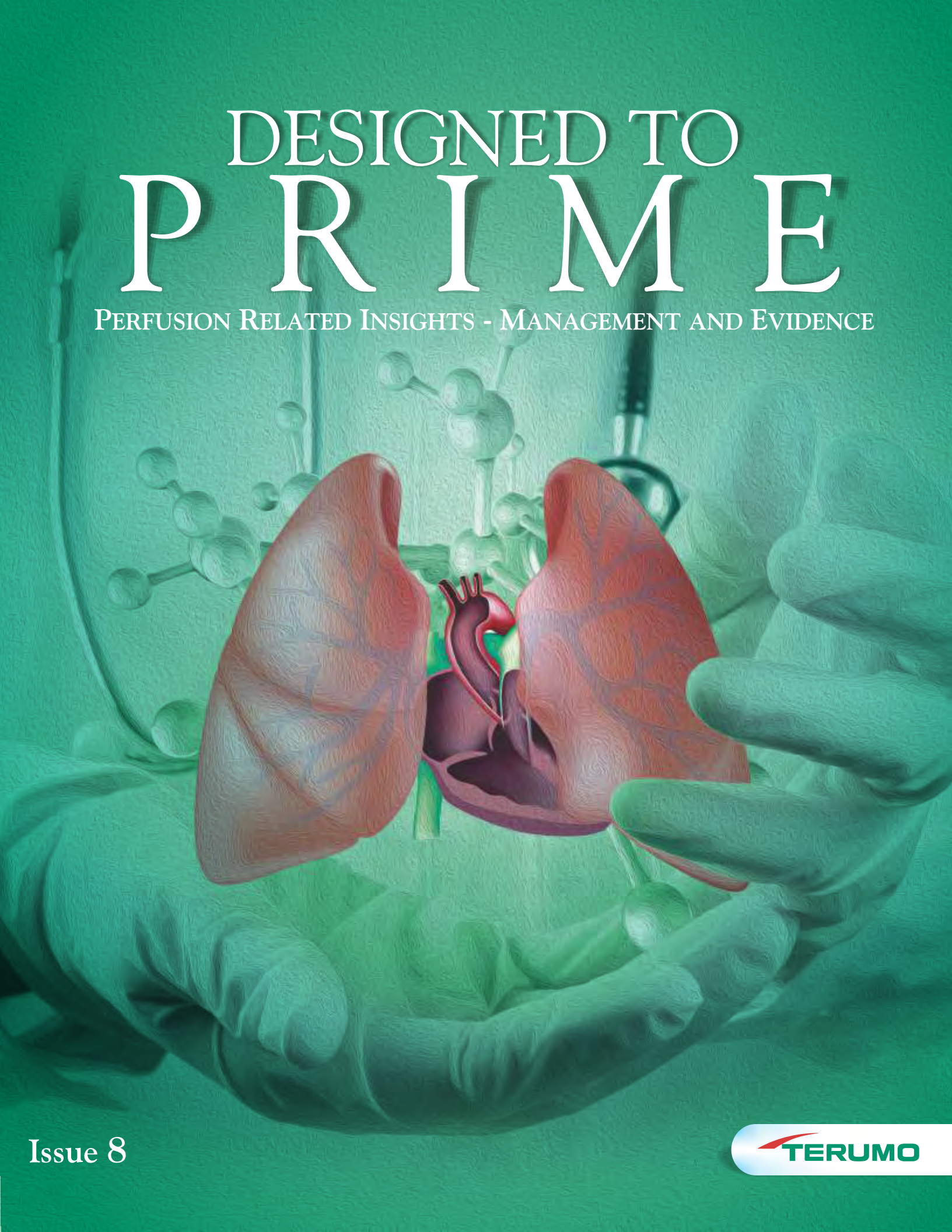
DESIGNED TO PRIME

Perfusion Related Insights - Management and Evidence



Issue 8

TERUMO

Scientific Committee

Name	Designation
Dr. Kamla Rana	HOD – Perfusion Department at Medanta - The Medicity, Gurgaon
P. V. S. Prakash	Consultant Chief Perfusionist at Narayana Hrudayalaya, Bengaluru
Bhaskaran Vishwanathan	Chief Perfusionist at Madras Medical Mission Hospital, Chennai
Manoj M. C.	Perfusionist at Kokilaben Dhirubhai Ambani Hospital, Mumbai
P. Mathavan	Chief Perfusionist at JIPMER, Puducherry
G. Naveen Kumar	Chief Perfusionist at Care Hospital, Hyderabad
Atul Solanki	Chief Perfusionist at U. N. Mehta Hospital, Ahmedabad
R. Nair	Sir Gangaram Hospital Delhi

PRIME Newsletter invites new authors for their contribution to the perfusion community. If you are interested in volunteering your time writing an article or a topic of your expertise and willing to share your knowledge with our readers, we certainly encourage you to do so. We invite everyone interested in joining our team, and you can contact us at the email given below. Any amount of time that you can volunteer in adding to our quality of publication will be greatly appreciated. Thank you for your interest in PRIME Newsletter. What are you waiting for?

