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- Cardiopulmonary Bypass
- Cardiac Surgery
- Cardiac Anaesthesia
- ECMO (Extra Corporeal Membrane Oxygenation)
- ECLS (Extra Corporeal Life Support)
- Mechanical Assist Devices
- Fluid Dynamics
- Blood Management
- Coagulation

IJECT also publishes a selection of editorial comments, review articles, case reports, innovations, technical challenges, invited commentary and letter to editor. This Annual journal is intended, in its publications, to stimulate innovative ideas and foster practical application from the evidence based practice and research findings.

Aim & Scope
The aim and scope of the journal is to provide an academic medium and an important reference for the advancement & dissemination of research results that support high-level learning, teaching and research in the fields of extra corporeal technology including cardiopulmonary bypass, extra corporeal life support. Original theoretical work and application-based studies, which contributes to a better understanding of extra corporeal technological challenges, are encouraged.

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“The sky is NOT the limit”

I firmly believe that the sky is not the limit, it’s our vision that limits. With this note, I would like to introduce this issue of the Indian Journal of Extra Corporeal Technology which marks the end of my tenure as editor of this journal. It has been a challenging and remarkable experience, one of the highlights of my career. Foremost, I would like to thank the almighty without his permission no one can be able to do anything.

Knowing nothing about being an editor, I was going to graciously decline, but the enthusiastic encouragement I received from Dr. Ajeet Bana - Chairman Cardiac Sciences, Eternal Hospital Jaipur, who have been a tremendous mentor for me. He endlessly encourages and inspires me saying sheer perseverance is the one true determining factor in startup success. His support of my efforts was critical during early period of my editorship. There are others who have played pivotal roles in this journey too namely all my reviewers.

Lastly I should thank all our submitting authors, who have toiled in the production of their work, and have chosen IJECT as the journal they would like to publish in.

I am confident that this issue and future issues of the journal will continue to provide important and clinically relevant information that can be used by entire perfusion fraternity to effectively give back to the society, not confined to cardiovascular patients rather to other specialties too.

The exciting journey that has been an important part of my life will continue on.

Happy Reading!!

Mukta Tiwari
Editor - IJECT
MESSAGE

Dear Colleagues,

I take great pleasure in inviting you to the 19th Annual Conference of ISECT from 22-23rd February, 2019.

The Program will provide amazing educational opportunities for Perfusionists interested in expanding their skills and academic thought process.

A Faculty of Speakers from the World's best will be present to help us update our knowledge.

A brief ground report on the progress made in respect of status of recognition of Clinical Perfusion Profession and its inclusion the pending bill to be placed before the Parliament under Allied Health Science subject or Statutory Regularization/Registration of Perfusion Profession.

With reference to our repeated requests in which we have mentioned to add guidelines for Perfusion Program in India under Allied Health Professions Bill 2017. Recently I have met with Director and Additional Secretary Allied Health Services along with our previous requests made through letters. According to the Director Allied Health Services, they have already initiated the process and still working on it. Their work is delayed because of some professional bodies have approached the Courts and have filed case against Health Ministry. According to the Ministry Officials such interference from Courts would harm and cause delay in processing the files for final placement before the Central Cabinet approval, before introducing the bill before the Parliament.

The Ministry of Health and Family Welfare Officials are trying their best to place bill in Parliament for approval either on next or next to next session of Parliament.

I wish to thank one and all of you for your kind cooperation during my tenure as President of ISECT. I pledge and assure to extend all my support the forth coming Cabinet of ISECT, which is likely to be elected during the forth-coming -National Conference with all of your co-operation.

I wish the conference "ISECT CON 2019" at Chennai a great success.

Dr Kamla Rana
President - ISECT
MESSAGE

Dear Colleagues

Best wishes of new year

I am happy to meet you all through “Indian Journal Of Extra Corporeal Technology” (IJECT). This is the third Journal coming out in this tenure of 2016-2019. Thanks to our Editor Dr. Mukta Tiwari & Editorial board doing excellent job and also to our perfusionists who send articles, papers, advertise etc. My humble request to all perfusionists that please collect research papers, articles for our IJECT and send to our Editor for publications. All paper presenters in ISECTCON should also send manuscript along with abstract for publications in IJECT.

Our website moderator Mr. Naveen developed our website www.isect.org to be a resource that will be used by everyone, ranging from the ISECT life members to students. Our website is the common place for all activities and we are hosting all our future conferences in annual meeting page since ISECTCON2018. Mr. Naveen uploaded so many new webpage and informative materials for perfusionists. My humble request every ISECT life members to login to the website and update their profile. Updating ISECT life member profile in our website with login ID and password will help in better communication.

On behalf of our colleagues and Indian Society of Extra Corporeal Technology (ISECT) we extend a warm invitation to the 2019 Annual Scientific Meeting i.e. ISECTCON2019 Chennai held this year in Chennai from 22"to 23"February 2019, which includes prompt keynote presentations, Oral talks, Poster presentations and Exhibitions.

Our aim is to aggregate researchers, academicians and scientists from the perfusionists community and create an avenue towards robust exchange of information on technological advances, new scientific achievements and the effectiveness of various regulatory programs towards perfusion. Bringing together the professors, researchers and students in all areas of cardiac surgery and to provide an international forum for the dissemination of original research results, new ideas and practical development experiences which concentrate on both theory and practices.

The focus of this year’s meeting is set firmly on the exciting and challenging future ahead for our specialty. The main focus this year is number of teaching hospitals and universities (both government and private) are offering Perfusion Training Programs but without any set standards on eligibility, number of seats, facilities, quality of teaching etc. There is also a mismatch between supply and demand. Hence it was resolved that a set of guidelines for Perfusion Training should be sent to all those institutions offering Perfusion Training Programs
with a request that minimum standards should be met. Life Members were cautioned not to take up teaching assignments in such institutes which do not maintain quality.

As the completion of 2016-2019 tenure of ISECT executive committee, we reflect on the changes bought about since we took office in February 2016. The goals that we set out in this tenure to accomplished were focused on Transparency and accountability in the operations and transactions of the ISECT.

ISECT audit report started giving to ISECT office bearers, ISECT EC members and all the life members before ECM / AGBM meeting well in advance. ISECT started Prime Academy Programme with the help of Terumo India Private Limited to keep our perfusionists updated with advances in cardiopulmonary bypass. Work on digitalization of our ISECT documents started, prepared guidelines for annual conferences i.e. ISECTCON, formulated rules and regulation for Life Time Achievement Award. Apart from routine secretarial work, all the applications for life membership were scrutinized thoroughly before accepting them and placed it before the AGBM for their approval. Every year renewal of ISECT registration with the registrar’s office in Chennai and Mr. Kuppuswamyand Mr. Surender Chennai are entrusted with this work.

I am always in constant touch with the ISECT office bearers, ISECT EC members and all life members to streamline the functioning of ISECT, always in contact with ISECT website moderator and editor IJECT to help them in their work. I extend my thanksto all ISECT office bearers, executive committee members and life members regarding their active participation in day-to-day activities of ISECT. I put in all efforts to the best of my ability to served ISECT in a responsible way transparently with due accountability.

Now on completion of 2106-2019 tenure of ISECT office bearers and executive committee members, there will bean ISECT election for 2019-2022 during ISECTCON2019 Chennai. My humble request to all ISECT life members to elect those candidates who is trustworthy, honest and faithful to ISECT and don't elect those candidates who is ISECT’s defaulter, involved in corruption, didn't believe in discipline………

My request to ISECT lifemembers that please remain present in large numbers and cast your vote for ISECT office bearers and Executive committee members for the tenure of 2019-2022.

Chennai or Madras as it was called before, on the Coromandel Coast, is the capital city of Tamil Nadu. It is a major industrial, commercial, cultural, economic and educational centreof the Southern India. Chennai City is known as the “Detroit of India” because many automobile industries are located here. A Legend also says, this city was first named Chennai in honour of Damal Chennappa Nayakkar. In 1996, then ruling Government of Madras, renamed it as Chennai and it stands good till date.

Beautiful Beaches, one day leisure outlets, modern sea port and airport, long and beautiful highways, convenient multi-transport system, Theme parks, industrial cities, Hi -Tech software silicon valley parks, sophisticated multi speciality hospitals, world class universities, high rise business and residential complexes are the present days outlook of the great Chennai. Top ten places for tourist interests are Mamallapuram, Arignar Anna Zoological park, Muttukadu Lake, Marina Beach, Elliot's Beach, Gundy National Park, Snake Park, Vedanthangal Bird Sanctuary, Birla Planaturium, Government Museum…..

We look forward to seeing you at the ISECTCON2019 Chennai……

Mr. Chhipa Usmangani Y.
General Secretary ISECT
MESSAGE

I feel great pride and enthusiasm to invite you go through this last issue of Indian Journal of Extra Corporeal Technology (IJECT), for the tenure 2016-2019. I would like to thank our editor Dr. Mukta Tiwari along with the editorial board and reviewers for the sincere efforts and outstanding results.

An enormous amount of work has been done to the development of this journal and I believe you will appreciate the effort reflected in this edition and in the impact it will have on the field.

As we look at IJECT, it is important to keep in mind that it represents the collective thinking of entire perfusion society and we want IJECT to be an academic platform of ISECT.

Transformation and change. These words cause uneasiness. Our endeavor will be no different. As we dare to be a new kind of scholarly journal, questions will arise about our work/efforts. We are prepared to answer those questions. Be assured IJECT, like all quality scientific journals, uses blind peer review with vigorous evaluation criteria fully vetted through an editorial board. As you examine the board’s makeup you will see a remarkable breadth of disciplines, experiences, and backgrounds. Without the guidance, support, and feedback of the board, its editing and publishing has made this issue a reality.

I hope many delegates across the country and overseas will come to ISECTCON 2019 at Chennai and make it a grand success.

With best wishes and warm regards

Thanks,

Dr. Vishvanath Sharma
Vice President, ISECT
President, Rajasthan Society of Extra Corporeal Technology
Chief Minister Distress Relief Fund Cheque from Indian Society of Extra Corporeal Technology (ISECT) is handed over to the Chief Minister of Kerala Mr. Pinarayi Vijayan by Mr. Subhash & Mr. Venugopal on behalf of ISECT.
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outbreaks of influenza viral strains with accompanying incidents of patients suffering from Acute Respiratory Distress Syndrome (ARDS), contributed as a major factor in the resurgence of VV ECMO (4).

The indications for use of VV ECMO (6) are listed as follows and are not limited to:

1. **Acute Respiratory Distress Syndrome (ARDS):**
   - Severe Hypoxemia (PaO2 <80mmHg with FiO2 on ventilator >80% for more than 2 hours)
   - Uncompensated Hypercapnia (PaCO2 >50mmHg despite aggressive ventilation strategies)

2. **Severe Pneumonia**
3. **Respiratory failure secondary to pathogenic infections (H1N1, Coronavirus, etc)**
4. **Meconium Aspiration Syndrome (Infants)**
5. **Hyaline Membrane Disease (Infants)**

Among the contraindications for use of VV ECMO (6) include:

1. **Uncontrolled coagulopathy (general contraindication)**
2. **End Organ Failure (general contraindication)**
3. **Severe Pulmonary Artery Hypertension**
4. **High Positive Pressure Ventilation > 7 days**

**VV ECMO circuit**

The ECMO circuit for VV ECMO includes a membrane oxygenator, Blood pump, tubing circuit, drainage and return cannulas. Drainage cannulas are inserted on to the femoral vein (right or left), while the
A return cannula is placed in the right internal jugular vein. A double lumen cannula (AVALON, TANDEM LIFE cannulas) has the drainage section placed in the RA IVC junction with the return cannula section placed in the RA orienting towards the tricuspid valve.

The membrane oxygenator is composed of Poly-Methyl-Pentene (PMP), designed for optimal oxygenation/CO2 removal and prolonged use, principle of gas transfer being diffusion.

The blood pump used is a centrifugal pump which employs centrifugal force derived by spinning magnets against a motor base, magnetic in nature and responsible for generating the drive force. The output of these pumps is dependent on preload (venous volume) and sensitive to modulations of afterload (vascular resistance).

The circuit tubing is made of Poly Vinyl Chloride (PVC, DEPH Di-ethylhexyl phthalate free) designed to withstand high shear stress resulting from blood flow. Most of these circuits are internally treated with physiological coating, generally involving heparin, designed to minimize platelet aggregation and subsequent circuit thrombosis.

The challenges faced can be broadly split in two categories:

1. General challenges for patients on ECMO
2. Specific challenges for patients on VV ECMO

General challenges for patients on ECMO - Among the general challenges faced during the management of patients on ECMO include the following:

1. Balancing anti-coagulation on ECMO - This is often the most common challenge faced. Balancing the degree of anti-coagulation to maintain a fine line between preserving circuit patency and minimizing bleeding requires an exceptionally precise monitoring of anticoagulation and related drug administration protocols. While unfractionated heparin (UNFH) is the most common anticoagulant used, alternatives like Direct Thrombin Inhibitors like bivalirudin and argatroban are used in cases of Heparin Induced Thrombocytopenia (HIT). (6), (7)

The monitoring of anticoagulation on ECMO is carried out using an array of tests like Activated Clotting Time (ACT), Thromboelastography (TEG) (9), Activated Partial Thromboplastin Time (APTT). While ACT is the most commonly used method, it has its own fallacies; it is affected by conditions like Anemia, hyperfibrinogenemia, thrombocytopenia, etc. It is also affected by hemodilution and hypothermia. Hence there is a need for other monitoring tests in conjunction with ACT to provide sufficient anticoagulation levels on ECMO. Thromboelastography (TEG), Thromboelastometry (ROTEM), which measures the efficacy of the coagulation cascade, right from fibrin formation to clot lysis can provide with vital information about the type of blood product required to be administered. (5), (9)

The monitoring of anticoagulation on ECMO is carried out using an array of tests like Activated Clotting Time (ACT), Thromboelastography (TEG) (9), Activated Partial Thromboplastin Time (APTT). While ACT is the most commonly used method, it has its own fallacies; it is affected by conditions like Anemia, hyperfibrinogenemia, thrombocytopenia, etc. It is also affected by hemodilution and hypothermia. Hence there is a need for other monitoring tests in conjunction with ACT to provide sufficient anticoagulation levels on ECMO. Thromboelastography (TEG), Thromboelastometry (ROTEM), which measures the efficacy of the coagulation cascade, right from fibrin formation to clot lysis can provide with vital information about the type of blood product required to be administered. (5), (9)

Of particular interest is the use of Activated Partial Thromboplastin Time (APTT) - a plasma based test that
uses an activator to measure time to fibrin formation in the absence of cellular components. Recent and evolving literature point out to increasing use of APTT in Extra Corporeal Life Support (ECLS) to manage and monitor Anticoagulant dosage, even in pediatric ECLS, with better co-relation to UNFH doses compared to ACT. APTT values and APTT ratio are finding increasing application in the management of Anti coagulation on ECMO (5).

Bleeding on ECMO is an undesirable event. It can interfere with patient care and management of parameters on ECMO. The standard approach is to administer blood products in case of critical events. While no clear guidelines are established as to the threshold for transfusion, most ECLS units try to maintain near normal haemoglobin levels on ECMO. FFP, cryoprecipitate and platelets are administered according to required interpreted by APTT, INR and TEG/ROTEM values. Standard drug therapy for bleeding include administration of antifibrinolytic drugs like Tranexamic Acid (9),(10).

1. Management of perfusion parameters – The basic aim of ECLS is to provide stable circulatory output to maintain oxygen supply and tissue perfusion reducing cardio-pulmonary workload while allowing recovery of native cardio-pulmonary function. Monitoring patient parameters which are indices of adequacy of perfusion contributes to increased efficacy of management and necessary intervention. Periodic blood gases, Monitoring of ECMO pump and oxygenator parameters, preferably real time monitoring, all contribute to maintain status quo and enhance effectiveness of intervention in case of a potentially adverse event.

