = 54)

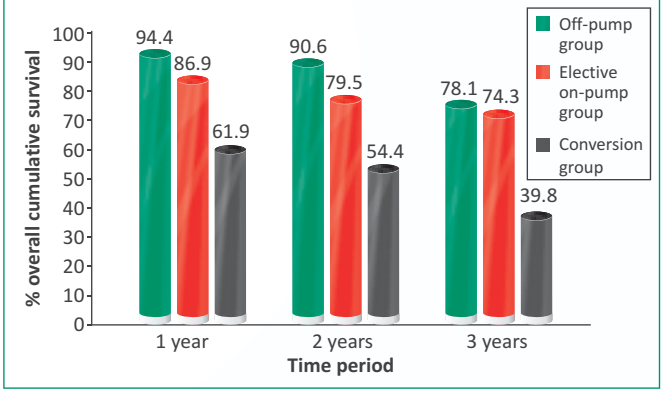
They then analyzed the preoperative donor and recipient demographics, baseline characteristics and the post-operative outcomes. With the help of 1:1 propensity score matching, they identified patients, operated upon using elective CPB, who had risk profiles similar to those operated upon off-pump (propensity matching 1) as well as those emergently converted from off-pump to CPB (propensity matching 2).

Results

Preoperative group demographic characteristics were comparable, except that the 'off-pump' patients were significantly older in age. The 'conversion' group had significantly more patients with primary pulmonary hypertension, pulmonary fibrosis, preoperative mechanical ventilation, and preoperative extracorporeal life support (ECLS). The 'conversion' group also had significantly poorer postoperative arterial oxygen partial pressure (PaO_2)/ fractional inspired oxygen (FiO_2) ratios upon arrival in ICU and at 24, 48 and 72 hours after surgery, needing more prolonged ventilation and longer ICU admission. There was an increased need for ECLS in this group compared to the other groups.

Overall cumulative survival at 1, 2 and 3 years was significantly worse in patients from the 'conversion' group compared to the 'off-pump' and 'elective on-pump' groups (Figure 1).

FIGURE 1 Comparison of overall cumulative survival at 1, 2 and 3 years



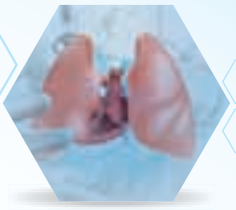
The 'off-pump' group had significantly better PaO_2 /FiO_2 ratios and a significantly shorter duration of ventilation, ICU stay and hospital length of stay when compared to the propensity matched 'elective on-pump' group.

No statistically significant differences in postoperative outcomes and overall survival rates were noted between the 'conversion' group and the propensity matched 'elective on-pump' group.

CONCLUSION

Compared to an elective on-pump strategy, an off-pump strategy is associated with better early post-operative outcomes and an improved early survival. Although most high-risk patients require intraoperative conversion from off-pump to CPB, the outcomes are suboptimal . But using an elective on-pump strategy offers no significant benefit over emergent conversion in high-risk patients.

Source: Mohite PN, Sabashnikov A, Patil NP, Garcia-Saez D, Zych B, Zeriouh M, *et al*. The role of cardiopulmonary bypass in lung transplantation. *Clin Transplant*. 2015 Dec 11.



Case 1: Umbilical Cord Blood as Prime

G. Naveen Kumar, M. Jyothi, K. Raghunath, Care Hospital, Hyderabad

Abstract

Autologous umbilical cord blood (AUCB) reduces the detrimental effects of homologous blood transfusion in neonatal cardiac surgical patients. The following case report describes the use of AUCB as an alternative to homologous blood transfusion during neonatal cardiac surgery.

Case report

Fetal echocardiography has allowed prenatal diagnosis of obstructed total anomalous pulmonary venous communication at the 28th week of gestation. Elective cesarean section (C-section) was performed at 36th week. Around 100 mL of AUCB was collected using aseptic technique in a citrate-phosphate-dextrose with adenine (CPDA) blood bag. A female baby weighing 3.4 kg at birth was taken up for surgery one hour after C-section.

Cardiopulmonary bypass (CPB) circuit included 3/16 inch arterial line, 1/4 inch venous line, and Maquet infant oxygenator. Prime for the CPB circuit included 100 mL AUCB, 35 mL albumin, 8.5 mL mannitol, 7 mL sodium bicarbonate, and 130 mL isolyte A. Our standard neonatal perfusion technique was used. Total anomalous pulmonary venous communication repair was done in total CPB time of 216 min and aortic cross clamp time of 103 min. Modified ultrafiltration was performed post CPB.

The patient was ventilated for 50 hours and discharged successfully after 5 days from ICU.

Discussion

Chronic pressure or volume overload lesions of the heart result in significant myocardial dysfunction leading to chronic congestive failure. Early correction of these cardiac defects before myocardial and pulmonary dysfunction may result in a better outcome.

Autologous umbilical cord blood collected after full-term deliveries can be used as autologous blood in neonates requiring surgery. To harvest enough UCB volume, immediate clamping of the umbilical cord is commonly used as standard practice. Autologous umbilical cord blood is considered beneficial, as it enables neonatal surgical patients to avoid allogeneic transfusions. Therefore, AUCB collection should be considered in patients antenatally diagnosed to have complex cardiac malformations.

CONCLUSION

Autologous umbilical cord blood can be used in priming the circuit during open heart surgery performed in the first hours of life in neonates. It is a safe and an efficient alternative to homologous blood transfusion. Collecting AUCB allows immediate surgical repair in the first hours of life and avoids the use of homologous blood transfusion, resulting in better neonatal surgical outcomes.