E-mail- rahul_sharma@terumo.co.jp

TERUMO

Editorial Letter

Dear Readers,

It's our pleasure to introduce you to the eighth issue of PRIME — "Perfusion Related Insights - Management and Evidence." This scientific newsletter is published every quarter by our editorial board members, who carefully choose the latest reviews, clinical trials, and guidelines. Through PRIME, we also encourage experts to share their personal experiences and techniques in perfusion.

In this eighth issue of PRIME, four articles are discussed under the section "Review Articles". An observational study shows that hemoglobin is an independent predictor for in-hospital and long-term mortality, especially in patients aged ≥ 65 years. Another retrospective study highlights the role of extracorporeal membrane oxygenation therapy in the treatment of acute respiratory distress syndrome in patients who failed to respond to conventional therapy. A review on hyperlactatemia in high-risk cardiac surgery reiterates the importance of hyperlactatemia. A meta-analysis demonstrates that coronary artery bypass graft surgery seems to be a better option for managing left main coronary artery disease because percutaneous coronary intervention with a drug-eluting stent is associated with an increased risk of repeat revascularization than coronary artery bypass graft surgery.

The “Expert Experiences” section covers two interesting topics by the experts — abdominal aortic aneurysm repair as a challenging perfusion technique using left heart bypass and cardiopulmonary bypass for port-access cardiac surgery.

The “Guidelines” section focuses on various aspects that must be monitored during cardiopulmonary bypass recommended by the American Society of ExtraCorporeal Technology Standards and Guidelines for Perfusion Practice.

The “Latest News” section explains how to avoid bacterial contamination of heater-cooler devices that put patients at risk of infection. Another news talks about the safety of a gelatin solution used for the priming of cardiopulmonary bypass in cardiac surgery.

We hope that perfusionists will find these articles interesting and helpful. We look forward to receive your valuable feedback, comments, and suggestions that will help us work better on our future issues.

Dr. Sandeep Arora
Director - Medical and Clinical Affairs
Terumo India Pvt. Ltd.

Mr. Rahul Sharma
Manager Clinical Excellence
Terumo India Pvt. Ltd.
rahul_sharma@terumo.co.jp

Table of Contents

Hemoglobin: An Independent Predictor of In-Hospital and Long-Term Mortality in Elderly Patients with ST-Segment Elevation Myocardial Infarction

Introduction

Advanced age and low hemoglobin levels portend a poor prognosis in ST-segment elevation myocardial infarction (STEMI). A low hemoglobin level reduces the oxygen supply to the heart, and hence, is a potential risk factor for myocardial infarction (MI). Despite adverse outcomes associated with anemia, its effect on STEMI in elderly patients remains unknown. In this context, Velásquez-Rodríguez and his colleagues aimed to assess the effect of hemoglobin levels at admission on the management and prognosis of STEMI patients aged 65 years and above.

Methods

The researchers reviewed the data derived from the Descripción del Infarto Agudo de Miocardio: Actuaciones, Novedades, Terapias y Evolución – Description of Acute Myocardial Infarction Management, New Therapies and Evolution (DIAMANTE) registry. This registry provided data about patients with STEMI admitted to the coronary intensive care unit of the Gregorio Marañón University Hospital (Madrid, Spain), a primary percutaneous coronary intervention (PCI) center.

In this analysis, patients presenting within 12–24 hours of symptom onset and those who underwent urgent reperfusion therapy and/or primary PCI were included. The primary endpoint was death from any cause during hospitalization. In total, 1,111 patients were included in the analysis.

Study outcome

The mean age of the study patients was 64.1 ± 14.0 years, and nearly one-fourth of the population comprised of women. A total of 60 patients (5.4%) died during hospital admission. The patients were followed up for a mean period of 23.8 ± 19.4 months, and 147 patients (13.2%) died at the end of the follow-up period.

- Increasing age (≥ 65 years) was associated with a lower hemoglobin level at admission, which in turn was associated with an increased rate of in-hospital death in both men and women.
- The Killip (II–IV) classification at presentation and hemoglobin levels were independent predictors of in-hospital and long-term mortality.
- A positive correlation between mean hemoglobin levels and Killip class was identified.
- A long-term prognosis was associated with normal hemoglobin levels, especially in men aged above 65 years.

CONCLUSION

In patients with STEMI, hemoglobin level turns out to be an independent predictor of in-hospital and long-term mortality, especially in patients aged 65 years and above. However, this association was also evident in men ≥ 65 years with normal hemoglobin levels.

Source: Velásquez-Rodríguez J, Diez-Delhoyo F, Valero-Masa MJ, Vicent L, Devesa C, Sousa-Casasnovas I, *et al.* Prognostic impact of age and hemoglobin in acute ST-segment elevation myocardial infarction treated with reperfusion therapy. *American Journal of Cardiology.* 2017.