2. Monitoring patency of ECMO circuit/Intervention for adverse events – Maintaining circuit patency is the most important factor towards rendering a successful outcome in ECMO. The ECMO circuit needs to be checked from “tip to tip” for any possible thrombus, stasis, or flow abnormality. The oxygenator needs to be monitored for efficacy of gas exchange and visually inspected. Some lab parameters are indicators of oxygenator function. Of particular interest is the factor D-Dimer test. Evidence indicates increasing levels of D-Dimer to be predictive of oxygenator dysfunction and in conjunction with increasing trans-membrane pressures are strongly indicative of the need to replace the oxygenator (8).

Specific challenges to veno-venous ECMO - Veno-venous ECMO poses it’s own challenges. One of the major challenges before the ECMO team is the prevention/minimizing of hypoxemia. Hypoxemia is known to occur because of the following phenomena, some of which are technically associated with ECMO and some of which are physiological. The phenomena are as follows-

Circuit Re-circulation

Recirculation of blood in the ECMO blood occurs when the drainage and return cannulas are placed close to each other, such that only a small fraction of oxygenated blood reaches the pulmonary circulation, limiting the benefits derived from the procedure. The phenomenon of re-circulation occurs more frequently when VV ECMO is performed using bilateral femoral venous cannulation (6), (11).

Recirculation should be suspected when the blood gas samples from Drainage and inflow show comparably similar readings in PO2 with patient PO2 samples being consistently low. Location of the cannulas can be verified by X-ray images confirming the same. Recirculation ratio can be calculated using the formula

\[
\text{Re-circ ratio} = \frac{(\text{SatdO2} - \text{ScvO2}) \times 100}{(\text{SatrO2} - \text{ScvO2})}
\]

Where SatdO2 – Oxygen Saturation at Drainage Cannula
SatrO2 – Oxygen Saturation at Return Cannula
ScvO2 – Oxygen Saturation at Superior Vena Cava

A re-circulation ratio between 25 to 30% is considered to be acceptable (6). Remedial measures to minimize re-circulation include re-positioning the cannulas and re-checking saturations. Changing cannula position from bilateral femoral venous to femoro-internal jugular venous configuration. Anatomical landmarks to indicate cannula position include umbilicus for drainage cannula and nipple for return cannula. Furthermore the use of Trans-Oesophageal Echocardiography (TOE/TEE) can help confirm the internal placement of cannulas, thereby effectively minimizing re-circulation (6), (11).

Pulmonary shunting

Pulmonary shunting is an unavoidable feature of VV ECMO (6),(12). It is one of the factors negatively influencing oxygenation efficiency. The primary causes
include changes in pathophysiology following the onset of ARDS namely alveolar fluid filling causing the alveoli to remain unventilated even while being perfused. The percentage of pulmonary shunting can be calculated by the following formula:

\[
Pulmonary \ Shunt\% = \frac{(CcO_2 - CvO_2)}{(CcO_2 - CaO_2)} \times 100\%
\]

Where:
- \(CcO_2\) = Capillary Oxygen Content
- \(CaO_2\) = Arterial Oxygen Content
- \(CvO_2\) = Venous Oxygen Content

Formula to calculate Oxygen Content:
- \(CaO_2\) (mL O2 / 100 mL blood) = 1.36 X Hb X Arterial SatO2 + 0.0031 X PaO2
- \(CvO_2\) (mL O2 / 100 mL blood) = 1.36 X Hb X ScvO2 + 0.0031 X PvO2
- \(CcO_2\) (mL O2 / 100 mL blood) = 1.366 X Hb X (Ventilator FiO2 X 690).

(Values in mL O2/100 mL blood)

Strategies to reduce pulmonary shunting include the use of Positive End Expiratory Pressure (PEEP) to decrease the alveolar collapse. Another strategy is to minimize metabolism using mild hypothermia and/or reduce the dosage of inotropic drugs (6),(7)

Low ECMO flow ratio to cardiac output

Native cardiac output also plays a decisive role in determining the outcome of ECMO. ECMO flow ratio should be commensurate to cardiac output. The ratio of ECMO blood flow to cardiac output serves as an important indicator of prognosis of ECMO. A flow ratio greater than 0.6 is considered as optimal. (6)

Strategies to lower cardiac output include – Use of neuromuscular blocking agents, beta blockers and hypothermia which contributes to lowering cardiac output thereby effecting a favourable ratio. (6),(7)

Oxygenator dysfunction

Oxygenator dysfunction is one of the most common causes of hypoxemia on ECMO. Causes include microthrombi on the oxygenator surface due to aggregation of formed elements, as a result of prolonged extracorporeal circulation. Indicators of Oxygenator dysfunction include increasing transmembrane pressures. Another factor predictive of oxygenator dysfunction is the factor D-Dimer test. A rising D-Dimer level is strongly predictive of oxygenator dysfunction. Decreasing PO2 in spite of increasing sweep gas and FiO2 is strongly indicative of the need to replace the oxygenator. Oxygenator change-out is the only recommended solution. (6) (8)

A recommended set of steps for a better outcome:
- Hct around 40%
- Low driving pressure (10 cm H2O)
- Resp Rate: 10/min
- PEEP = 10-15 mmHg
- FiO2 around 30%
- Recirc ratio 25-30%
- ECMO blood flow to cardiac output ratio > 0.6

While these are not strict guidelines, these will ensure a favorable outcome for patients on VV ECMO.

Conclusion

While VV ECMO poses its unique challenges, a dedicated approach to identifying the reason for a particular clinical condition, an evidence based strategy to incorporate a particular strategy and follow up on existing line of therapy will prove to be game changers in ensuring a favourable outcome.

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Femoral limb Ischemia and cerebral monitoring during VA ECMO

Vishwanath Belavi
KLE's Hospital and MRC, Nehru Nagar Belagavi, Karnataka

Abstract

Introduction: Extracorporeal Membrane Oxygenation also commonly referred to as ECMO, is a form of extracorporeal life support by a modified heart-lung machine that is potentially lifesaving in patients with cardio-respiratory failure. Its use was first described by Hill et al. in 1972, in the treatment of a young man with acute respiratory distress syndrome (ARDS) after a motor vehicle accident, and has since been increasingly used to temporarily support patients with cardiac, respiratory or combined cardio-respiratory failure for a period of days to weeks.

Traditionally the use of this form of support was reserved primarily for the pediatric population, especially in the treatment of neonatal respiratory failure, but its initial application in adults was limited. Early trials in adults were disappointing, with poor outcomes and no survival benefit being reported over conventional treatment. However, with advancements in mechanical cardio-respiratory technology, such as the development and use of new and improved centrifugal pumps and oxygenators, and increasing center experience in the management of these patients, outcomes for adults that are placed on this form of support are improving, and the use of ECMO in this population is increasing. Percutaneous femoral Veno-arterial (VA) or jugular Veno-venous (VV) ECMO can result in delivery of hypoxic blood to the brain, coronaries and upper extremities. Additionally, VA-ECMO by percutaneous femoral artery cannulation may compromise perfusion to the lower limbs. Use of Near-Infrared Spectroscopy (NIRS) detects regional ischemia and warns of impending hypoxic damage. We report the first known series with standardized monitoring of this parameter in adults on ECMO.

Methods & Results

Twenty patients were analyzed (Median age: 47.5 years), 17 patients were placed on VA-ECMO, and 3 patients on VV-ECMO. The median duration on ECMO was 7 days (Range 2 -26). 100% of patients had a significant drop in bilateral cerebral oximetry tracings resulting in hemodynamic interventions, which involved increasing pressure, oxygenation and/or ECMO flow. In 16 (80%) patients, interventions corrected the underlying ischemia. 4 (20%) patients required further diagnostic intervention for persistent decreased bilateral and/or unilateral cerebral oximetry tracings, and were found to have a cerebrovascular accident (CVA). Six (30%) patients had persistent unilateral lower limb oximetry events, which resolved upon placement or replacement of a distal perfusion cannula. No patient was found to have either lower limb ischemia or a CVA with normal NIRS tracings.

Conclusion: Use of NIRS with ECMO is important in detecting ischemic peripheral vascular and cerebral events. This allows for potential correction of the underlying process, thus preventing permanent ischemic damage.

Keywords: Extracorporeal Membrane Oxygenation, Near-Infrared Spectroscopy, Ischemia, lower limb Cerebral Oximetry.
**Introduction**

Extracorporeal Membrane Oxygenation also commonly referred to as ECMO, is a form of extracorporeal life support by a modified heart-lung machine that is potentially lifesaving inpatients with cardio-respiratory failure. Its use was first described by Hill et al. in 1972, in the treatment of a young man with acute respiratory distress syndrome (ARDS) after a motorvehicle accident, and has since been increasingly used to temporarily support patients withcardiac, respiratory or combined cardio-respiratory failure for a period of days to weeks.

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ECMO can be divided into 2 basic types. Veno-Arterial or VA-ECMO is used to supportboth the heart and lungs. Common indications for VA-ECMO are; failure to wean fromcardiopulmonary bypass (CPB), cardiogenic shock secondary to multiple etiologies as a bridge to device or transplant for stabilization and/or recovery of end organs, etc. Veno-Venous or VV-ECMO is used for lung support alone and is used primarily in patients with potentially reversible respiratory failure, such as ARDS, that is refractory to conventional management. It is important to note that the successful use of ECMO is determined not only by technical factors related to circuit design or clinician experience, but also on the various monitoring systems that are employed by clinicians to evaluate the critically ill patient.

Near-Infrared Spectroscopy (NIRS) is one such monitoring system. It employs the use of near infrared wavelengths emitted by sensor pads to evaluate regional oxygenation of the organ or tissue being monitored. The difference in absorption of these wavelengths by oxygenated and deoxygenated hemoglobin is calculated, providing the clinician with information regarding the regional oxygen saturation (rSO2) of the perfused tissue.

**Materials & Methods**

Patient demographics, indications for ECMO, duration on ECMO, occurrence of cerebral or extremity events, and neurologic or lower limb complications were analyzed and reported. Neurological injury was defined as the occurrence of a hemorrhagic and/or ischemic infarct and/or diffuse axonal brain injury, that was confirmed by neuro-imaging (MRI, CT Scan, Nuclear brain perfusion scan, EEG) or in the case of brain death serial exams 24-hours apart by two independent neurologists. Lower limb complications were classified into two categories; “need for fasciotomy” and “loss of limb”.

**VA-ECMO/VV-ECMO Cannulation Method:** All twenty patients were cannulated peripherally via percutaneous insertion of the ECMO cannula using the Seldinger technique.

Femoral cannulation was the preferredplacement in all patients on VA-ECMO. All patients on VV-ECMO were cannulated via the neck into the internal jugular vein using the AvalonTM bicaval dual-lumen cannula. Distal arterial perfusion ports were placed in all patients with peripheral femoral cannulation.

The heart and lung support (HLS) Maquet cannulae (bio-compatible polyurethane) from the patient’s blood vessels were connected to a closed crystalloid primed circuit (~300ml); both cannulae and tubing have heparin coating. The circuitry for ECMO consisted of the Quadrox-D (diffusion membrane hollow-fiber) oxygenator and a Rotaflow centrifugal pump (Maquet Cardiovascular LLC, California) with a heater or cooler exchange.

**NIRS Device:** The INVOSTM cerebral somatic oximeter sensor pads were placed bilaterally on the forehead (Figure 1a) in all patients, and medially on the left and right lower limbs midway between the knee and ankle (Figure 1b) in patients only on VA-ECMO. Sensorpads were replaced every 72 hours, or earlier if indicated. Values that represented the adequacy of tissue oxygenation were calculated by the device and assigned values called “rSO2” (Regional Oxygen Saturation). A 4-channel monitor screen placed at the bedside of every patient, presented a 4 hour view of the cerebral and lower limb tracings (Figure 1c), which allowed the clinician to track the oxygenation of cerebral and distal limb tissues.
over time. Monitoring of this parameter was initiated within minutes upon placement on ECMO, and was discontinued only after a successful wean to recovery, bridge to a ventricular assist device or death. Baseline values were established early in the course of ECMO therapy and rSO2 numbers were compared to the previously established baseline daily. Clinically significant events warranting interventions were defined as below;

1) Drop in rSO2 values below 40.
2) Drop in rSO2 values more than 25% from baseline.

A bilateral drop in cerebral tracings that responded to interventions was termed a “Systemic Event”, a bilateral or unilateral drop in cerebral tracings that was secondary to neurological injury was termed a “Cerebral Event” and a unilateral drop in extremity tracings that required an intervention was termed a “Lower Limb Event”. Tracings were recorded, analyzed and correlated with clinical events.

ECMO Cerebral Oximetry Management: Management protocols for intervention were established at the beginning of the study period for patients who had clinically significant drops in cerebral rSO2 values. All patients who had drops in either bilateral or unilateral cerebral rSO2 values were managed first by ruling out mechanical causes (head position, proper placement of ECMO cannulae, and sensor pad placement). Should mechanical causes be ruled out, our next step in management involved increasing the oxygen and/or blood supply to tissues by increasing ECMO flow, ECMO oxygen supply, mean arterial pressure and ensuring normal hemoglobin levels. If the interventions delineated above did not resolve the low values, patients with persistent low bilateral rSO2 readings were placed on the “Persistent Bilateral Decreased Cerebral Tracing Protocol” (Figure 2a), whereas patients with persistently low unilateral rSO2 readings went directly to neuro-imaging (Figure 2b).

ECMO Lower Limb Oximetry Management: Similar management protocols were established for patients on VA-ECMO with clinically significant drops in lower limb oximetry values. Patients with significant drops in rSO2 values on the side of arterial cannulation were started on the “Decreased Lower Limb Tracing Protocol” (Figure 2c). Interventions invariably led to a restoration of previously established baseline readings or prophylactic fasciotomy to prevent the development of compartment syndrome and subsequent limb loss.

VV-ECMO Oximetry Management: The application of NIRS in patients on VV-ECMO is similar to its use in patients on VA-ECMO. It is used to primarily monitor for neurological injury. However, our unit also relied on NIRS in conjunction with Chest X-Ray’s, Arterial Blood Gas values and Pulse oximetry in guiding our weaning protocol. Patients were weaned off VV-ECMO if all the following criteria were met; NIRS tracings were similar to or > baseline readings, Pulse oximeter readings >85%, Minimal ventilator settings, ECMO FiO2 at 50% or less, and a clear or markedly improved chest x-ray.

Results

During the study period, twenty-three patients were placed on extracorporeal life support via ECMO. A total of twenty patients had cerebral and/or lower limb oximetry monitoring using NIRS technology. Of these twenty, eleven (55%) were male. The median age of our patient population was 47.5 years (Range 17-74) and the median duration on ECMO was 7 days (Range 2 – 26). Seventeen (85%) patients were supported by VA-ECMO and the remaining three (15%) by VV-ECMO. The main and only indication for placement on VV-ECMO was ARDS (3/3, 100%). The two most common indications for initiation of VA-ECMO were; Failure to wean from CPB (4/20, 20%) and Cardiogenic shock secondary to Acute Myocardial Infarction (4/20, 20%). Upon analysis of tracings and correlation with clinical events, it was noted that all twenty (100%) patients on ECMO had a bilateral drop in cerebral tracings. Interventions as outlined above were undertaken to resolve these low readings, which succeeded in sixteen patients(16/20, 80%) An example of this is shown in Figure 3a and Figure 3b. Of the four that did not respond to interventions (Cerebral Event), two patients had persistent bilateral low rSO2 readings, and were eventually sent for neuro-imaging as outlined in the“Persistent Bilateral Decreased Cerebral Tracing Management Protocol”, which confirmed diffuse anoxic brain injury in both patients. Following serial neurological exams 24-hours apart by neurologists, they were declared brain dead. The remaining two patients had persistent unilaterally low rSO2 readings, and were sent directly for neuro-imaging that revealed large unilateral infarcts. These events are summarized in Table 2 and the cerebral tracing graph demonstrating this event is shown in Figure 4.