Case 2: Extracorporeal Membrane Oxygenation Support for a Neonate Post Takeuchi Procedure Unable to Wean off after Surgery

Malini Nair*, P.V.S. Prakash, Sunil Mekala, Lavanya, Dr. Chinnaswamy Reddy

A 2-month-old female baby weighing 3.6 kg was diagnosed with an anamolous origin of the left coronary artery arising from the pulmonary artery (ALCAPA), a rare but serious congenital anomaly that is often associated with global left ventricular (LV) dysfunction and a high mortality rate of 90%. She underwent Takeuchi's procedure to correct this anomaly; the surgery involving median sternotomy, followed by aortic and selective bicaval cannulation after heparinization. However, as in most of such cases, she could not be weaned off from the cardiopulmonary bypass (CPB) owing to poor LV function and elevated left atrial pressure. Three attempts at weaning her off the bypass were met with failure, with her mean arterial pressure dropping drastically each time.

Transesophageal echocardiography (TEE) that was done postoperatively revealed LV dysfunction, and hence, venoarterial extracorporeal membrane oxygenation (VA ECMO) using a centrifugal pump was used instead of the CPB. This was established with central cannulation using the Dideco polymethyl pentene oxygenator in a pediatric intensive therapy unit (PITU) with ECMO facilities. Further, LV venting was done for decompression of the heart, which was connected to the ECMO circuit (venous line) using a y-connector. The heart was completely on ECMO support with a full flow of 0.6 L/min. The patient was placed under observation for 24 hours while all hematological dynamics and parameters were monitored and managed. An activated clotting time of 180–200 seconds and a hematocrit of 30–35% were maintained with heparin and blood infusions, respectively. Cryoprecipitate and platelets were transfused to manage bleeding.

There were no ejections for 3 days, the pressures were in the range of 30–40 mmHg continuously for 4 days, and the central venous pressure (CVP) was < 4 mmHg**.** The pre- and post-membrane pressure gradient was monitored, the circuits were periodically checked for clots, and routine investigations were done every 12 hours. Echocardiography showed an improvement in the cardiac function on the fifth day with ECMO. Slight ejections were observed, and the pressures along with the CVP also improved. On day 6, the patient's heart was functioning normally with good ejections and pressures. Hence, the flows were gradually reduced while monitoring the hemodynamic parameters simultaneously; and the patient was successfully weaned off the ECMO.

On the fifth day after ECMO, the patient's X-ray reports had shown left upper lung collapse. The PO_2 level had also come down. Chest physiotherapy with regular suctioning and cardiac rehabilitation helped the patient to overcome the crisis. Nebulization was done every 2 hours. On day 24 postoperatively, improvement in the breathing pattern was observed with an increase in the PO_2. After confirming normal biochemical parameters, the patient was shifted to the ward on day 27, but she was taken back to PITU due to tachypnea. She recovered, was shifted again to the ward, and finally discharged on day 32 from the hospital. Extracorporeal membrane oxygenation helped in unloading the distended and poorly contractile heart by decreasing the ventricular wall stress and myocardial workload. It is thus a supportive therapy in such cases, creating a favorable environment for myocardial recovery.

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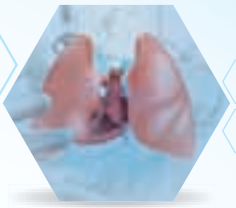
*Malini Nair is a final year student of MSc Perfusion Technology at Narayana Hrudayalaya. This paper was presented as an oral presentation at the ISECTCON 2015 Hyderabad Conference.



GUIDELINES

SECTION 3

The American Society of Extracorporeal Technology Standards and Guidelines for Perfusion Practice (2013)

Gas exchange

Gas exchange should be maintained during cardiopulmonary bypass (CPB) according to protocol, accounting for the individual patient characteristics/risk profile, oxygenator type, design and instructions for use, and blood flow, temperature and metabolic demand. Further, devices used to measure gas exchange should be calibrated as per the manufacturer's instructions for use. Blood gas analysis should be performed and recorded according to protocol. Point-of-care testing should be considered so that accurate and timely information is obtained for blood gas analysis. Oxygen delivery and consumption calculations should be used to evaluate and optimize gas exchange.

Source: Baker RA, Bronson SL, Dickinson TA, Fitzgerald DC, Likosky DS, Mellas NB, *et al.* Report from AmSECT's International Consortium for evidence-based perfusion: American Society of Extracorporeal Technology Standards and Guidelines for Perfusion Practice: 2013. *J Extra Corpor Technol*. 2013 Sep;45(3):156–66.

LATEST NEWS

SECTION 4

Early and Long-term Results of Cardiac Surgery with Extracorporeal Circulation and Concomitant Malignancy

Researchers evaluated early and long-term results of cardiac surgery using extracorporeal circulation (ECC) in patients affected by malignancies. Further, the potential influence of ECC on malignancy progression during follow-up was also assessed.

Patients (n = 7078) referred for cardiac surgery were evaluated before surgery, as 241 consecutive patients (3.4%) had malignancy either known before or detected during hospital stay. Cardiac surgery with ECC consisted in isolated (n = 176) or multiple procedures (n = 65), while follow-up (mean 57 ± 40 months) was complete (99%).

There is no increase in hospital-induced mortality with cardiac surgery in cancer patients. Cardiac surgery provides satisfactory freedom from cardiac death as well as long-term survival in early stages of cancer. Hematological malignancies seem to have a negative impact on the overall outcome.

Source: Nardi P, Pellegrino A, Pugliese M, Bovio E, Chiariello L, Ruvolo G. Cardiac surgery with extracorporeal circulation and concomitant malignancy: Early and long-term results. *J Cardiovasc Med (Hagerstown)*. 2016 Feb;17(2):152–9.

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