Extracorporeal Membrane Oxygenation is a Promising Therapeutic Modality for Acute Respiratory Distress Syndrome

Introduction

Acute respiratory distress syndrome (ARDS)-associated mortality and morbidity are high despite advances in ventilation techniques. At present, extracorporeal membrane oxygenation (ECMO) is viewed as a potential therapeutic option for ARDS until lung functions are recovered. It also serves as a bridge to further therapeutic modalities when conventional therapy fails. Panholzer and his colleagues retrospectively analyzed the data of patients with severe ARDS who were treated with ECMO.

Methods

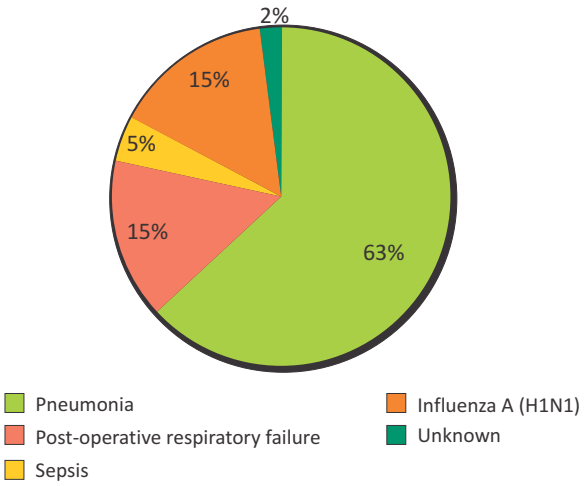
In a retrospective study, data of 46 consecutive ARDS patients who were supported with venovenous ECMO were analyzed. All conventional options were tried before ECMO. Extracorporeal membrane oxygenation therapy was continued until lung recovery or death of the patient. Several clinical parameters were recorded before and after ECMO, as well as 2 hours, 1 day, and 2 days after treatment initiation. These parameters included ECMO duration, days of ventilation after ECMO, ECMO-related complications, blood transfusion during ECMO, renal replacement therapy (RRT) before and on ECMO, changes in the blood gas analysis, hemodynamics, and laboratory variables.

Study results

The mean age of the study population was 54 years (18–72 years); the patients comprised 30 men (65.2%) and 16 women (34.8%).

- Pneumonia was the primary cause of ARDS in most of the patients (Figure 1).
- The median sequential organ failure assessment (SOFA) score was 13 (10–19), and the median lung injury score (LIS) was 3.5 (2.67–4).
- Extracorporeal membrane oxygenation support was provided for a median of 12 days.
- Renal replacement therapy was administered in 28.3% and 67.4% of the patients before and after ECMO, respectively. Post ECMO, 29% and 71% of the patients required RRT due to renal failure and fluid overload, respectively.
- Twenty-eight patients (60.9%) were successfully weaned off ECMO, and 22 patients survived (47.8%). Death was reported in 18 patients (39.1%) while on ECMO and additional six patients died after they were weaned off ECMO.
- Mechanical ventilation was provided to all survivors for a median period of 7 days.
- Extracorporeal membrane oxygenation-related complications were reported in seven patients (15.2%).
- During ECMO, all patients required blood transfusion.
- Immediately after ECMO initiation, a significant improvement in gas exchange and ventilation parameters was noted; the improvement was sustained until the removal of ECMO.
- During ECMO, RRT was administered more frequently in nonsurvivors than in survivors (37.5% vs. 18.2%; $P < 0.01$).

Figure 1: Causes of ARDS



CONCLUSION

The study outcomes clearly show that it is necessary to consider acute kidney injury and transfusion as the adverse outcomes of ECMO.

Source: Panholzer B, Meckelburg K, Huenges K, Hoffmann G, von der Brelie M, Haake N, *et al.* Extracorporeal membrane oxygenation for acute respiratory distress syndrome in adults: An analysis of differences between survivors and non-survivors. *Perfusion.* 2017:1–6.

Importance of Hyperlactatemia in Cardiac Surgery

Hyperlactatemia, defined by its level of 3–5 mmol/L, is observed in patients after cardiac surgery, and it may have either an early or a late onset. Both hypoxic and nonhypoxic mechanisms are implicated in the pathogenesis of hyperlactatemia.

Stress-induced accelerated aerobic metabolism can be attributed to the nonhypoxic mechanism. In this context, lactate production is increased due to the "mass-action effect" in which the pyruvate production exceeds the rate of pyruvate oxidation. In this situation, the lactate/pyruvate ratio is normal (< 20). Owing to impaired global or regional oxygen delivery, the lactate/pyruvate ratio is typically elevated (> 20). At physiological pH, lactate — a strong anion — is dissociated completely. Intrinsically, an increased lactate level exerts an acidifying effect on the blood.

An adverse outcome is prominent in case of early-onset hyperlactatemia and is perhaps a consequence of both hypoxic (e.g., microcirculatory shock) and nonhypoxic (accelerated aerobic metabolism) mechanisms. Late-onset hyperlactatemia can be observed even in the absence of any evidence of global or regional tissue hypoxia. It is a benign, self-limiting condition that typically arises within 6–12 hours of admission to an intensive care unit (ICU) and spontaneously resolves within 24 hours.

Hyperlactatemia is frequently observed after treatment with β2-agonists namely epinephrine. Accelerated aerobic metabolism is linked to epinephrine-induced hyperlactatemia, which, however, requires no specific intervention.