Of the seventeen patients that were placed on VA-
ECMO, six (6/17, 35%) had a clinically significant drop in unilateral lower limb tracings (Lower Limb Event). Interventions as outlined above in the “Decreased Lower Limb Tracing Protocol” were undertaken, which resolved the low rSO2 readings in all six patients (6/6, 100%). However, four patients (4/6, 67%) required prophylactic distal limb two-compartment fasciotomies against compartment syndrome. There was no loss of limbs in patients peripherally cannulated via the femoral vessels in our study. Figure 5 depicts the development of a “Lower Limb Event” in a patient monitored by NIRS technology. Lastly, no patient with normal cerebral or lower limb tracings was found to have neurological injury or lower limb ischemia.

In the three patients that were placed on VV-ECMO in our study, two were successfully weaned off ECMO using the criteria as mentioned above. NIRS along with other factors guided the weaning of these patients from ECMO and contributed to their successful discharge and overall survival. However, one patient had a large stroke that was detected by cerebral oximetry and due to her poor prognosis care was withdrawn.

Discussion:
The reliability of this device in detecting neurological events has also been well reported in the literature. Samra et al reported a sensitivity of 80% and a specificity of 82.2% in detecting strokes at a NIRS tracing threshold of >20% change from baseline, whereas Ali et al reported a sensitivity of 75% and a specificity of 97.5% at a similar threshold in patients. Unquestion could then be posed as to why NIRS monitoring is beneficial in patients on ECMO? The authors believe that it is so for the following reasons. Firstly, in a peripherally cannulated ECMO patient, oxygenated blood flows in a retrograde fashion, travelling proximally towards the heart. This flow is opposed by potentially poorly oxygenated or deoxygenated blood (dependent on respiratory status) pumped by a still beating, although weakened heart. With high ECMO flow and a low pulse pressure, the mixing oxygenated and poorly oxygenated (or deoxygenated) blood occurs at a level proximal to the bifurcation of the great vessels allowing for the provision of oxygenated blood to the brain and upper extremities (Figure 4a). However, with increasing pulse pressures or increased resistance to ECMO flow, this level of mixing can potentially occur distal to the bifurcation of these vessels rendering these organs susceptible to ischemic damage (Figure 4b). The level at which this mixing occurs can be hard to define with no good technique reported to date. However, the side effects of mixing distal to the great vessels can be evaluated by cerebral oximetry, which potentially prevents the development of permanent ischemic damage to an already vulnerable brain. Secondly, a major complication that can occur in patients supported by ECMO is the development of neurological injury. Studies have shown that neurological complications are greatly underappreciated and occur with relative frequency in ECMO patients.

In our experience, neurological complications occurred in 20% of our patients, which is in accordance with the rates reported in the literature. It emphasizes the importance of having a clinically validated neuro-monitoring system that can detect developing ischemic damage with the hope of potentially reversing it.

Lastly, in VA-ECMO patients with peripheral femoral artery cannulation, distal limb ischemia represents a potentially hazardous complication. This is due to the large cannula size relative to the diameter of the femoral artery that near occludes the vessel with resultant downstream ischemia. In our experience, placement of a distal perfusion cannula into a vessel distal to the site of ECMO cannulation ensures that there is downstream flow and lower limb oximetry (NIRS) monitors the adequacy of that flow. A report of distal limb ischemic complications in ECMO patients observed a complication rate of 21% in patients who did not receive a distal perfusion cannula, and no distal limb complications in patients who had one placed. In our group of 17 patients, distal perfusion cannulae were placed prophylactically but femoral events still occurred that warranted intervention, highlighting the still likely possibility of developing distal limb ischemic damage with a distal perfusion cannula. Clinical assessment of compartment syndrome has always been subjective and unreliable especially in critically ill patients that are incapable of communicating pain or sensation. The only reliable method to diagnose and prevent the development of this syndrome in such situations (manual measurement of compartment pressure) is invasive, which requires the use of hollow bore needles attached to pressure transducers that are inserted into muscle compartments.

Conclusion:
We conclude this report with a reiteration on the
importance of monitoring tissueoxygenation in patients on ECMO, particularly in the brain and distal limb. We have found that NIRS technology is a useful and highly applicable monitoring parameter that not only provides us with important bedside “point of care” information, but also serves as a new “vital sign” that has improved the quality of care and outcomes of critically ill ECMO patients in the surgical cardiac care unit at our institution.

Legends of figures

Figure 1: 1a (top). Left and right INVOSTM cerebral somatic oximeter sensor pads placed on the forehead of the patient 1b (middle). INVOSTM cerebral somatic oximeter sensor pad placed on lower limb(mid calf). 1c (bottom). INVOSTM cerebral somatic oximeter 4-channel monitor screen showing left cerebral regional oxygen saturation, rSO2 = 48, right cerebral rSO2 = 58, left leg = rSO2 69, and right leg = rSO2 47 (bottom).

Figure 2. Compartment syndrome & critical lower limb ischemia should be closely observed during ECMO as it might occur from decreased blood supply & limb hypo-perfusion.

Figure 3. Different parts of distal arterial tree can be used for cannulation sites including CFA, Superficial femoral artery, Posterior tibial artery for retrograde perfusion & dorsalis pedis.

If Ankle pressure < 50mmHg than perfusion catheter will be inserted distal to cannulation site for limb perfusion.

We chose 8.5 fr(13cm) super Arrow flex catheter as distal perfusion as this is kink resistant cannula and the catheter is placed directly into SFA through open seldinger's technique Blood flows through catheter is 250ml/min under 100mmhg pressure because resting blood flow in the Superficial femoral artery of normal resting leg is approx. 150ml/min. Average flow of catheter is 258ml/min as per manufacturer for distal limbs.
Figure 4. A (Top). Baseline tracing of a patient on ECMO (top). BLUE line indicates trend of the right cerebral regional oxygen saturation (rSO2), GRAY line indicates trend of the left cerebral rSO2, ORANGE line indicates trend of the right lower limb rSO2, and GREEN line indicates trend of the left lower limb rSO2.

B (Bottom). Decreased bilateral cerebral and lower limb rSO2 tracings was observed and returned to baseline by blood transfusion.

Figure 5. A cerebral event noted by NIRS. Day 1: Normal bilateral cerebral rSO2 tracings. Day 2: Left cerebral rSO2 tracing drop indicating early perfusion decompensation. Day 4: Further investigation (neuroimaging) of persistently low cerebral rSO2 diagnosed a left middle cerebral artery infarct. Day 5: Subsequent drop in right cerebral RSO2 secondary to severe cerebral edema and loss of bilateral cerebral blood flow.

References
Comparative Analysis Between Two Crystalloid Balanced Electrolyte Priming Solution (plasmalyte-a And Sterofundin Iso) In Adult Patient Undergoing Cardiopulmonary Bypass In The Cardiac Surgery.

Mr. Akhalesh Sureshchand Maurya, Mr. Rajeev Gupta, Mr. Byas Kumar, Dr. Sachin Talwar
Department of Cardiothoracic & Vascular Surgery
All India Institute of Medical Sciences (AIIMS)
Ansari Nagar, New Delhi

ABSTRACT
Objective
The use of optimal prime among repertoire of ideal solution for cardiopulmonary bypass is unsubstantiated. To compare two crystalloid balanced electrolyte solution is being studied to pave the way for improvement in the use or routine priming solution for CPB.

Methodology
Sixty patient of either age adult patients will be randomly divided into two groups A and B. In group A (n=30) priming of the CPB pump circuit will be done with Plasmalyte A. In group B (n=30) priming of the CPB pump circuit will be done with sterofundinISO. All surgeries were conducted by using same surgical, anaesthetic and perfusion techniques. Intraoperative fluid and iconoic shifts were studied.

Result
There was no significant difference in group A & group B. The variables like lactate, blood glucose and pH are showing changes independently over the period of time in which group B is on lower side as these factors are showing adequacy of perfusion during procedure.

Conclusion
In our study we found that both balanced crystalloid solution are better whereas Sterofundin ISO it has advantages over the metabolizable anions, it also suggest that base deficit occured comparatively less in group B (Sterofundin ISO) it also maintained adequate calcium levels on bypass.

Key words
Cardiopulmonary bypass (CPB), Priming solution, Plasmalyte A, Sterofundin ISO.
**Introduction**

Cardiopulmonary bypass (CPB) is a technique of extracorporeal circulation (ECC) that allows surgeons to empty the heart and stop its beat as necessary, to open any desired chamber, and safely carry out the operative procedures. Dr. F. John Lewis performed the first successful open heart operation (closure of atrial septal defect) using general hypothermia and inflow occlusion.

September 2, 1952. The first attempts to use a heart-lung machine for total CPB to permit intracranial surgery in humans were also carried out at the University of Minnesota Hospital by Dennis et al. on April 5, 1951. One successful case by Dr. John H. Gibbon Jr. in 1953, early clinical experience with CPB was discouraging and had unacceptably high mortality rates. The primary purpose of CPB is to facilitate cardiac surgery. CPB is the technique in which a machine takes over the oxygenation and pumping function of the lungs and heart, making open heart surgery possible. In the CPB blood is totally diverted from the heart into a machine with gas exchange capacity and subsequently, blood is returned to the systemic circulation at appropriate pressure and flow rate. Priming fluids are used as priming solution to de-air the circuit of CPB during open heart surgery.

During the early period of open heart surgery (OHS), heart-lungs machine were primed with fresh heparinised homologous blood but the disadvantage and complications associated with blood priming demanded a search for alternative priming solution. Non haemic priming -

Two types of solutions are used for non-haemic priming:
1. Crystalloid solutions
2. Colloid solutions

**Crystalloid Solutions**

The use of crystalloid priming solution is the normal in the present day management of CPB. Balanced salt solutions with or without glucose are common basic priming solutions. The addition of a colloid may be justified in perfusion procedures of long duration to prevent the development of excessive tissue oedema. The crystalloid solutions are of small molecular weight so they can easily diffuse throughout the extracellular space. In general; modern priming solutions are similar in electrolyte content to plasma and have a similar osmolarity. These solutions are simple volume expanding solutions. Various crystalloid solutions commonly used for CPB priming are Ringer's lactate (RL) solution, Dextrose 5% and 5% NaCl, balanced Isotonic Solution Sterofundin ISO, Plasma Lyte A.

**Colloid Solutions**

These are large molecular weight solutions, use as replacement solution for increasing vascular volume and supporting the cardiac output. Solutions used include 5% and 25% albumin, dextran 40% and 70%, 5% plasma protein fraction and 6% hydroxyethyl starch (HES), (voluven) 130/0.4, balanced 6% hydroxyethyl starch (volulyte) 130/0.4.

Few major factors which should be considered for selecting priming solution such as:

**Osmolarity**

The osmotic pressure of the priming solution should be optimally the same as that of plasma such a solution is called isotonic. Priming with an isotonic solution preserves the interstitial intravascular fluid balance as long as solutes are rapidly metabolized.

**Electrolytes**

Normal electrolyte balance must be maintained in order to prevent post CPB electrolyte abnormalities. The concentration of the important electrolytes in the priming fluid should approach normal plasma electrolyte levels.

**Volume**

Volume of the priming solution neither be too high as it causes excessive hemodilution nor too low because at low volume perfusion cannot be conducted safely because of risk of air embolism.

**Hemodilution**

When non-haemic prime is used the formed elements of blood and plasma protein became diluted in proportion to the volume of prime. Priming volume should be sufficient to allow for adequate flow rate. However the volume of prime should not be so great as to decrease the haematocrit to dangerously low levels or overload the patient's vascular system.

**Potassium (K+)**
The major intracellular ion is necessary for the cardiac muscle to perform normal contractions. The intracellular space accounts for 98% of the potassium of the body.

**Sodium (Na⁺)**

It is the major extracellular ion and has many roles in the distribution of the body fluids. The sodium pump keeps sodium out of the cells in order for potassium to stay intracellular.

**Calcium (Ca²⁺)**

It is involved with myocardial contractility, blood clotting, neurotransmission and muscle contraction. Blood calcium is regulated by parathyroid hormone and vitamin D.

**Magnesium (Mg²⁺)**

It is an intracellular ion required for many chemical activities. Magnesium controls transmembrane electrolyte and energy metabolism.

**Chloride (Cl⁻)**

The major extracellular anion, chloride functions mainly to balance the electric charge of the cations. Chloride ions also play a role in the buffering action of the blood by participating in the chloride shift.

<table>
<thead>
<tr>
<th>Comparison of balanced electrolytes composition in Plasmalyte A &amp; SterofundinISO</th>
<th>Concentration (mmol/Lt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SODIUM</td>
<td>140</td>
</tr>
<tr>
<td>POTASSIUM</td>
<td>5</td>
</tr>
<tr>
<td>CHLORIDE</td>
<td>98</td>
</tr>
<tr>
<td>CALCIUM</td>
<td>0</td>
</tr>
<tr>
<td>MAGNESIUM</td>
<td>1.5</td>
</tr>
<tr>
<td>ACETATE</td>
<td>27</td>
</tr>
<tr>
<td>GLUCONATE</td>
<td>23</td>
</tr>
<tr>
<td>MALEATE</td>
<td>0</td>
</tr>
</tbody>
</table>

**Acetate:** The normal plasma acetate concentration is very low and has been reported to range from 0.06 to 0.2 mmol/L.²⁴ Patient undergoing acetate haemodialysis have had plasma acetate levels as high as 6.5 mmol/L.²³²⁴ As acetate is ethanol metabolite, the plasma acetate concentration may increase to 0.8 mmol/L during administration of ethanol.

Two important conclusions can be drawn
1. For every mole of acetate oxidized, one mole of bicarbonate is produced, this is expected effect of acetate for HCO₃⁻ replacement or alkalinization
2. For every two moles of oxygen consumed, only one mole of CO₂ is produced this is surprising side effect in that the respiratory quotient (RQ) for acetate is only 0.5.²⁵ Compared with glucose (dextrose), which has an RQ for 1.0, this means that the metabolism of acetate causes only half the inhaled oxygen to exhaled as CO₂.

**Maleate**

The effect of maleate are less well documented then those of acetate at a patient pH of 7.40, all of maleate is present as divalent anion (maleate) so that for every mole of maleate oxidized, two moles of bicarbonate (HCO₃⁻) are produced.²⁶ The resultant alkalinizing effect is significantly slower than that of acetate which may be quite desirable when using maleate in combination with acetate.

**Gluconate**

Compared with HCO₃⁻, lactate or acetate, the alkalizing effect of gluconate is almost zero therefore it cannot be used as a metabolizable anion.

**Method & Materials**

We had conduct this study to compare the effect of using balanced crystalloid salt solution Plasmalyte A & SterofundinISO) solution for CPB priming in adult patients undergoing various operations with the use of CPB.

**Inclusion Criteria**

This study will be performed on 60 adult of either sex in the range of 25 to 70yrs of age with weight more than 30kg undergoing cardiac surgery with use of cardiopulmonary bypass.

The patients will be randomly divided into two groups A and B.

1. In group A (n=30) priming of the CPB pump circuit will be done with plasmalyte A along with heparin.
2. In group B (n=30) priming of the CPB pump circuit will be done with sterofundinISO in place of...
plasmalyte A.

The two groups A and B will be comparable with regard to age, sex body weight, and approximate CPB time. The surgical and anaesthetic technique, CPB prime volume, haematocrit flow, conduct of bypass method will be similar in both groups.

This study was performed from June 14, 2018 to November 24, 2018. In Five months this study is conducted in respective operation theatres of our centre. The total amount of priming solution per kg of body weight will be kept same for both groups of patient.