Irrespective of the cause, the presence of hyperlactatemia should prompt an immediate remedy toward impaired tissue oxygenation because normal or even supranormal indices of global oxygen delivery are more likely to occur, despite regional tissue hypoperfusion.

Source: Minton J, Sidebotham DA. Hyperlactatemia and cardiac surgery. *J Extra Corpor Technol.* 2017 Mar;49(1):7–15.

Coronary Artery Bypass Graft Surgery is a Better Option over Percutaneous Coronary Intervention with Drug-Eluting Stents in the Treatment of Left Main Coronary Artery Disease

Introduction

Left main coronary artery disease (LMCAD) is a common presentation in 4–9% of patients undergoing coronary angiography. Owing to the high risk of mortality with medical therapy and restenosis and adverse outcomes with percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG) surgery was considered a standard of care for LMCAD. However, the results have been inconsistent with CABG surgery and PCI for LMCAD. In this context, Garg and his colleagues conducted a meta-analysis to evaluate the long-term outcomes of PCI using a drug-eluting stent (DES) compared with CABG in patients with LMCAD. In this analysis, five randomized control trials

(RCTs; n = 4,595 patients) were included. The median follow-up period was 60 months.

Methods

Studies published between January 1, 2000, and November 1, 2016, and those reporting direct comparisons between PCI with DES and CABG for LMCAD were scrutinized, and five RCTs were included for the analysis. The primary endpoints were all-cause mortality, cardiovascular mortality, myocardial infarction, stroke, and repeat revascularization at maximal available follow-up.

Results

Of the 4,595 patients, 2,297 were randomly assigned to PCI with DES and 2,298 were randomly allocated to CABG.

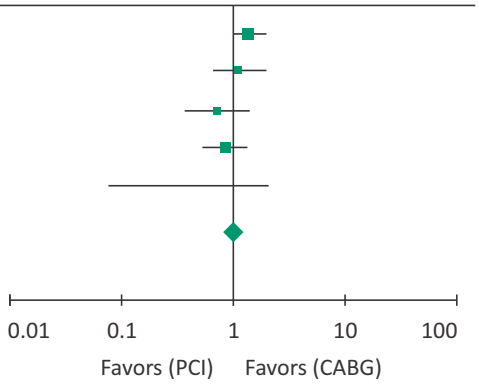
- The mean age of the study population was 66 years, and three-fourth of the population comprised men.
- No significant difference between PCI with DES and CABG was observed in terms of all-cause mortality (Figure 1) and cardiovascular mortality. Further, no evidence of heterogeneity was observed across studies.
- No statistically significant differences between PCI with DES and CABG was evident for myocardial infarction (odds ratio [OR] = 1.45; 95% confidence interval [CI] = 0.87–2.40) and stroke (OR = 0.87; 95% CI = 0.38–1.98); however, there was a significant heterogeneity (I^2 = 57% and I^2 = 64%, respectively).
- Compared with CABG, the risk of repeat revascularization was significantly higher with PCI with DES (OR = 1.82; 95% CI = 1.51–2.21). There was no evidence of heterogeneity across studies.

Figure 1: Difference between PCI with DES and CABG in terms of all-cause mortality

Study or subgroup	PCI Events	PCI Total	CABG Events	CABG Total	Weight	Odds ratio M-H, Random, 95% CI
EXCEL	71	948	53	957	32.5 %	1.38 [0.96, 1.99]
NOBLE	36	592	33	592	23.1%	1.10 [0.67, 1.78]
PRECOMBAT	17	300	23	300	15.2%	0.72 [0.38, 1.38]
SYNTAX	45	346	48	322	26.4%	0.85 [0.55, 1.32]
Boudriot *et al.*	2	100	5	101	2.8%	0.39 [0.07, 2.07]
Total (95% CI)		**2286**		**2272**	**100.0%**	**1.01 [0.76, 1.34]**
Total events	171		162			

Heterogeneity. Tau^1 = 0.03; Chi^2 = 5.64, df = 4 (*P* = 0.23); I^2 = 29%

Test for overall effect Z = 0.06 (*P* = 0.95)



Abbreviations: CABG, coronary artery bypass graft surgery; DES, drug-eluting stent; EXCEL, Evaluation of XIENCE versus Coronary Artery Bypass Surgery for Effectiveness of Left Main Revascularization; NOBLE, Nordic-Baltic-British Left Main Revascularization Study; PCI, percutaneous coronary intervention; PRECOMBAT, Premier of Randomized Comparison of Bypass Surgery versus Angioplasty Using Sirolimus-Eluting Stent in Patients with Left Main Coronary Artery Disease; SYNTAX, Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery.

CONCLUSION

Although there is no difference in the risk of ischemic adverse events associated with PCI with DES and CABG in LMCAD, PCI with DES was associated with a higher risk of repeat revascularization versus CABG.

Source: Garg A, Rao SV, Agrawal S, Theodoropoulos K, Mennuni M, Sharma A, *et al.* Meta-analysis of randomized controlled trials of percutaneous coronary intervention with drug-eluting stents versus coronary artery bypass grafting in left main coronary artery disease. *The American Journal of Cardiology.* 2017.

Thoracoabdominal Aortic Aneurysm Repair: A Challenging Perfusion Technique Using Left Heart Bypass

Contributed by: Azarudeen S, Baskaran V, Angeline, Rani D, Analiya, Benjamin N and Sherif EA ICVD, Madras Medical Mission, Mogappair, Chennai - 600 037

Background

Open surgical repair was performed in a 56-year-old man (body weight = 79 kg, body surface area = 1.92 m^2) with a thoracoabdominal aortic aneurysm (TAAA) to facilitate effective replacement of the diseased segment and prevent aneurysm rupture. The procedure carries a substantial risk of perioperative morbidity and mortality due to ischemic insults. Challenges related to perfusion support during TAAA repair include maintenance of distal perfusion and avoidance of both hypothermia and excessive hemodilution.

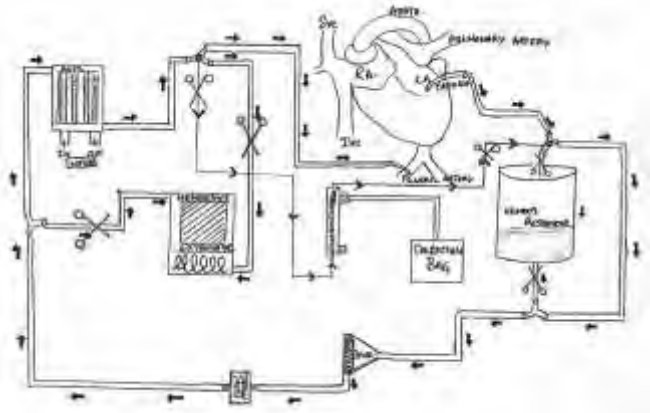
Method and perfusion technique used

We reviewed the outcome of TAAA repair in a patient with a (left heart bypass) perfusion technique. In this case, we devised a left heart bypass circuit, consisting of a 28 Fr angled RMI cannula with 3/8-inch long tubing connected from the left atrium to a centrifugal pump inlet and from the pump outlet to the femoral artery using a 24 Fr angled RMI cannula via the low prime SPICTRA myocardial protection system (MPS) heat exchanger (Figure 1). These precautionary measures were taken to prevent hypothermia. We took nearly 346 minutes for left heart bypass in this patient. The aorta was clamped for about 273 minutes. Blood flow and perfusion pressure were maintained at around 2.9 L/m and 75 mmHg, respectively. Arterial blood gases were normal, temperature was maintained around 34 °C, and a hematocrit value of 23% was achieved. A minimal dose of heparin 80 + 20 + 20 mg was administered at three different intervals. Activated clotting time was raised up to 270 seconds. Urine output was around 1,500 mL throughout the time the pump was running. A routine adult membrane oxygenator was primed and kept clamped, along with the left heart bypass circuit, without being used in case to avoid an alarming situation. Incorporation of hemofilter was planned but was not used.

Results

The patient had a reasonable ICU and hospital stay with no reports of adverse effects or events. The low prime and custom circuit reduced hemodilution and cost. The early follow-up outcome of this patient was satisfactory.

Figure 1: Left heart bypass circuit diagram



CONCLUSION

Open surgical repair of TAAA can be lifesaving in patients who are at risk of perioperative morbidity and mortality. The well-established circuit bypass associated with advanced perfusion techniques will reduce the risk of complication and show a good outcome.

Cardiopulmonary Bypass for Port-Access Cardiac Surgery

Contributed by: Rana K, Khare A, Srivastava R, Khalid SM, Srivastava LK, Saroha A, Wasir H, Mehta Y, and Trehan N, Medanta the Medicity Gurgaon

Introduction

Minimally invasive cardiac surgery was introduced in the 1990's. A small lateral incision results in better cosmesis, especially in women. Young active patients wishing to avoid sternotomy scars and patients older than 75 years who might not tolerate sternotomy are the best candidates for minimally invasive cardiac surgery. In addition, minimally invasive cardiac surgery results in alleviated pain, shorter hospital stay, and cost effectiveness. Port-access surgery was started with a mitral valve procedure, arterial septal defect repair, aortic valve procedure, and tricuspid valve repair.

Methods

In this study, we included 10 patients in the age group of 50–60 years requiring either repair or replacement of the mitral valve, arterial septal defect, and tricuspid valve. These patients underwent port-access minimally invasive cardiac surgery with the endovascular cardiopulmonary bypass (CPB) system. In all patients, access to the heart was achieved via a small (4–8 cm) right lateral chest incision in the fourth intercostal space.