Statistical Analysis

Statistical analysis was performed on SPSS (version 11.5) software with t-test and Two-sample Wilcoxon rank-sum (Mann-Whitney) test Continuous variables with normally distributed data were compared with analysis of variance. If there are significant differences between groups, the other comparisons between groups (Group A & B) were performed by the q-test. A p value of less than 0.05 is considered statistically significant. All data are presented as mean ± standard deviation [SD].

Result

The demographic data showed no statistically significant differences regarding age, weight, height bypass time clamp time between the group A (Plasmalyte A) and group B (Sterofundin ISO). The two groups were comparable.

Table 1: Pre-operative Demographic data

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>39.5±15.72</td>
<td>36.63±13.52</td>
<td>0.45</td>
</tr>
<tr>
<td>Sex M</td>
<td>18</td>
<td>20</td>
<td>0.59</td>
</tr>
<tr>
<td>Sex F</td>
<td>12</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Height (cms)</td>
<td>159.7±9.47</td>
<td>158.3±10.25</td>
<td>0.58</td>
</tr>
<tr>
<td>Weight (kgs)</td>
<td>53.45±11.33</td>
<td>55.58±9.34</td>
<td>0.43</td>
</tr>
<tr>
<td>BSA (m²)</td>
<td>1.53±0.19</td>
<td>1.55±0.16</td>
<td>0.61</td>
</tr>
<tr>
<td>Bypass Time (min)</td>
<td>103.5(48-226)</td>
<td>63(27-180)</td>
<td>0.001</td>
</tr>
<tr>
<td>Cross Clamp Time (min)</td>
<td>63(27-180)</td>
<td>43 (22-95)</td>
<td>0.003</td>
</tr>
<tr>
<td>Blood Priming (ml)</td>
<td>350 (100-1200)</td>
<td>400 (50-1000)</td>
<td>0.85</td>
</tr>
<tr>
<td>Volume Removal (ml)</td>
<td>600 (200-900)</td>
<td>600 (100-900)</td>
<td>0.46</td>
</tr>
</tbody>
</table>

* Mean ± Standard Deviation values are taken
# Median (minimum- maximum) values are taken as it was not normally distributed
* p value < 0.05 is considered significant.
* Bypass time and Clamp time is in (min).
* Blood Priming and Volume Removal is in (ml)
* BSA – Body Surface Area
Table 2: Pre-Operative Data Analysis

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Difference</th>
<th>Conf.Interval (95%)</th>
<th>P value *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (mg/dl)</td>
<td>12.36±2.4</td>
<td>12.75±2.24</td>
<td>0.39</td>
<td>(-0.77,1.56)</td>
<td>0.51</td>
</tr>
<tr>
<td>pH</td>
<td>7.40±0.04</td>
<td>7.39±0.04</td>
<td>0.001</td>
<td>(-0.03,0.00)</td>
<td>0.14</td>
</tr>
<tr>
<td>PO₂ (mmHg)</td>
<td>212.13±137.75</td>
<td>213.2±152.21</td>
<td>1.06</td>
<td>(-71.84,73.98)</td>
<td>0.97</td>
</tr>
<tr>
<td>PCO₂ (mmHg)</td>
<td>35.03±6.38</td>
<td>37.4±5.15</td>
<td>2.36</td>
<td>(-0.54,5.27)</td>
<td>0.11</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>21.16±4.66</td>
<td>22.53±1.99</td>
<td>1.36</td>
<td>(-0.43,3.16)</td>
<td>0.13</td>
</tr>
<tr>
<td>BE*</td>
<td>-2.31±2.16</td>
<td>-2.01±1.68</td>
<td>-</td>
<td>-</td>
<td>0.38</td>
</tr>
<tr>
<td>So₂</td>
<td>21.16±4.66</td>
<td>22.53±1.99</td>
<td>1.36</td>
<td>(-0.43,3.16)</td>
<td>0.13</td>
</tr>
<tr>
<td>Osmolarity (mOsm/l)</td>
<td>276.06±24.51</td>
<td>275.63±5.77</td>
<td>-0.43</td>
<td>(-3.31,2.44)</td>
<td>0.76</td>
</tr>
<tr>
<td>Na⁺ (mmol/l)</td>
<td>137.26±2.94</td>
<td>136.16±3.36</td>
<td>-1.1</td>
<td>(-2.68,0.48)</td>
<td>0.17</td>
</tr>
<tr>
<td>K⁺ (mmol/l)</td>
<td>3.55±0.32</td>
<td>3.63±0.38</td>
<td>0.08</td>
<td>(-0.09,0.25)</td>
<td>0.38</td>
</tr>
<tr>
<td>Ca++ (mmol/l)</td>
<td>0.73±0.05</td>
<td>0.87±0.16</td>
<td>0.14</td>
<td>(0.08,0.20)</td>
<td>0.001</td>
</tr>
<tr>
<td>Sugar (mg/dl)</td>
<td>112.40±47.47</td>
<td>113.44±36.36</td>
<td>0.39</td>
<td>(-21.23,22.02)</td>
<td>0.97</td>
</tr>
<tr>
<td>Lactate* (mmol/l)</td>
<td>1.41±0.70</td>
<td>1.35±0.60</td>
<td>-</td>
<td>-</td>
<td>0.38</td>
</tr>
<tr>
<td>Urine (ml)*</td>
<td>107±95.62</td>
<td>124.66±93.03</td>
<td>-</td>
<td>-</td>
<td>0.34</td>
</tr>
<tr>
<td>ACT (sec)</td>
<td>164.46±24.51</td>
<td>156.1±20.92</td>
<td>-8.36</td>
<td>(-19.8,3.06)</td>
<td>0.15</td>
</tr>
</tbody>
</table>

* Mean ± Standard Deviation values are taken for t test for normal distribution.
# mean ± Standard Deviation values taken with difference, 95% Confidential interval taken for abnormal distribution.
*p value is of Group A & Group B*  p value is independent of the group over a period of time
*p value < 0.05 is considered significant.
Table 3: After the clamp (on CPB) Data Analysis

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group A @ P value</th>
<th>Group B</th>
<th>Group B @ P value</th>
<th>Difference</th>
<th>Conf.Interval (95% )</th>
<th>P value *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (mg/dl)</td>
<td>9.36±1.52</td>
<td>0.001</td>
<td>9.56±1.26</td>
<td>0.001</td>
<td>0.19</td>
<td>(-0.5,0.89)</td>
<td>0.58</td>
</tr>
<tr>
<td>pH</td>
<td>7.41±0.06</td>
<td>0.62</td>
<td>7.39±0.04</td>
<td>0.74</td>
<td>-0.01</td>
<td>(-0.04,0.01)</td>
<td>0.20</td>
</tr>
<tr>
<td>PO₂(mmHg)</td>
<td>236.7±36.45</td>
<td>0.33</td>
<td>265.9±64.59</td>
<td>0.11</td>
<td>29.16</td>
<td>(2.84,55.48)</td>
<td>0.03</td>
</tr>
<tr>
<td>PCO₂(mmHg)</td>
<td>38.13±5.63</td>
<td>0.04</td>
<td>35.83±4.82</td>
<td>0.23</td>
<td>0.77</td>
<td>(-1.93,3.33)</td>
<td>0.6</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>23.46±1.73</td>
<td>0.01</td>
<td>23.2±1.58</td>
<td>0.12</td>
<td>-0.26</td>
<td>(-1.1,0.56)</td>
<td>0.53</td>
</tr>
<tr>
<td>BE*</td>
<td>-0.91±2.14</td>
<td>-</td>
<td>-1.23±1.71</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.44</td>
</tr>
<tr>
<td>So₂</td>
<td>0.99±0.00</td>
<td>0.009</td>
<td>0.96±0.16</td>
<td>0.54</td>
<td>-0.02</td>
<td>(-0.08,0.02)</td>
<td>0.32</td>
</tr>
<tr>
<td>Osmolarity (mOsm/l)</td>
<td>274.1±6.41</td>
<td>0.01</td>
<td>274.8±7.04</td>
<td>0.39</td>
<td>0.7</td>
<td>(-2.68,4.08)</td>
<td>0.68</td>
</tr>
<tr>
<td>Na⁺(mmol/l)</td>
<td>135.23±2.89</td>
<td>0.001</td>
<td>136.28±3.91</td>
<td>0.87</td>
<td>1.04</td>
<td>(-0.06,2.77)</td>
<td>0.23</td>
</tr>
<tr>
<td>K⁺ (mmol/l)</td>
<td>4.36±0.57</td>
<td>0.001</td>
<td>4.31±0.59</td>
<td>0.001</td>
<td>-0.04</td>
<td>(-0.33,0.24)</td>
<td>0</td>
</tr>
<tr>
<td>Ca²⁺(mmol/l)</td>
<td>0.77±0.22</td>
<td>0.4</td>
<td>1.15±0.05</td>
<td>0.001</td>
<td>0.38</td>
<td>(0.30,0.46)</td>
<td>0.001</td>
</tr>
<tr>
<td>Sugar (mg/dl)</td>
<td>142.06±41.76</td>
<td>0.001</td>
<td>135.46±28.23</td>
<td>0.001</td>
<td>-7.03</td>
<td>(-25,10.94)</td>
<td>0.44</td>
</tr>
<tr>
<td>Lactate* (mmol/l)</td>
<td>2.23±0.75</td>
<td>-</td>
<td>2.25±0.85</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.87</td>
</tr>
<tr>
<td>Urine (ml)*</td>
<td>200(2-400)</td>
<td>-</td>
<td>100(10-750)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.01</td>
</tr>
<tr>
<td>ACT (sec)</td>
<td>672.1±152.61</td>
<td>0.001</td>
<td>684.56±130.28</td>
<td>0.001</td>
<td>12.46</td>
<td>(-58.72,83.66)</td>
<td>0.73</td>
</tr>
<tr>
<td>Hemofilter volume*</td>
<td>125(50-900)</td>
<td>-</td>
<td>225(100-1300)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.64</td>
</tr>
</tbody>
</table>

* Mean ± Standard Deviation values are taken for t test for normal distribution.
# mean ± Standard Deviation values taken with difference, 95% Confidential interval taken for abnormal distribution.
*p value is of Group A & Group B
@ p value is independent of the group over a period of time
### Table 4: POST CPB (After 2 hours) Data Analysis

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group A P value</th>
<th>Group B</th>
<th>Group B P value</th>
<th>Difference</th>
<th>Conf.Interval (95%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (mg/dl)</td>
<td>11.59±1.29</td>
<td>0.05</td>
<td>11.99±1.77</td>
<td>0.02</td>
<td>0.39</td>
<td>(-0.38,1.17)</td>
<td>0.32</td>
</tr>
<tr>
<td>pH</td>
<td>7.40±0.06</td>
<td>0.58</td>
<td>7.40±0.05</td>
<td>0.13</td>
<td>0</td>
<td>(-0.01,0.03)</td>
<td>0.55</td>
</tr>
<tr>
<td>PO₂ (mmHg)</td>
<td>206.66±64.88</td>
<td>0.82</td>
<td>214.53±68.54</td>
<td>0.96</td>
<td>7.86</td>
<td>(-25.62,41.35)</td>
<td>0.64</td>
</tr>
<tr>
<td>PCO₂ (mmHg)</td>
<td>35.83±5.44</td>
<td>0.57</td>
<td>34.4±5.13</td>
<td>0.03</td>
<td>-1.43</td>
<td>(-4.08,1.22)</td>
<td>0.29</td>
</tr>
<tr>
<td>HCO₃⁻ (mEq/L)</td>
<td>21.83±2.15</td>
<td>0.47</td>
<td>21.63±2.05</td>
<td>0.12</td>
<td>-0.2</td>
<td>(-1.25,0.85)</td>
<td>0.71</td>
</tr>
<tr>
<td>BE*</td>
<td>-2.89±2.48</td>
<td>-</td>
<td>-2.73±1.98</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.71</td>
</tr>
<tr>
<td>So₂</td>
<td>0.99±0.00</td>
<td>0.001</td>
<td>0.99±0.00</td>
<td>0.02</td>
<td>0.001</td>
<td>(-0.00,0)</td>
<td>0.4</td>
</tr>
<tr>
<td>Osmolarity (mOsm/l)</td>
<td>277.26±8.67</td>
<td>0.4</td>
<td>276.6±5.65</td>
<td>0.22</td>
<td>-0.66</td>
<td>(-4.34,3.0)</td>
<td>0.72</td>
</tr>
<tr>
<td>Na⁺ (mEq/L)</td>
<td>140.6±3.52</td>
<td>0.001</td>
<td>140.5±2.83</td>
<td>0.001</td>
<td>-0.06</td>
<td>(-1.67,1.53)</td>
<td>0.93</td>
</tr>
<tr>
<td>K⁺ (mEq/L)</td>
<td>3.52±0.48</td>
<td>0.65</td>
<td>3.74±0.46</td>
<td>0.28</td>
<td>0.21</td>
<td>(-0.02,0.45)</td>
<td>0.07</td>
</tr>
<tr>
<td>Ca²⁺ (mEq/L)</td>
<td>0.73±0.09</td>
<td>0.92</td>
<td>0.96±0.14</td>
<td>0.001</td>
<td>0.22</td>
<td>(0.16,0.28)</td>
<td>0.001</td>
</tr>
<tr>
<td>Sugar (mg/dl)</td>
<td>166.3±38</td>
<td>0.001</td>
<td>179.23±48.54</td>
<td>0.001</td>
<td>12.93</td>
<td>(-8.94,34.8)</td>
<td>0.24</td>
</tr>
<tr>
<td>Lactate* (mEq/L)</td>
<td>4.10±2.78</td>
<td>-</td>
<td>3.07±1.80</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.14</td>
</tr>
<tr>
<td>Urine (ml)*</td>
<td>275(100-800)</td>
<td>-</td>
<td>400(30-1650)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.08</td>
</tr>
<tr>
<td>ACT (sec)</td>
<td>140.1±15.68</td>
<td>0.001</td>
<td>139.33±17.05</td>
<td>0.001</td>
<td>-0.76</td>
<td>(-8.98,7.42)</td>
<td>0.85</td>
</tr>
<tr>
<td>Chest Drainage (ml)*</td>
<td>30(10-550)</td>
<td>-</td>
<td>30(10-500)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.82</td>
</tr>
</tbody>
</table>

* p value < 0.05 is considered significant.