Procedure

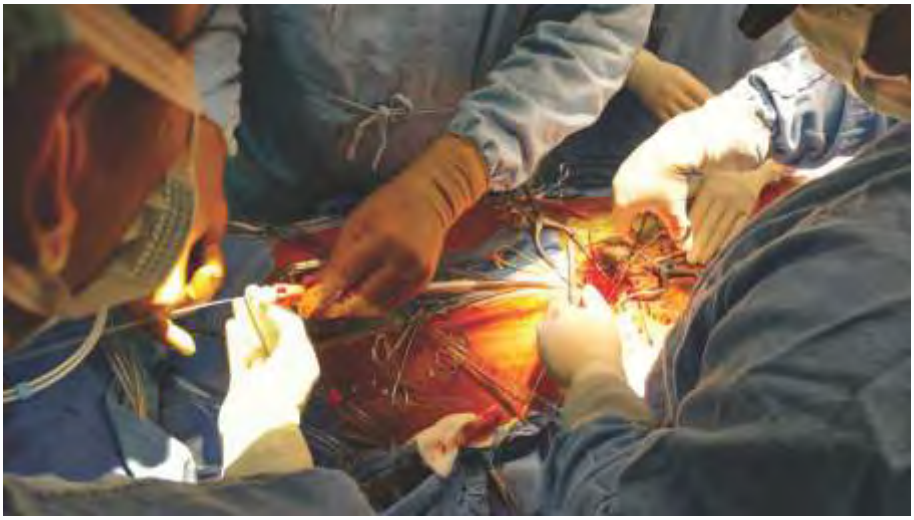
Cardiopulmonary bypass was initiated in 100 patients by using an endoreturn arterial cannula in the femoral artery and an endoreturn venous cannula in the femoral vein. Aortic occlusion was accomplished either with a balloon catheter inserted through the arterial cannula (n = 50) or with a long vascular (Chitwood) clamp in the second intercostal space (n = 50). Cardioplegic solution was administered either through the end of the balloon catheter (n = 50) or through the DLP 12Ga aortic root cannula (n = 50).

Patients were placed on the CPB system through femoral cannulae and centrifugal drainage, and the system was cooled to 28 °C to maintain a perfusion pressure of 55–58 mmHg. An endopulmonary artery vent was placed in the main pulmonary artery through the jugular vein. For mitral valve surgery, a catheter was placed in the coronary sinus for delivering cardioplegic solution. An endoaortic clamp was used for occluding the ascending aorta. For the delivery of cardioplegic solution, aortic root venting, and pressure measurement, a endoaortic catheter was inserted through the femoral artery and was positioned with the help of fluoroscopy and transesophageal echocardiography (TEE). Migration of the endoaortic catheter was monitored using the TEE of the ascending aorta. The aortic root vent pump was adjusted to keep the aortic root pressure positive and to avoid drawing air in to the aortic root. Femoral and jugular cannulae and catheters were positioned into the coronary sinus, pulmonary artery, and ascending aorta to arrest and vent the heart to deliver antegrade cardioplegia solution. Venous blood was drained into the oxygenator and oxygenated blood was returned into the peripheral circulation. Placements of cannulae and catheters were guided by fluoroscopy and TEE imaging. An endoaortic balloon was used to arrest the heart because it is less traumatic and is associated with fewer cerebral microemboli and less acute renal injury. The endoclamp aortic catheter is a 10.5 Fr wire-wound triple lumen catheter having an elastomeric balloon nearby its tip to occlude the ascending aorta. The endoclamp catheter occludes the ascending aorta, vents the aortic root, and allows the delivery of cardioplegic solution to arrest the heart. The pressure in the aortic root is monitored via the pressure lumen. Aortic root pressure should be 250–300 mmHg. Pressure in the aortic root is changed to an appropriate level during administration of cardioplegic solution.

Picture of endoclamp and endoarterial return cannula

Endoarterial return cannula is of two sizes 21 Fr and 23 Fr. It includes introducer — 0.38 gauge guidewire and connector hub. The sidearm and rotating hemostasis valve allow for passage of the endoclamp aortic catheter.

EOPA arterial cannulae 18 Fr to 24 Fr and Biomedicus arterial cannulae 19 Fr and 21 Fr are used for femoral cannulation.



Picture of endovenous return cannula

DLP Medtronic cannulae from 22 Fr to 28 Fr are thin wall, wire-reinforced and allow excellent flow. These cannulas are compatible with the percutaneous approaches.

CONCLUSION

Through this procedure, clinical outcomes were better with a shorter hospital stay, faster recovery time, and alleviated postoperative pain. Minimally invasive cardiac surgery resulted in a smaller incision and better cosmesis, reduced blood loss, less surgical trauma, and a reduced risk of wound infection.

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

Standards and recommendations for monitoring of patients undergoing cardiopulmonary bypass (CPB):

- Monitor arterial blood pressure of the patient constantly during CPB.
- Monitor arterial line pressure continually during CPB.
- Monitor arterial blood flow continually during CPB.
- Monitor cardioplegia dose, delivery method, line pressure (antegrade), coronary sinus pressure (retrograde), and ischemic intervals continually during CPB.
- Monitor patient and device temperatures continually during CPB:
  - Nasopharyngeal, rectal, bladder, and esophageal temperatures of the patient
  - Arterial, venous, and cardioplegia temperature in the heart lung machine
  - H_2O temperature in the heater-cooler device
- Monitor blood gas analyses continually or at regular intervals during CPB.
- Monitor hematocrit (or hemoglobin) continually during CPB.
- Monitor oxygen fraction and gas flow rates continually during CPB.
- Monitor the percentage of venous line occlusion of the venous occluder continually during CPB.
- Monitor venous oxygen saturation continually during CPB.
- Monitor carbon dioxide removal continually during CPB. Monitor arterial oxygen saturation continually during CPB.
- Monitor the following pressure parameters during CPB:
  - Central venous pressure and/or
  - Pulmonary artery blood pressure
- Use continuous in-line blood gas monitoring during CPB.
- Use cerebral oximetry during CPB.
- Monitor arterial blood flow continually at a point in the CPB circuit where it accurately reflects the flow delivered to the patient during CPB (e.g., distal to intra-circuit shunts).

Source: Baker RA, Bronson SL, Dickinson TA, Fitzgerald DC, Likosky DS, Mellas NB, *et al*; International Consortium for Evidence-Based Perfusion for the American Society of ExtraCorporeal Technology. 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.

How to Eliminate *Mycobacterium chimaera* in a Heater-Cooler Device Used During On-Pump Cardiothoracic Surgery?

Mycobacterium chimaera (M. chimaera) infections have been associated with heater-cooler units (HCUs) of a one-tank system (T1) or a three-tank system (T3). Elimination of mycobacteria from the HCUs to reduce the risk of infection in patients is challenging. Nielsen *et al* from Aalborg University Hospital, Denmark, reported how they managed to eliminate nontuberculous mycobacteria (NTM) by changing the cleaning procedure of the Sorin Group HCU T3.

The hospital had three HCU T3 devices and one Variotherm 550 device manufactured by the Sorin Group. All samples obtained from the T3 devices were positive for *M. chimaera*, while the Variotherm device tested negative. The HCU T3 devices were removed from clinical service for 6 weeks. Water was changed every month, and two Micropur Classic MC 10T Purification Tablets (containing silver chloride) were added at 37 °C according to the instruction manual. The devices were cleaned 10 times. However, culture reports for water samples remained positive for *M. chimaera.* To eliminate *M. chimaera*, the researchers disconnected all tubing and boiled all connections from all three devices. New tubing and the boiled connections were fitted to the devices. Then, they cleaned all three devices with Micropur added to the water. The HCU T3 was kept running for 15 minutes to keep circulation in the tubing. The device was emptied, and the procedure was repeated 10 times. After the 10th cleaning procedure, the samples of water were tested. The cultures were negative for NTM.

The Sorin Group issued new instructions for cleaning, which included the use of hydrogen peroxide 3%. The procedure included draining the water and refilling the tank again by adding hydrogen peroxide 3% every seventh day. It also involved adding 150 mL of hydrogen peroxide 3% to water and circulating it for 15 minutes every fortnight before changing the water. However, all devices again tested positive for NTM. They performed an additional round of cleaning by keeping the water circulating in the tubing for 15 minutes and subsequently emptied the tank. This was repeated 10 times. Further, NTM cultures from the HCU T3 water samples were still positive for *M. chimaera*, but the new cleaning procedure resulted in a lower number of colonies from the devices in daily use. After performing the cleaning procedure 10 times, including twice with hydrogen peroxide 3%, they got negative cultures from the two devices in daily use, but the device not in use still had positive NTM cultures. They hypothesized that circulation in the tubing is important to keep the devices free of *M. chimaera* and established circulation in the tubing every day. Six months following these changes in procedures, cultures from all devices remained negative. Further studies are mandated to confirm the effectiveness of this cleaning procedure.

Source: Nielsen C, Winther CL, Thomsen PK, Andreasen JJ. Elimination of Mycobacterium chimaera in a heater cooler device used during on-pump cardiothoracic surgery. *Perfusion.* 2017;1–4.

Gelatin Solution is Safe for the Priming of Cardiopulmonary Bypass in Cardiac Surgery

The results of a systematic review and meta-analysis suggest that gelatin solution is as safe as modern-generation tetrastarches or crystalloids for the priming of cardiopulmonary bypass in cardiac surgery.

The colloid solution is used as a part of priming fluid to reduce the drop in colloid oncotic pressure due to dilution after initiating cardiopulmonary bypass. Hydroxyethyl starches (HES) priming solution is harmful in critically ill patients. Gelatin is increasingly being used as the preferred colloid for volume resuscitation in intensive care as well as in elective surgical patients. The safety profile of gelatin solutions is yet to be established in different clinical situations. Ghijselings *et al.* investigated the adverse effects of gelatin colloids as a priming solution for cardiopulmonary bypass versus HES or crystalloids in a systematic review and meta-analysis.

The researchers searched medical databases, such as MEDLINE (Pubmed), Embase, and CENTRAL, to identify studies comparing the two in patients undergoing cardiac surgery. Only randomized controlled trials comparing cardiopulmonary bypass (CPB)-priming with gelatin with either crystalloids or HES solutions of the newest generation were included.