### Table 6: Post-operative observation

The demographic Post-operative data showed no statistically significant differences regarding **Duration of**
### Table 5: POST CPB (24 HOURS) Data Analysis

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group A P value @</th>
<th>Group B</th>
<th>Group B P value @</th>
<th>Difference</th>
<th>Conf.Interval (95%)</th>
<th>P value *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (mg/dl)</td>
<td>11.55±1.24</td>
<td>0.09</td>
<td>11.48±1.25</td>
<td>0.001</td>
<td>-0.06</td>
<td>(-0.69,0.56)</td>
<td>0.83</td>
</tr>
<tr>
<td>pH</td>
<td>7.38±0.03</td>
<td>0.02</td>
<td>7.37±0.03</td>
<td>0.02</td>
<td>-0.01</td>
<td>(-0.02,0.0)</td>
<td>0.24</td>
</tr>
<tr>
<td>PO₃(mmHg)</td>
<td>176.46±68.11</td>
<td>0.23</td>
<td>143.13±54.73</td>
<td>0.17</td>
<td>-33.33</td>
<td>(-64.33,-2.33)</td>
<td>0.03</td>
</tr>
<tr>
<td>PCO₂(mmHg)</td>
<td>39.8±3.46</td>
<td>0.001</td>
<td>39.03±3.46</td>
<td>0.13</td>
<td>-0.76</td>
<td>(-2.5,0.97)</td>
<td>0.38</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>22.33±1.21</td>
<td>0.001</td>
<td>22.96±1.79</td>
<td>0.37</td>
<td>-0.36</td>
<td>(-1.13,0.4)</td>
<td>0.34</td>
</tr>
<tr>
<td>BE*</td>
<td>-1.33±1.67</td>
<td>-</td>
<td>-1.60±1.77</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.40</td>
</tr>
<tr>
<td>SO₂</td>
<td>0.98±0.01</td>
<td>0.06</td>
<td>0.98±0.01</td>
<td>0.39</td>
<td>0.001</td>
<td>(-0.01,0.0)</td>
<td>0.03</td>
</tr>
<tr>
<td>Na⁺(mmol/l)</td>
<td>140.43±4.04</td>
<td>0.001</td>
<td>140.13±4.88</td>
<td>0.001</td>
<td>-0.3</td>
<td>(-2.54,1.94)</td>
<td>0.79</td>
</tr>
<tr>
<td>K⁺ (mmol/l)</td>
<td>3.86±0.35</td>
<td>0.001</td>
<td>3.88±0.53</td>
<td>0.001</td>
<td>0.01</td>
<td>(-0.20,0.24)</td>
<td>0.87</td>
</tr>
<tr>
<td>Ca²⁺(mmol/l)</td>
<td>0.74±0.07</td>
<td>0.51</td>
<td>0.84±0.07</td>
<td>0.25</td>
<td>0.09</td>
<td>(0.06,0.13)</td>
<td>0.001</td>
</tr>
<tr>
<td>Sugar (mg/dl)</td>
<td>143.03±33.74</td>
<td>0.001</td>
<td>142±34.79</td>
<td>0.001</td>
<td>0.15</td>
<td>(-17.38,17.68)</td>
<td>0.98</td>
</tr>
<tr>
<td>Lactate*</td>
<td>1.80±1.04</td>
<td>-</td>
<td>1.48±0.68</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.23</td>
</tr>
<tr>
<td>Urine (ml)*</td>
<td>1312(200-3380)</td>
<td>-</td>
<td>1320(305-3355)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.36</td>
</tr>
<tr>
<td>Chest Drainage (ml)*</td>
<td>120(10-950)</td>
<td>-</td>
<td>2235(50-2730)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Ventilation, addition of Blood during and post-operativeperiod, addition of Platelets, Cryoprecipitate, Fresh frozen Plasma, Intensive care unit stay period between the group A (Plasmalyte A) and group B (Sterofundin ISO). The two groups were comparable.

* P value is of Group A & Group B
* This data is calculated by Two-Sample Wilcoxon rank-sum (mean-Whitney) test, the values written here are Median (minimum-maximum) of independent group.
* p value < 0.05 is considered significant.
Fig 1: Showing variation in value of pH between Group A (Plasmalyte A) & Group B (sternofundin ISO) at different stages

![pH Chart]

Fig 2: Showing variation in value of Osmolarity between Group A (Plasmalyte A) & Group B (sternofundin ISO) at different stages

![Lactate Chart]
Comparative analysis between two crystalloid balanced electrolyte priming solution (Plasmalyte-a and Sterofundin ISO) in adult patient undergoing cardiopulmonary bypass in the cardiac surgery

Fig 3: Showing variation in value of Lactate between Group A (Plasmalyte A) & Group B (Sterofundin ISO) at different stages

Discussion

The studies were very heterogeneous in terms of patient population, amounts and duration of fluid given, timing of fluid in relation to surgery when performed, the type of crystalloid used and the outcomes reported. It was therefore not possible to make any global statement related to effects on mortality or morbidity, including length of stay, need for organ support, haemostasis.

The detailed comparison of the effect of infusion of two 'Isotonic' crystalloid solutions in adult patient has shown that balanced crystalloid solution (Sterofundin ISO and Plasmalyte A containing acetate maleate and gluconate) has the physiological electrolyte pattern of plasma in terms of sodium, potassium, calcium, magnesium and chloride and achieves a physiological acid base balance with bicarbonate or metabolizable anions. Acetate and malate based crystalloid solution metabolized faster. For every mole of acetate or lactate oxidized, one mole of bicarbonate is produced; while for maleate oxidized, 2 moles of bicarbonate are produced respectively. As both acetate and maleate

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of Ventilation (hrs)</td>
<td>8.5 (2-20)</td>
<td>6 (3-24)</td>
<td>0.001</td>
</tr>
<tr>
<td>Addition of Blood</td>
<td>2 (1-4)</td>
<td>2 (1-10)</td>
<td>0.22</td>
</tr>
<tr>
<td>Platelets</td>
<td>2 (1-6)</td>
<td>2 (1-4)</td>
<td>0.54</td>
</tr>
<tr>
<td>Cryo</td>
<td>2 (1-3)</td>
<td>1 (1-1)</td>
<td>0.34</td>
</tr>
<tr>
<td>FFP</td>
<td>2 (1-6)</td>
<td>2 (1-9)</td>
<td>0.5</td>
</tr>
<tr>
<td>ICU stay hours</td>
<td>37 (12-144)</td>
<td>36 (18-72)</td>
<td>0.21</td>
</tr>
</tbody>
</table>
are rapidly metabolized in the liver and muscle, the potential base excess of the solution is 0 mmol/L. This means that, after infusion and metabolism of acetate and maleate, these solution can have no effect on the patient’s acid-base balance and therefore, will cause neither acidosis nor alkalosis.

Postoperatively in the ICU however because, intravenous fluid and further management was not a part of the study so, the difference in sodium bicarbonate and calcium use could not be commented upon.

The aim of the development of balanced crystalloid solution was to combine favourable pharmacokinetics with an improved carrier solution, while avoiding the unnecessary repeated addition of sodium bicarbonate drug, which is produced as the end product of acetate & maleate metabolism. There was no significant statistical difference in the pulmonary alveolar - arterial differences of oxygen (pAO₂-paO₂) between the two groups.

In both the groups pH was higher on group A refer to the (Figure 1) due to addition of soda bicarbonate extra in the circuit. In group B pH was quit low during bypass as minimum value 7.32±0.54 which is even non-significant when both data is calibrated p value is 0.19 even the Base excess is quit higher after two hrs of bypass 2.89±2.48 in group A but at that same time -2.73±1.98 in compare with the p value is coming 0.71 which is not significant.

There is no significant changes observed in haemoglobin the most affected cause of CPB in relationship with hemodilution. it does not occur because almost 600ml (table 1) of crystalloid priming volume is removed from both the groups, average P value is 0.46 which is not significant but it plays important role in hemodilution, more the hemodilution causing more acidosis.

pO₂ & pCO₂ both remain not significant till the patient discharge from ICU, pO₂ was rise significantly when patient put on bypass its common and remain same while going on pump p value 0.03, further it never rises significantly and remains maintained.

As the Na⁺ is same 140 mmol/1 in both the groups there is no significant rise and drop seen throughout the surgery.

The Ca²⁺ it was maintained in group B while in group A it was quite less 1.15±0.05 in group B in group A it was 0.77±0.22 on bypass, as calcium decreases in bypass due to excess of urine output and use of hemofiltration. Calcium value should maintained normal after the cross clamp release to avoid arrhythmias.

The potassium was well maintained in both the groups at each interval of time as P value of potassium remains not significant.

The Blood glucose level is quite high in the Group A (Plasmalyte A) compare to Group B (SterofundinISO) the highest value of sugar after release of cross clamp in group A as 188.5±52.89 whereas in group B 166.9±41.44 which is not significant as p value is 0.07. It takes 24 hours to settle down post CPB.

Hemodynamically Blood pressure & Temperature are remains normal in both the groups as it is not showing any significant difference in the interval.

Urine output in both the groups remains almost same with respect to time interval post CPB after 12 hrs its significantly got decrease in group A is 1476.66±689.22 while in group B it was 1207.5±51.94 the p value of the same is 0.05 after 24 hrs it got settled in both the groups.

Osmolarity of the blood is remain superior in group A rather than group B but not significantly. As p value is 0.72 in post bypass. During bypass its mean remain constant in both the groups.

Chest drainage is almost less in group A in after 24 hrs is 187.5±201.93at that same time in group B it was 481.33±629.66 which is significantly rise p value of the same is 0.01 getting drain in the chest is difficult to move for the patient.

Post operatively after two hrs lactate production were more in group A (Plasmalyte A) that is 4.10±2.78 compare to group B (Sterofundin ISO) which is 3.07±1.80, if the lactate concentration of 8 mmol/L, which are associated with very high mortality (17,18).

Conclusion

Both balanced crystalloids solutions Plasmalyte-A and Acetate and Maleate containing ‘Sterofundin ISO’ are safe to use as a priming solution of CPB circuit without any adverse effects in adult patient. In our study we found that Sterofundin ISO it has advantages over the metabolizable anions, it also suggest that base deicit occurred comparatively less in group B (Sterofundin ISO), the less requirement of Soda bicarbonate and sugar levels remains normal on cardio pulmonary bypass also maintained adequate calcium levels on bypass, less ventilation support and less blood products, less ICU stay compared to Plasmalyte A solution. Due to high cost and unavailability of “Sterofundin ISO” it is not used frequently for priming the CPB circuit. Caution must be taken while priming with Sterofundin in the CPB circuit.
for severe alkalosis patients and the patients having hepatic disease. There is no morbidity in both the group of patients.

**Study Limitation**

This study is not performed in paediatric patients, since they are more sensitive to calcium as group A (Plasmalyte A) does not contain calcium at that same time in group B (Sterofundin ISO) it contains calcium 2.5mmol/L, it may causes problem to arrest the Heart while on CPB, which also leads to post-operative arrhythmias. This study cannot be perform in hepatic failure patients because elimination time of balanced salt is more.

**References**

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Implantable Left Ventricular Assist Device for End Stage Heart Disease
- Our Institutional Experience

Selvakumar Rajamani, P.V.S. Prakash, Sam Immanuel S, Dr. Devi P Shetty, Dr. Julius Punnen, Dr. Varun Shetty
Narayana Hrudayalaya, Bengaluru

Abstract

Background: Patients with end-stage heart failure require support and assistance for their damaged left ventricle. Left ventricular assist devices (LVADs) provides circulatory support and are an alternative to heart transplant for these irreversibly damaged LV. They are initiated as a bridge to transplant or as destination therapy.

Material and Methods: we have a modest experience of 11 patients who were put on implantable LVAD. Their EF was in the range of 15-25%. Our Inclusion Criteria included patients with advanced heart failure symptoms (NYHA Class III or IV), on optimal medical management and are failing to respond or Class IV heart failure and dependent on IABP and/or inotropes, VO2max <=14 ml/kg/min. We have an experience of 4 Ventracore assist LVAD and 7 Heartmate II LVAD implantation cases.

Results: In our experience of 11 patients, 8 patients survived (72.7%). Out of the four Ventracore LVAD one succumbed due to septicemia in the immediate postoperative period. One patient survived for nearly six years and expired at home. One patient required Dorr's repair due to LV wall thinning after few months of implantation hence the VAD was explanted and Dorr was performed. After 10 years one patient underwent successful orthotopic transplantation and explantation of the VAD. Out of the seven Heartmate II patients 5 survived and two succumbed one due to septicemia and another due to septicemia. One patient who belonged to INTERMACS 3 underwent LVAD with park's stitch for Aortic Incompetence and was successfully discharged. One patient INTERMACS 1 required temporary RVAD and succumbed in the postoperative period due to multiorgan dysfunction. We found out that patient who belonged to INTERMACS 3-4 profile had better outcome and the recovery was fast in the postoperative period. Patients who were in the INTERMACS 1-2 had a long post operative stay with lot of co-morbidities.

Conclusion: LVAD support as a bridge-to-transplant or as destination therapy has been shown to improve the survival rate, improved life style of patients who were suffering from end stage heart disease. The role of perfusionist in the Implantable VADs is vital and has opened a new career to pursuit.

Keywords: Left Ventricular assist device, Right ventricular assist device, INTERMACS-Interagency Registry Mechanical Assist Circulatory Support.
Introduction

Heart failure (HF) is one of the leading cause of morbidity and mortality globally. Because of the poor LV function most of these patients suffer from symptoms of end stage heart disease like dyspnea, fatigue and usually have restricted lifestyle in spite of medical support.(1) They are subjected to advanced therapies that include heart transplantation, continuous inotropic therapy with or without temporary mechanical circulatory support. Heart transplantation is the recommended option for advanced HF, but there is huge gap between the availability of organ and the demand. Many patients succumb due to non-availability of heart at the right time. Hence for isolated left heart failure durable VADs have emerged as an alternative treatment option. Till date, over 18,000 continuous flow devices have been implanted worldwide. In the US alone, 131 hospital centers are approved to implant permanent MCS devices, demonstrating the staggering expansion of MCS as a therapeutic option for end-stage HF.(2,3). We have a modest experience of 11 patients who were put on implantable LVAD. We have performed 4 Ventracore assist LVAD and 7 Heartmate II LVAD implantation cases. We would like to share our experience of Durable LVADs in treating end stage heart failure patients.

Inclusion criteria: In our 11 patients whom we operated the age group ranged from 19-68 years (Median=43.5). Our Inclusion Criteria included patients with objective measurements of peak VO2 (oxygen uptake) <14mL/kg/min, a 6-minute walk distance <300 meters, and poor cardiac function, advanced heart failure symptoms (NYHA Class III or IV), on optimal medical management and are failing to respond and dependent on/or IABP and/or inotropes. Our patients EF (Ejection Fraction) were in the range of 15-25% with fair RV function that was assessed by TAPSE, PAPi and PVR. The INTERMACS profiles have been shown to provide prognostic information and guidance for the optimal timing and the associated risk of implantation.(5)It’s better to assess the patient’s prognosis using variables that have been shown to predict outcome, such as findings in history and physical examination (NYHA class, blood pressure, signs of congestions, etc.), laboratory tests (serum sodium, liver enzymes, troponins, etc.), neuro-hormonal activity (Plasma renin activity, Angiotensin II, etc.), and functional (peak VO2) and haemodynamic variables. It is evident that there are different manifesting subsets of advanced HF, which have been described with the INTERMACS profiles, a classification of 7 clinical profiles.(9)

Intermacs Patient Profiles and Timeframe for Initiating Mechanical Circulatory Support

<table>
<thead>
<tr>
<th>Profile</th>
<th>Description</th>
<th>Time To Initiate MCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>“Crashing and burning” - critical cardiogenic shock</td>
<td>Within hours</td>
</tr>
<tr>
<td>2</td>
<td>“Progressive decline” - inotrope dependence with continuing deterioration.</td>
<td>Within a few days</td>
</tr>
<tr>
<td>3</td>
<td>“Stable but inotrope dependent” - describes clinical stability on mild-moderate doses of intravenous inotropes.</td>
<td>Within a few weeks</td>
</tr>
<tr>
<td>4</td>
<td>“Recurrent advanced heart failure” - “recurrent” rather than “refractory” decompensation. “FREQUENT FLYERS”</td>
<td>Within weeks to months</td>
</tr>
<tr>
<td>5</td>
<td>“Exertion intolerant” - describes patients who are comfortable at rest but are exercise intolerant.</td>
<td>Variable</td>
</tr>
<tr>
<td>6</td>
<td>“Exertion limited” – a patient who is able to do some mild activity but fatigue results within a few minutes or any meaningful physical exertion.</td>
<td>Variable</td>
</tr>
<tr>
<td>7</td>
<td>“Advanced” - describes patients who are clinically stable with a reasonable level of comfortable activity, despite history of previous decompensation that is not recent.</td>
<td>Not a candidate for MCS</td>
</tr>
</tbody>
</table>
Patients with INTERMACS profile 1 to 3 are being managed with temporary mechanical or inotropic support, whereas patients with profile 4 to 7 are not inotrope dependent. We have implanted 4 Ventracore assist LVAD and 7 Heartmate II LVAD implantation cases. One out of four Ventracore group belonged to INTERMACS 2 and two out of seven patients in HM II group belonged to INTERMACS 1.