The following parameters were assessed:

- Primary endpoint: Blood loss during the first 24 hours
- Secondary outcomes: Perioperative transfusion requirements, postoperative kidney function, post-operative ventilation times, and length of stay in the intensive care unit (ICU)

Of the 16 studies identified, only 10 met the inclusion criteria — four studies compared gelatin with crystalloid and six compared gelatin with HES priming. These studies consisted of 824 adult patients. Two of the studies compared HES and gelatin and reported postoperative blood loss after 24 hours. There was no significant difference in postoperative blood loss between the gelatin and HES groups when results of both studies were pooled. Similarly, a pooled analysis of three studies comparing gelatin and crystalloids did not show significant differences in postoperative bleeding after 24 hours. In addition, there were no differences in any of the secondary outcomes.

Two studies comparing gelatin with HES reported postoperative creatinine serum levels 14 and 20 hours after ICU admission, respectively; one study included the estimated glomerular filtration rate (eGFR) in the outcome reporting. There was no statistical difference in post-operative creatinine serum levels. The eGFR deteriorated temporarily on days 1, 2, and 4 postoperatively, but it improved similarly 4 weeks later in both groups. One study comparing gelatin and crystalloids measured levels of serum creatinine and urea at 24 hours. The levels of urea, but not of creatinine, were significantly higher in the gelatin group than in the crystalloid group at 24 hours postoperatively.

The researchers concluded that gelatin solution has a safety profile noninferior to modern-generation tetrastarches or crystalloids. However, the grade of evidence was rated low because of the poor methodological quality of the included studies, inconsistent outcome reporting, and a lack of uniform endpoint definitions.

Source: Ghijselings I, Himpe D, Rex S. Safety of gelatin solutions for the priming of cardiopulmonary bypass in cardiac surgery: A systematic review and meta-analysis. *Perfusion.* 2016:1–13.

SELF ASSESSMENT

SECTION 5

1. Cardiopulmonary bypass is associated with an intense inflammatory response because of:

a. Conversion to laminar flow ☐
b. Blood contact with the artificial bypass surface ☐
c. Cold cardiac ischemia ☐
d. Hypothermia ☐
e. All of the above ☐

2. Cardiopulmonary bypass is a reason for aspirin resistance after coronary artery bypass grafting.

a. True ☐
b. False ☐

3. Cardiogenic shock is defined as:

a. A systolic blood pressure of less than 90 mmHg for at least 30 minutes, which is secondary to myocardial dysfunction ☐
b. Altered mental status ☐
c. Blood pressure more than 120 mmHg for more than 30 minutes ☐
d. Severe myocardial ischemia for a prolonged period ☐

4. Which one of the following effects is not an effect of cardiopulmonary bypass on the endocrine system?

a. Increase in epinephrine ☐
b. Increase in vasopressin ☐
c. Lowered levels of T3 and T4 ☐
d. Transient endotoxemia ☐

5. A common complication after coronary artery bypass grafting is _____.

a. Basal lung collapse ☐
b. Blood loss of approximately 250 mL in the first hour after surgery ☐
c. Atrial arrhythmias ☐
d. New Q waves on electrocardiogram ☐
e. Diffuse cerebral injury resulting in an alteration in short-term memory ☐

6. In cardiopulmonary bypass:

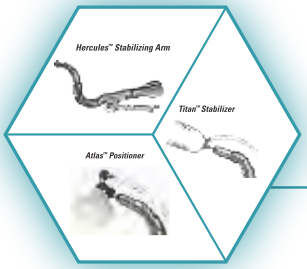
a. The optimal perfusion pressure is 120 mmHg ☐
b. Venous cannulation is normally into the inferior vena cava for closed procedures ☐
c. The arterial cannula is usually inserted in the descending aorta ☐
d. The femoral artery is a recognized site for inserting the arterial cannula ☐

Answers: 1–e; 2–a; 3–a; 4–d; 5–c; 6–b.

Contributing to Society through Healthcare

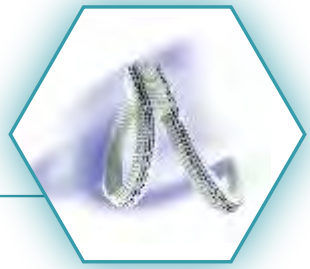
Terumo® Advanced Perfusion System 1
The Heart Lung Machine

CAPIOX® Series
Hollow Fibre Oxygenator



Beating Heart Portfolio
Cardiac Stabilizer

VASCUTEK™ Range of Grafts
Vascular Graft



96 years of relentless efforts in the field of Cardiovasular Surgery

TIPL-014-06-PRI Date of preparation: May 2017

For the use of a registered medical practitioner or a hospital or a laboratory only

Developed and Designed by
InSignia Sign of Distinction

For further information, please contact
Terumo India Private Limited
1601 & 1602 Tower B, 16th floor, Unitech Cyber Park, Sector 39, Gurgaon, Haryana - 122001, India.

TERUMO

Disclaimer: This material is provided by Terumo as a professional service to the medical community. Information related to any product(s) may not be consistent with the instruction for use (IFU). Please read the full instruction for use (IFU) for approved information on any products discussed in this publication and before patient usage.