Durable VADs that we Implanted
Ventracore Assist

Heartmate II

Perfusion and Surgical Strategy for LVAD Implantation:
All the patients were subjected to CPB under normothermia. After systemic Heparinization, standard central Aortic and Right Atrial Two stage venous cannulation was performed in 10 cases except for one patient who had Severe TR. Patients MAP was maintained above 65 mm of Hg by maintaining full flows. Only one case required cardioplegia as it had severe Aortic Incompetence and the remaining 10 cases were done without cardioplegia in a beating heart. Continuous i.v infusion of Milrinone and Inhalational Nitric oxide was kept on flow throughout the operative period to counter RV dysfunction.(6) The role of TEE is vital to eliminate any residual air in the LV and in the outflow graft. Surgery was carried out by keeping the patients in trendlenberg position that prevents air to reach the cerebral circulation.(13) Weaning from CPB and initiation of the Durable VAD were done in a smooth and coherent manner by maintaining the normal ranges of CVP, PA pressures and MAP. TEG was also used that acts as a guide to transfuse appropriate blood products when we encounter post-operative bleeding.

Results: In our experience of 11 patients, 8 patients survived (72.7%). Out of the four Ventracore LVAD one succumbed due to RV failure & septicemia in the immediate postoperative period. One patient survived for nearly six years and expired at home. One patient required Dorr's repair due to LV wall thinning after few months of implantation hence the VAD was explanted and Dorr was performed. After 10 years one patient underwent successful orthotopic transplantation and explantation of the VAD. Out of the seven Heartmate II patients 5 survived and two succumbed one due to RV failure, Multi organ dysfunction, cardiogenic shock refractory to inotropes and another due to RV failure and irreversible neurological injury.

One patient who belonged to INTERMACS 3 underwent LVAD with park's stitch for Aortic Incompetence and was successfully discharged.
Picture: 1 Parks stitch on Aortic Valve that will prevent recirculation post LVAD for AR cases.

One patient INTERMACS-1 required temporary RVAD (RA-PA with CentriMag) and succumbed in the postoperative period due to multiorgan dysfunction.

Picture 2 & 3 shows: PA inflow cannula and Right femoral venous drainage for RVAD (RA-PA with CentriMag) with Heartmate II LVAD

We found out that patient who belonged to INTERMACS 3-4 profile had better outcome and the recovery was fast in the postoperative period. Patients who were in the INTERMACS 1-2 had a long post operative stay with lot of co-morbidities.

Discussion:

Patients suffering from end stage heart failure especially with isolated LV dysfunction with fair RV function have resulted better after Durable LVAD implantation.(10) Patients who had preoperative poor RV function required higher inotropic supports, Milrinone, nitric oxide therapy with or without temporary RVAD. Right ventricular dysfunction is a leading cause of death after LVAD implantation, because the LVAD function depends on proper filling of the left ventricle (LVAD preload), which in turn is dependent on RV function.(5,6) We had three patients who had severe RV dysfunction post LVAD (one patient was put on temporary RVAD) and all the three cases expired in the immediate postoperative period.(11,13)

Patients who belonged to INTERMACS 1-2 (3 cases) had poor end organ perfusion and their response after Durable LVAD was not as favourable when compared with INTERMACS 3-4 (8 cases) profile.(7) The INTERMACS 3-4 (8 cases) profile patients had their biochemical parameters especially LFT and RFT in the desirable normal range and were ambulated much faster in the postoperative period. Their functional status improved dramatically and were able to lead a normal life.(12)

Durable LVAD Patients require anticoagulation in the post procedure period and they are usually on heparin infusion in the immediate postoperative period followed by warfarin and acitrome to maintain INR in the range of 2.0-2.5.

Pump thrombosis is one of the potential complication of Durable VADs, but we have not noticed any such cases so far. One patient died after 6 years of LVAD implantation at home but the reason remains unclear. GI bleeding, Cerebrovascular Bleed/Emboli are other complications that can precipitate in the LVAD patients.(4)

Driveline infection is one of the common problem that occurs hence patient education about hygiene of driveline wound is mandatory and observed periodically. They are advised not to swim or take a bath in a bathtub.

The responsibility and the role of perfusionists in implanting the Durable LVADs are exemplary especially while handling the hardware and accessories involved in the durable LVADs. They can become a VAD coordinator who takes care of the patients and be a one point of immediate contact.(14)

Conclusion:

Durable VADs are definitely a life saving treatment modality for the end stage heart failure patients with
reasonably fair RV function that provides them a better life style and quality of life. They are a substitute for heart transplant (Destination Therapy) or a bridge to transplant.(8) The role of perfusionist in the Implantable VADs is vital and has opened a new career to pursue in the management of these cases.

References
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Extracorporeal Membrane Oxygenation for Multi-drug Intoxication

Jesima Yasmin, Lakshmipathi T, Theodore S, Siva Kumar R
Department of CTVS, CSSH
Corresponding Author: Dr. Sanjay Theodore

Abstract
A young woman presented to our hospital following Multidrug suicidal poisoning. The patient's condition deteriorated and she developed severe Metabolic Acidosis and Refractory cardiogenic shock on conventional therapy. In order to prevent the Multi organ failure, Veno-Arterial Extracorporeal Membrane Oxygenation (VA-ECMO) was initiated. The patient's hemodynamic improved significantly after the application of ECMO. She was weaned successfully after 69 hours.

Keywords:
β-blocker and calcium channel blocker Poisoning, Extracorporeal Membrane Oxygenation.

Abbreviations:
VA-ECMO - Veno Arterial Extracorporeal Membrane Oxygenation.
ACT - Activated Clotting Time.
ABG - Arterial Blood Gas.
VBG - Venous Blood Gas.

Introduction
Drug overdose and poisoning with cardio toxic drugs like β-blockers (BB) and Calcium Channel Blockers (CCB) are rare. Successful management of these patients with severe Cardiogenic Shock and Multi-organ dysfunction can be achieved with early institution of VA-ECMO[1,2].

Extracorporeal Life Support using ECMO provides Respiratory and Circulatory support for many fatal conditions[2]. In this case, we report the use of VA-ECMO for a patient with Refractory cardiogenic shock due to β-blocker (BB) and Calcium Channel Blocker (CCB) toxicity. BB and CCB toxicity pose a great threat to the cardiovascular system by producing significant cardiovascular depression which can be fatal [1].

The goal of preventing Multi-organ deterioration and providing adequate hemodynamic support until the complete drug clearance from the patient's system has been successfully achieved through the incorporation of ECMO[1].

Case Report
A 23 year old woman was admitted with vomiting and drowsiness in our Emergency Department. There was history of ingestion of 60 tablets of Amlodipine (300mg) and Metoprolol (3000mg). On admission the patient was drowsy but oriented. Her Heart Rate was 54
beats/min and Blood pressure was 70/20mmHg. She was Tachypnoeic and SpO2 was 87%. She was given oxygen. Dopamine infusion of 10mcg/Kg/min was started. She continued to have bradycardia, hypotension and oliguria that gradually deteriorated. Oral activated charcoal therapy had been given in the Emergency Department to enhance the elimination of toxic drugs.

Table 1: Worsening Metabolic Acidosis.

<table>
<thead>
<tr>
<th>Time</th>
<th>pH</th>
<th>pO2 (mmHg)</th>
<th>pCO2 (%)</th>
<th>pCO2 (mmHg)</th>
<th>HCO3- (mmol/L)</th>
<th>Lac (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:02 AM</td>
<td>7.19</td>
<td>88</td>
<td>84</td>
<td>30</td>
<td>11</td>
<td>3.9</td>
</tr>
<tr>
<td>10:06 AM</td>
<td>7.15</td>
<td>124</td>
<td>97</td>
<td>35</td>
<td>11</td>
<td>3.9</td>
</tr>
<tr>
<td>12:42 AM</td>
<td>7.26</td>
<td>306</td>
<td>99</td>
<td>21</td>
<td>9</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Her chest X-Ray showed bilateral non-homogenous opacities, consistent with pulmonary oedema. Metabolic Acidosis steadily increased and hemodynamic worsened overtime. Considering the Refractory Cardiogenic Shock, worsening Metabolic Acidosis, severe Acute Respiratory Distress Syndrome, and Acute Kidney Injury and to prevent the Multi-organ deterioration, ECMO was initiated after 22 hours of Resuscitation.

Veno-Arterial cannulation was done through femoral vein and artery. A 17Fr Femoral Artery cannula (Biomedicus, Medtronic; Minneapolis, USA) was inserted percutaneously into the Left Femoral Artery. A 19Fr venous drainage cannula (Biomedicus, Medtronic; Minneapolis, USA) was inserted percutaneously into the Right Femoral vein. The circuit consisted of Poly Vinyl Chloride tubing, a centrifugal pump (JostraRotaflow Centrifugal pump; Macquet, JostraMedizintechnikAG, Hirrlingen, Germany) and a Membrane Oxygenator (Quadrox i). Heater – cooler system (Cincinnati Sub Zero products Inc; Cincinnati, Ohio, USA) was used.

**ECMO Management**

Blood flow was initiated with a flow rate of 2L/min/m2 and gas flow through the membrane was set at 2L/min. The lungs were kept ventilated with SIMV mode, PEEP-8, Pressure support – 12 and Fio2 – 80%. The Activated Clotting Time was maintained between 200 – 250 secs with the continuous infusion of Unfractionated Heparin.

The ACT and ABG were checked every one hour. Mixed Venous Oxygen Saturation and Lactate levels were used to monitor the tissue perfusion. The VBG revealed a MVO2 in the range of between 60-75% throughout the procedure which reflects the adequate tissue perfusion.

The pressure drop of the oxygenator (ΔP) helps in predicting any clots within the oxygenator membrane.

\[ \Delta P = MAP\ pre-oxy – MAP\ post-oxy \]

The ΔP was monitored continuously and maintained within 10mmHg throughout the procedure.

The urine output increased immediately after initiation of ECMO and the inotropic supports were slowly tapered as the hemodynamic improved. After 10 hours of ECMO the Lactate levels decreased to a more physiological level of 1.6 mmol/L.

Table 2: Indicates the improvement of metabolic parameters.

<table>
<thead>
<tr>
<th>Time</th>
<th>pH</th>
<th>pO2 (mmHg)</th>
<th>SO2 (%)</th>
<th>pCO2 (mmHg)</th>
<th>HCO3- (mmol/L)</th>
<th>Lac (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before ECMO initiation</td>
<td>7.26</td>
<td>341</td>
<td>99</td>
<td>21</td>
<td>9</td>
<td>4.6</td>
</tr>
<tr>
<td>At initiation of ECMO</td>
<td>7.30</td>
<td>117</td>
<td>98</td>
<td>28</td>
<td>14</td>
<td>3.9</td>
</tr>
<tr>
<td>After 10 hours of ECMO</td>
<td>7.38</td>
<td>267</td>
<td>99</td>
<td>35</td>
<td>20</td>
<td>1.6</td>
</tr>
<tr>
<td>After 24 hours of ECMO</td>
<td>7.35</td>
<td>79</td>
<td>96</td>
<td>37</td>
<td>21</td>
<td>1.4</td>
</tr>
<tr>
<td>After 48 hours of ECMO</td>
<td>7.43</td>
<td>106</td>
<td>98</td>
<td>35</td>
<td>21</td>
<td>1.3</td>
</tr>
<tr>
<td>After 65 hours of ECMO</td>
<td>7.43</td>
<td>95</td>
<td>98</td>
<td>35</td>
<td>23</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Continuous Arterio-Venous Hemofiltration (CAVH) was instituted to regulate the intravascular volume and to treat the Acute Kidney Injury.

The inotropic support was progressively tapered and discontinued completely with improvement in cardiac function. On day 4, with adequate Respiratory, Metabolic and Hemodynamic parameters, the patient was weaned off ECMO and decannulated.

Discussion

Cardiovascular failure is the leading cause of the death in
patients with drug overdose [2]. VA-ECMO can be used as a bridge to recovery for these patients who are not responding to conventional therapy [3]. Only a few reports have been published about the use VA-ECMO in drug overdose patients presenting with refractory cardiogenic shock [1,2]. ß-blocker and Calcium Channel Blocker toxicity results in poor myocardial contractility, hemodynamic deterioration due to cardiogenic shock and Arrhythmias [1]. We did not observe any major rhythm disturbance except bradycardia. The effect of ß-blocker and Calcium Channel Blocker induced bradycardia was counterbalanced by the chronotropic effect of high dose vasoactive drugs and helped in maintaining a near normal Heart Rate of 60-80 beats/min [1].

Metoprolol is mainly metabolised in Liver and its metabolites are excreted in urine. Its Half-life is 3-7 hrs [4]. Elimination of Amlodipine is mainly by biotransformation in Liver where they are converted into inactive metabolites and are excreted in urine. Its Half-life is 30-50 hrs [5].

Any decrease in the renal blood flow or function decreases the Glomerular Filtration Rate, affecting the drugs that are dependent on this route of elimination. Hepatic failure or decreased hepatic blood flow hinders the enzymatic activity of Liver, affecting the drugs that are dependent on this route of elimination and eventually leading to drug toxicity [6].

Hemodilution on ECMO increases the volume of distribution of drug mainly the hydrophilic drugs and thereby decreasing its plasma concentration resulting in therapeutic failure of the drug. The decrease in plasma proteins due to hemodilution, particularly Albumin, affects the drugs that are highly protein-bound and increases the unbound fraction of drug leading to potential toxicity [6]. On the other hand the improved perfusion to Liver and Kidney due to VA-ECMO support may improve the metabolism and elimination of drug that are dependent on this route of elimination thereby decreasing the potential toxicity [6].

The most common complications of ECMO that have been reported are bleeding, Limb-ischemia and other cannulation related problems [2,7].

In conclusion, VA-ECMO is an effective resuscitation tool in patients with overdose of Cardio toxic drugs. Early and appropriate timing of institution will result in excellent prognosis.

References
Anticoagulation Management in a VV ECMO patient for ARDS with Severe Intra Uterine Bleed

Kalai Mani, D, P.V.S. Prakash Sam Immanuel, Selvakumar R
Ahana Maria, Dr. Riyan Shetty, Dr. Varun Shetty
Narayana Hrudayalaya, Bengaluru

Objective
To describe the anticoagulation management of a Viral Pneumonia patient on ECMO who was on her second trimester, control of intrauterine bleed after miscarriage and successful wean off from ECMO after 19 days.

Background
Extracorporeal membrane oxygenation (ECMO) can be a lifesaving therapy in patients with refractory severe respiratory failure or cardiac failure. Severe acute respiratory distress syndrome (ARDS) still has a high-mortality rate, but ECMO may be able to improve the outcome. Use of ECMO for respiratory failure has been increasing since 2009. Initiation of ECMO for adult ARDS should be considered when conventional therapy cannot maintain adequate oxygenation. ECMO can stabilize gas exchange and haemodynamic compromise, consequently preventing further hypoxic organ damage. ECMO is not a treatment for the underlying cause of ARDS. What added to the complication was the second trimester pregnancy of the patient and the control of intrauterine bleed after miscarriage was challenging.

Materials and Methods
31 year old female patient came with severe breathlessness and was on ventilator. She was put on VV ECMO when conventional methods failed. ECMO was initiated with Rotaflow Centrifugal pump and Maquet PLS Quadrox oxygenator. Access cannula was from the femoral vein (28 Fr long femoral venous) and return cannula into the Internal jugular vein (20 Fr Edwards). She was on her second Trimester of pregnancy. Initial plan was to save both the child and mother with good oxygenation by ECMO flows and monitoring of fetal heart rate. On the second day of ECMO there was absence of fetal heart rate and abdominal ultrasound scan confirmed the fetal death. In order to evacuate the fetus uterine contractions were pharmacologically induced. She developed severe intrauterine bleeding.

In order to reduce bleeding Heparin was stopped and circuit was run heparin free for the next two days. Intrauterine bleed persisted and this was managed with blood products and intrauterine packs. Massive transfusion was administered to compensate the Intra
Uterine bleed. The number of units of blood transfusion was PRBC’s – 15 units, FFP – 18 units, Cryo – 12 units, platelets – 16 units. (Average HCT - 25.3 %, Lowest - 16 %).

There was Dilutional coagulopathy due to the pregnant state and the bleeding was severe. This was managed by TEG monitoring and administering appropriate blood products. Interventional radiologist embolized some uterine arteries to reduce bleeding.

Circuit and Oxygenator Management

Since the bleeding was severe we had to run the circuit heparin free for a couple of days. Constant vigil was kept on the delta pressure and physical examinations with flash light were done for observation of clots in the circuit and oxygenator. We noticed that during this period the delta Pressure increased from 15 mm of Hg to 85 mm of Hg. The ACT was maintained at 140 -150 Seconds. In order to prevent clotting RPM was kept more than 2800 and blood Flow Rate was maintained more than 4 lpm. A backup ECMO circuit was kept nearby the patient for emergency circuit change. The oxygenator clot grading scale was also maintained in hourly torch tests to identify the growth of clots.

Assessment of bleeding with TEG

Since Thromboelastogram offers the possibility of quickly identifying whether the bleeding is due to incompetent clotting (coagulopathy), excessive clot lysis (hyperfibrinolysis), both or neither one. This information helped us to guide appropriate use of blood products and other interventions such as antifibrinolytics. The initial TEG findings were thrombocytopenia (fig3a) then platelets was transfused, then the patient developed severe fibrinolysis (fig3b), it was managed with antifibrinolytics. We did TEG twice in a day and managed bleeding accordingly.

3a. The Maximum amplitude is less than 40mm so it is a guidance to transfuse platelets.
3b.Since the maximum amplitude decreases rapidly and increased alpha angle confirms fibrinolysis.

Discussion

The use of ECMO for severe ARDS in pregnant and postpartum women was associated with a 66% survival rate. The most common cause of death was bleeding. Managing the patient without heparin and running at low ACT was a big challenge for the perfusionist. (Intensive care medicine, April 2011, Volume 37, Issue 4 Andrew r Davis, john beca, Elisabeth Sullivan et al.)

The patient was anuric and required dialysis because of multiple transfusions. Bronchiolitis obliterans organizing pneumonia (BOOP) was suspected and was treated aggressively with steroids. BOOP is an inflammation of the bronchioles (bronchiolitis) and surrounding tissue in the lungs. Thrombo Elasto Graph (TEG) was extensively used to administer blood products and control the bleeding. The ECMO was a life saving therapy for this patient as it offered support during the recovery of lungs from infection.
Serial of X Rays during the ECMO course and the recovery phase

Day 1                                         Day 5

Day 14                                        Day 18

Conclusion
The patient was weaned of ECMO Successfully after 19 days and was discharged from hospital after 40 days. Appropriate management and multidisciplinary team approach salvaged this difficult subset of patient. These type of cases help us to move towards heparin free ECMO management.

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4. Prolonged heparin-free extracorporeal membrane oxygenation in multiple injured acute respiratory distress syndrome patients with traumatic brain injury
A typical size of Right Atrial Myxoma

Mr. Akhalesh Sureshchand Maurya
Miss Namita Mishra, Dr Suruchi Hasija
Dr. Ujjwal kumar Chowdhury

Department of Cardiothoracic & Vascular Surgery
All India Institute of Medical Sciences(AIIMS) Ansari Nagar, New Delhi.

Introduction

The primary tumors of the heart are rare. They have been found in only 0.0017% to 0.19% of unselected patients at autopsy. Seventy-five percent of these tumors are benign; 50% are myxomas. Of the myxomas, 75% to 80% are located on the left side of the interatrial septum. Prior to the development of cardiac catheterization in 1951, intracardiac tumors were diagnosed only at autopsy. Since then, echocardiography has replaced cardiac catheterization as the mainstay of diagnosis, because of its noninvasive advantages.

The 1st successful excision of a left atrial myxoma was reported in 1955. Right-sided cardiac myxomas present surgeons with a technical challenge because placement of the cannula for cardiopulmonary bypass used to be difficult. We report the presentation and management of a case of a large, right atrial myxoma, and we describe our technique of cannulation for cardiopulmonary bypass.

Case Report

In February 2018, a 44-year-old female presented with a 2-week history of New York Heart Association class III fatigue and dyspnea. She also reported a 3-month history of cough and night sweats, which had been treated with antibiotics. She had suffered from mild dyspnea for the past 2 years. On examination, the patient was found to have mild central cyanosis and a mid-diastolic murmur with an occasional systolic click at the mitral and tricuspid areas. (Hemoglobin 15.5 g/dL)

Echocardiography revealed a large right atrial tumor (6.1×3.4mm) intect to inter atrial septum (ias) (diameter = 7 cm) on a long stalk that allowed it to prolapse through the tricuspid valve. This patient was found to be hypoxic (SaO₂ = 90% in room air), the patient was taken to surgery urgently.

Exposing of the heart through a median sternotomy and found that the right atrium was large and tense. The mass appeared to occupy the entire right atrium, except for a little space near the superior vena caval (SVC) attachment. The patient was heparinized, the SVC 22fr angle cannula was inserted, cardiopulmonary bypass was instituted, and the heart was cooled down to 33 °C. Then inferior vena cava (IVC) space was not adequate for cannulation without subjecting the patient to the risk of tumor fragment detachment. Placement of a purse-string suture in the right atrium near the IVC junction was done, cannulation of IVC 28 fr straight venous cannula(small cannula) at the lowest available space is also been done. The SVC cannula was subsequently adjusted to achieve complete bypass, which was followed by cold-blood cardioplegia (St.Thomas II) solution. Opening of the right atrium with an oblique incision is done. The tumor was so large that was projected from the atrium. It was attached by a stalk to the posterior wall of the inter atrial septum, near the IVC end. Excision of the tumor and the base of the right atrial wall has been done. Then closser of this meticulously heart has been done by reanalzing previously undetected patent foramen ovale. The right atrium was closed during rewarming, de-airing was done routinely, and the aortic cross-clamp was removed. Ivc cannula was
placed back in to the Right Atrium. The heart reverted to sinus rhythm, and cardiopulmonary bypass was discontinued gradually. The patient had an uneventful post-operative recovery.

Discussion

Right atrial myxoma accounts for only 15% to 20% of all cardiac myxomas. It is usually found in the inter atrial septum, at the border of fossa ovalis. Atypical locations and multiple myxomas occur most frequently in cases of familial myxoma. Our patient's tumor was situated at the posterior atrial wall, adjacent to the origin of the IVC. This is a rare site of origination, but familial history was absent in our patient. Myxoma can present in any age group, but, as in our patient, it occurs most often between the 3rd and 6th decades of life. Myxomas are usually polypoid and pedunculated. Our patient's tumor had the usual polypoid mass and pedunculated structure, and it also had a lobulated surface. It had considerable mobility, as shown by the transesophageal echocardiogram the stalk was 6.1mm long and 3.4mm in diameter and the grediant of 13mm. Myxomas are usually compact and show little tendency toward spontaneous fragmentation, although the less common papillary or villous myxomas have a surface of multiple fine, villous extensions that tend to break off and produce embolism. Since this patient presented with mild cyanosis and hypoxia, we did not know the macroscopic appearance of the tumor, we had to exclude the presence of pulmonary emboli. In light of our surgical findings, we can attribute the patient's desaturation and cyanosis to right-to-left shunting through the patent foramen ovale, because the mobile tumor was obstructing the tricuspid orifice, thus creating high right atrial pressure. Right-to-left shunting serves as an overflow valve for venous return, so signs of right heart failure are often absent. Mobile myxomas often exacerbate shortness of breath when the patient assumes a particular posture, but we could detect no such relationship. The motion of the tumor can damage the atrioventricular valve and rupture the chordae, but our patient's tricuspid valve appeared normal. "ball-valve" movement of the mass. Constitutional symptoms, including fever, malaise, weight loss, and myalgia, are common in patients with myxoma and have been attributed to the finding that myxomas release cytokine interleukin, which is responsible for inflammatory and autoimmune manifestation. These signs disappeared after the tumor was excised. The recurrence of myxoma was first reported by Gerbode and has been noted by others. Adequate excision of the entire mass, along with resection of normal tissue surrounding the base, prevents recurrence, except in cases of familial myxoma. In addition, careful handling of the myxoma itself may prevent intracardiac implantation or peripheral embolization of the tumor fragments. In our case, the method of cannulation we have described was appropriate for such a large mass, in order to prevent embolization. Femoral cannulation is another option, but is associated with risks as injury to the vessels, lymphorrhea at the groin, and deep vein thrombosis, groin infection, etc.

Conclusion

By considering all of the factors the rare location for a large myxoma, Right Atrium should always be considered in the differential diagnosis of a right-sided heart mass, especially when the patient shows signs and symptoms of heart failure with uncertain etiology. While cannulating for Crdio Pulmonary Bypass myxoma dislocation should be avoided by countinious monitoring of Trans Esophageal Echocardiography. Cardiologists and surgeons need to make an early diagnosis and treat patients with these tumors to improve the prognosis.

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A typical size of Right Atrial Myxoma

1984;32:143-7


SVC cannulation in Total Anomalous Pulmonary Venous Connections repair surgery using a vent catheter

Shalu Chaudhary, Mr Alok Kumar, Dr. Suruchi Hasija, Dr. Ujjawal Kr Chowdhary
Department of Cardiothoracic & Vascular Surgery
All India Institute of Medical Sciences(AIIMS) Ansari Nagar, New Delhi.

Abstract
A baby of 10 days with obstructive infracardiac TAPVC was planned for surgery and underwent Cardiopulmonary bypass. A Medtronic 10Fr vent catheter was used to cannulate SVC instead of regular cannula i.e. an angled venous wire-reinforced cannula for upper body venous drainage.

Introduction
Total anomalous pulmonary venous connection (TAPVC) (1) typically presents in the very young and often requires early surgical intervention. Surgical correction of TAPVC has become increasingly successful; this success has been attributed to early and accurate diagnosis, improvement in surgical techniques, better myocardial protection as well as improved postoperative care of these sick infants.

Case report
A 10 days male baby weighing 2.6kg diagnosed with obstructive infracardiac TAPVC(2) at level of Ductus venous (2.6mm) of cyanotic etiology with severe pulmonary artery hypertension (PAH), non-restrictive OS-ASD (RL), and right ventricular volume overload (RVVO) with Middle pulmonary veins draining into common chamber forming a good sized vent. He was clinically evaluated and planned for surgery. Surgical strategy involved Creation of anastomosis between LA and Common pulmonary venous chamber, Disconnection of common pulmonary venous chamber from the systemic venous circuit and Closure of atrial septal defect.

Circuit planning
Based on requirement routine CPB circuit was used which includes a venous reservoir with integrated oxygenator and heat exchanger (Baby RX-05) with custom tubing pack of arterial and venous loops of 1/4inches and suction tubing with connectors of required size.
(Kindly describe the priming protocol adopted for the procedure)

**Strategy**

Based on the requirements, the circuit was assembled, primed, de-bubbled, circulated properly, and the AV loop line divided for cannulation. Heparin 300 U/kg IV was administered before arterial cannulation with a target ACT (measured after 3 min) of more than 480 seconds. During arterial cannulation, systolic pressure was restricted to 90–100 mm Hg to reduce the risk of aortic dissection. The aortic cannulation was performed first to provide volume resuscitation in case of hypotension associated with venous cannulation. Once the aortic cannula is connected to the tubing, line pressure is checked to rule out dissection. Ascending Aorta was cannulated with a 6 Fr DLP aortic cannula. Cannulae connect the patient's blood to the circuit and hence to the CPB machine. They are made of polyvinylchloride (PVC) with wire reinforced to prevent obstruction due to kinking. Venous cannulae: single-stage cannulae are used during most open-heart surgeries, where two cannulae are inserted into the superior and inferior vena cava and joined by a Y-piece. Dual-stage cannulae are used for most closed-heart procedures, where a single cannula is inserted into the right atrium. Drainage occurs through gravity. Vacuum applied to the reservoir allows the use of smaller cannulae and tubing, thus decreasing the circuit. Bicaval cannulation was performed, cannulating SVC and IVC separately, vacuum applied for adequate venous drainage. For cardioplegia delivery, Romson's coronary catheter was used. Vent catheter of 10Fr size was used for venting the heart.

**The Problem**

As the patient was a 2.6 kg infant, there was difficulty in cannulating SVC with a 12Fr angled venous cannula, the smallest available venous cannula in our institute. It was small in size, much lesser than 4mm in diameter. So we thought of something else to provide better surgical view without hampering the proper flows and drainage. Hence an alternative solution had to be implemented without compromising optimal venous drainage.

**The Solution**

It was then decided to use a Medtronic DLP vent of 10Fr to cannulate the SVC. Firstly, on Cardio-pulmonary bypass was initiated with single IVC cannula, following which SVC was cannulated with vent catheter. We observed that unimpeded upper body venous drainage providing good dry field for surgery. Full CPB was instituted and ventilation is discontinued.

Total bypass time was 90 minutes and aortic cross clamp time was 52 minutes. Blood-crystalloid cardioplegia in 4:1 parts i.e St. Thomas cardioplegia was administered at rate of 30-35ml/kg body weight for 3 minutes (total 90ml dose) and also a second half potassium dose was given after 36 minutes of first cardioplegia dose administration. Normothermia was maintained throughout the surgery. VAVD was not instituted to maintain adequate venous drainage. SVC was draining adequately via 10Fr vent catheter.

Post-operatively also there was no complications after weaning off from CPB. After shifting in ICU patient was extubated within 24 hours. And kept under observation for 3-4 days in ICU itself and then shifted to ward.

**Fig3- the above image shows aorta cannulated with 08Fr Biomedicus cannula and SVC cannulated with 10Fr vent catheter and IVC being cannulated with a straight venous cannula and snugged.**
Discussion

The selection of cannula and cannulation technique is one of the main components of cardiopulmonary bypass. Selection of drainage cannula as well as return cannula can be done according to body weight, C.O, vessel anatomy as well as compatibility of surgeon specially about either angled cannula or straight cannula, but the appropriate venous drainage and adequate pump flow through return cannula should not be compromised to protect vital organs of the body during cardiopulmonary bypass. Although 1/3rd part of venous drainage comes through SVC however, congestion in SVC drainage may cause cerebral damage and impact on surgical outcome. Moreover, if a smaller sized wire-reinforced venous cannula or vent catheter would be available it could be more better as it prevents accidentally kinking of venous cannula and improves venous drainage.

Conclusion

Using of 10Fr vent catheter for SVC cannulation was a good alternative but availability of a small sized venous cannula with wire enforcement would be more better as there was risk of kinking of vent during surgery. Also if vent would be available with wire enforcement it would be more safer. Other features of vent and venous cannula are comparable like presence of multiple pores at the site of entry, etc.

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Beating Heart Continuous Coronary Perfusion (BHCCP) for ASD Closure & Tricuspid Repair

Dr Vijaya Lanje, Dr Vivek Lanje
CVTS
Suretech Hospital, Jamtha Nagpur

Introduction
Prior to introduction of cardioplegia BHCCP was the only available method of myocardial protection. Currently cardiac surgery on cardiopulmonary bypass with cardioplegic arrest is the gold standard strategy. Nevertheless, all cardioplegic myocardial protective approaches devised to date subject the heart to a period of so-called “mandatory ischemia” wherein the heart is without circulation.

Aim and Objective
The primary aim of the beating-heart technique is to avoid ischemic-reperfusion injury and minimize aortic X-Cl time with the help of Antegrade continuous coronary perfusion (ACCP). We present our experience in closing all types of ASDs and Tricuspid valve repair for ASD with severe TR with the aid of antegrade continuous coronary perfusion of an empty beating heart, in the absence of systemic hypothermia. Its short study of single surgical team from March 2014 – July 2018 (52 cases) Ages 7yrs – 54yrs. Size of ASD ranged from 2cm through 4.5cm. The outcome of this prospective study is presented.

Method
Preoperative patients' clinical examination and diagnosis established with the aid of 2-dimensional echocardiography as well as color-flow Doppler echocardiography. The size, type and location of the ASDs were ascertained, along with possible associated anomalies. All valvular competencies also checked. All patients underwent median sternotomy with conventional CPB of Bicaval cannulation with ascending aortic cannulation. Antegrade cardioplegic needle inserted into ascending aorta to facilitate ACCP and de-airing upon completion. The technique of caval cannulation is modified if the patient’s anatomy requires for the presence of LSVC and SINUS VENOSUS ASD. Both cavae are looped. The aorta is cross clamped with back up of perfusion flow and aortic root perfused with 4-5 ml/kg/min normothermic oxygenated blood given throughout procedure and root pressure maintained 110-120 mmhg. Parameters such as an ECG –any ischemic changes, Aortic root pressure, Perfusion pressure, Temperature, Saturation and Urine output monitored throughout the procedure. Both caval loop snug down before right atriotomy. Cardiomyocardial sucker placed in coronary sinus ostium in order to keep operative field bloodless. All of these procedures carried out without cardioplegia. De-airing and right atrial closure were done in routine fashion.

During working with same surgical team performed number of ASD closure under conventional cardioplegic arrest. In neither group there were no difference in timing of surgical procedure and outcomes.

Results
All patients withstood the procedure well and were extubated within 4 hours after the procedure. 20 patients of ostium Secundum ASD were extubated on the table and were mobilized on same day. No patients required any inotropic support or vasodilatation and...
Intraoperative shock. There were no electrocardiographic changes during or after the procedure. None of the patients required stays in ICU in excess of 24 hours. Postoperative ECHO showed normal LV function and no residual shunt across the interatrial septum. A noteworthy finding in this cohort of perfused beating-heart cases was the absence of early postoperative arrhythmias, in comparison with those patients who were operated upon under cardioplegic arrest. We are deliberately deferring the statistical analysis of this phenomenon, because we wish to observe the late outcomes in these two groups over a respectable period of follow-up.

Discussion

Although major technological advances have been made in myocardial protection during cardiac operations over the past decade, perioperative adverse effects caused by myocardial ischemia have not been completely eliminated. Some degree of myocardial stunning occurs even with continuous warm-blood cardioplegia, which is considered the best form of myocardial protection because it keeps the heart in an aerobic state. Cardiac dysfunction can be caused by myocardial edema intrinsic to the diastolic state of the arrested heart. Therefore, cardioplegic arrest inevitably produces some degree of reperfusion injury. Keeping the heart beating results in less myocardial edema and better myocardial function.

Ischemic-reperfusion Injury During Cardiac Surgery

Ischemia induced artificially by AO-X CL and myocardial preservation strategies are employed throughout this ischemic period. Once surgery has been completed AO-X-CL released, heart is suddenly & globally reperfused with blood that is fully Anticoagulated, immunologically primed by exposed to CPB circuit & characterized by a very high pressure of Oxygen. Post declamped myocardium exposed to dramatic extremes of ischemia and reperfusion. Highly heterogeneous condition comes in role ranging across spectrum of co-morbidities, hypertrophy and contractile dysfunction. Clinically - Arrhythmia, Myocardial stunning, Low CO and peri-op MI. Biochemically evidence of MI - increased CK-MB and troponin

Other advantages of beating-heart ASD repair are the immediate ability to evaluate the severity of any associated mitral or tricuspid valvular insufficiency and to identify iatrogenic conduction injuries. This is particularly important in cases of ostium primum ASDs, wherein the atroioventricular node remains a surgically vulnerable spot. The primary aim of the beating-heart technique is to avoid ischemic-reperfusion injury. It is a safe and effective technique not only for closure of ASDs but also for various other noncoronary procedures, including valve repairs and replacements. Our experience to date suggests that beating-heart ASD closure is safe and requires no compromises in comparison with conventional techniques.

Conclusion

Ideal cardioplegia solution, techniques or delivery method has yet to be identified. Understanding severity about Complexity of ischemia reperfusion injury is important. IDEAL protection of myocardium is no longer limited to OT.

Need to develop new therapeutic strategies to protect the heart according to diseased pathophysiology.

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Median Term Biventricular Assist as Bridge to Heart Transplantation

Mr. Suneel Kumar Lakkipogu, Dr. Sandeep Attawar, Dr. Prabhat Dutta, Dr. Ravi Kumar
Dept. of CTVS, Gleneagles Global Healthcity, Chennai

Abstract
In India there is huge mismatch between organ donor and recipient, this mismatch resulting in loss of lives, Source- India today 02 November 2016. Bi ventricular assists are beneficial for such patients to live their routine life as they await heart transplantation. We present case of 64 year old man who came to our hospital with alcoholic dilated cardiomyopathy and deteriorated further while waiting for an organ.

The Bi ventricular assist device initiation and its management for 37 days of support will be discussed.

Keywords
Heart failure, Shortage of organ donations, Bi-Ventricular assist devices as Bridge to heart transplantation, management and heart transplantation

Introduction
We present a case of end stage alcoholic cardiomyopathy causing bi-ventricular dysfunction patient who was bridged to transplant using a Bi-ventricular assist device (Centrimag) for 37 days before proceeding with heart transplant.

We were able to employ Biventricular assist device until a donor was available and went on to perform a heart transplant successfully thereafter.

Case History
A 64 year old gentleman suffering from dilated cardiomyopathy for the past 2 years was referred to our hospital. On pre-operative evaluation, the patient had severe biventricular dysfunction with an EF of 20%. Despite diuretics and Inotropic supports his condition deteriorated with decreased urine output, increased pedal edema and increased requirement of inotropic support.

Team meeting was called and decided to put the patient on Bi-ventricular assist until a donor was available for heart transplant.

Patient was shifted to Operation theatre, cannulated right atrium with 34Fr Straight venous cannula and 21Fr Biomedicus Straight (femoral) arterial cannula was used on proximal ascending aorta and went on regular cardio-pulmonary bypass, later pulmonary artery was cannulated with 21Fr Biomedicus Straight (femoral) arterial cannula and Right superior pulmonary vein with a 32 Fr long bent venous cannula and kept it clamped. Later we came off bypass and connected to the Bi-VAD circuit to initiate support. A Centrimag pump was used in both the circuits to maintain the flow.
Postoperative care

Following Bi-VAD insertion, Patient was shifted to ICU with minimal inotropic support. Systemic arterial pressure approximately 90/70 with a mean of 70-80 mmHg, Pump flow: 4–5 LPM with Pump speed: 3000–4000 RPMRAP and LAP: 06-08 mmHg, ACT within normal range. Anticoagulation therapy was started after 6 to 12 hours after initiation of support to minimize usual postoperative bleeding.

Anti-coagulation Management:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pre Bi-VAD</th>
<th>Post Bi-VAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure</td>
<td>79/59mmHg (On ADR/DOPA/NORAD/MILRI)</td>
<td>112/68mmHg (All Inotropes tapered off after 48 hours)</td>
</tr>
<tr>
<td>CVP</td>
<td>21mmHg</td>
<td>06mmHg</td>
</tr>
<tr>
<td>SPO2</td>
<td>91% on O2@15L/min</td>
<td>99% on O2@2L/min (Extubated after 24 hours)</td>
</tr>
<tr>
<td>Lactate</td>
<td>5.3mmol/L</td>
<td>POD0 – 2.1mmol/L, POD1 – 1.6mmol/L</td>
</tr>
<tr>
<td>Creatinine/ Urea</td>
<td>2.0mg/dl/110mg/dl</td>
<td>0.6mg/dl/32mg/dl</td>
</tr>
<tr>
<td>Total Bilirubin</td>
<td>2.39mg/dl</td>
<td>0.96mg/dl</td>
</tr>
<tr>
<td>Urine output (24 hours)</td>
<td>450ml</td>
<td>3160ml</td>
</tr>
</tbody>
</table>

Patient was maintaining all other vital parameters, was extubated on 2nd post-operative day. Platelets count was improving requiring no blood products transfusion; hence he was started on oral anticoagulation on 4th post operative day.

Patient was shifted to ward with Bi-VAD support on 6th post-operative day. Round the clock pump flows were monitored. Cannula site sterile dressing was done on 12th post-operative day.
regular interval to avoid any infections. At the same time patient was actively involved in physical activities (sitting, walking, cycling).

After 37 days on Bi-VAD donor heart was available for Transplantation. Patient was shifted to Operation Theater with Bi-VAD and Intubated. Primed CPB circuit on table and divided to go on regular cardiopulmonary bypass. Target should be careful interchanging the lines without interrupting Bi-VAD flow Switch to RA and Aorta with CPB circuit by clamping and interchanging the lines. Cannulate SVC and IVC to go on Bi-Caval venous drainage. Remove RA, PA & LA cannulas to go ahead with explantation of native hear. Continue with same Aortic cannula to complete whole procedure. Patient subsequently underwent successful heart transplant. Total Ischemic time of 307 minutes, cold ischemia-204 minutes, warm ischemia- 103 minutes. After 37 days on Bi-VAD, after transplant he was discharged within 2 weeks of his transplant.

He was followed up in OPD for one month and then he was sent back to his country in November 2017.

He came for review in January 2018. All necessary investigations done including Endo-myocardial biopsy was done which showed no evidence of cellular or antibody-mediated rejection.

He was advised a follow up in June 2018. He visited us in June, 2018. He is doing well. Again cardiac biopsy revealed no evidence of cellular or antibody-mediated rejection.

**Discussion**

Nearly 50,000 heart patients require transplant every year. But just about 350 transplants were conducted in the last 24 years, Sources- Mohan Foundation Statistics. But the demand and donor ratio is far too skewed.

In this scenario, Ventricular assist device is a very wise decision to go with. BiVAD support can effectively be used as a bridge to heart transplantation and can be accomplished with low mortality and morbidity. For severely ill patients, the overall survival rate on device was 90%.

In future the number of heart failure patients is going to increase with current lifestyle what majority of our population is living. And getting a suitable donor heart will be difficult or almost nil. Future of Bi-VAD is seen there as bridging these patients to transplant till they get a suitable heart.

More experience with VADs will help professionals to meet future demands.

**Conclusion**

Acute shortage of organs resulting loss of lives. In future Bi-VAD’s would be lifesaving technique to reduce mortality rate caused by acute heart failure. Perfusionist play vital role in Bi-VAD support during waiting period to provide end organ perfusion and maintenance of biochemical parameters. Patients who go through bridge to transplants require living their routine lives as they await heart transplantation. While bridging aiming at normal physiology and should be doing activities of daily living till they get donor heart would be optimal.

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Management of Patient on Emergency TCA

Abhishek Chaudhary
Capitol Hospital
Jalandhar (Punjab)

Abstract
Patient diagnosed with OS ASD (atrial septal defect) was taken in OT (operation theatre) for on pump ASD closure. Operation went smoothly and ASD was closed, while weaning off from pump we observed something unusual, while filling the heart we found that the CVP (central venous pressure) was raising constantly with no ejection and no change in systemic pressure. Later we found that patient had supracardiac TAPVC (Total anomalous pulmonary venous connection). So we decided to go on TCA (Total circulatory arrest) (1) which lasted for 36 minutes.

Introduction
CPB (cardio pulmonary bypass) establishes perfusion while diverting the blood to an extracorporal circuit and thereby provides a bloodless heart for surgical access (2). Although CPB saves lives routinely, its use does result in abnormal physiological state. Cardiopulmonary bypass continues to be a high risk procedure. It is both life sustaining and life threatening. It is responsibility of the perfusionist to ensure the patient safety while the patient is on CPB. Perfusionist should be prepared to deal quickly and efficiently with any potential accident or error.

Case Report
A 19 years, 58 kg patient diagnosed with OS ASD was brought in O.T and standard monitoring was instituted such as ECG, CVP monitoring, Femoral and Radial arterial line pressure monitoring, nasal temperature monitoring, Oxygen saturation monitoring.

CPB was initiated with single stage cannulation at SVC, IVC and standard Aortic Cannulation. Aorta was cross clamped and 20ml/Kg blood cardioplegia was given at 8 degree. Myocardium was well protected. The ASD was successfully closed with Dacron patch. While weaning off from pump we noticed that CVP was rising with no ejection and no change in systemic pressure so we went on full bypass again. We started finding cause of it, to which we found that patient has unreported TAPVC.

It was planned to put the patient on TCA and do TAPVC correction. So we started cooling the patient. At 20 degree cerebral protective drugs (barbiturates: thiopentone sodium etc) (3) were given, the patient was brought into an alkalotic state by lowering Pco2 and adding sodium bicarbonate. ST Thomas cardioplegia was given; patient was placed on TCA at 18 degree for 36 minutes in trendelenburg position (4).

After 36 minutes CPB was restored the ABG (arterial blood gas) was corrected to normal limits. Cadioplegia was given and slow rewarming of patient was started. The cross clamp was released at 33 degree and the heart started beating with normal sinus rythem. Patient was weaned off successfully at 36 degree. Patient had good prognosis and was later discharged after 5 days.
Management

- Cerebral protective drugs (Barbiturates: Thiopentone sodium) were given
- Availability of equipment to efficiently cool the patient and sustain it.

Discussion

Various techniques have been followed in order to efficiently diagnose various disease and condition, but correctly diagnosing still remain a challenge, so we should co-relate and check other reports too rather than completely relying on ECHO report.
- In X-ray of supracardiac TAPVC patient the heart resemble figure of eight (5).
- The intraoperative Trans-esophageal echocardiography is important for precise diagnosis

Conclusion

- Intraoperative diagnosis of TAPVC is rare and difficult to manage.
- Early recognition and proper management is important in rectifying the situation.
- TCA offer an additional strategy in managing such situation as it offer clear bloodless field.

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“Cerebral ischemia: deep hypothermia”
Facts about Total Anomalous Pulmonary Venous Return or TAPVR
Veno-Venous Extracorporeal Membrane Oxygenation for the facilitation of Pulmonary sarcoid & Neuro sarcoid (Inter Departmental Management.)

Akhalesh sureshchand Maurya, Dinesh Rajendra Patil, Namita Mishra, Alok Kumar, Dr. Manoj Sahu, Dr M V Padma

Department of Cardiothoracic & Vascular Surgery
All India Institute of Medical Sciences (AIIMS)
Ansari Nagar, New Delhi

Introduction

Up to recent past, respiration and circulation couldn’t take rest throughout life, extracorporeal membrane oxygenation (ECMO) appears as the only makes shift arrangements in this juncture. It is always wise to take a timely decision to switch over to a temporary replacement treatment after assist therapy has failed and before secondary multi organ failure starts to set in.

ECMO (Extracorporeal membrane oxygenation) comes under the auspices of ELSO (Extracorporeal life support organization) is useful modality of mechanical circulatory/ ventilatory support for refractory cardiorespiratory and circulatory failure. ECMO is a special procedure for cardiac (Veno-Arterial) and respiratory support (Veno-Venous) that allows the sick or injured heart or lung to rest and recover. This technology arose from cardiopulmonary bypass used for cardiac Surgery.

ECMO uses a centrifugal & roller pump to circulate blood through an ‘artificial lung’ (blood oxygenator specially made membrane oxygenator with Poly-methylpentene hollow fibres) back into the bloodstream of a patient. This system provides heart-lung bypass support outside the patient body.

Sarcoidosis is a multisystem disorder that is characterized by non caseous epithelioid cell granulomas. It is a systemic granulomatous disease that is still of undetermined etiology,(1,2) which may affect almost any organ. Thoracic involvement is common(1) and accounts for most of the morbidity and mortality associated with the disease. Thoracic radiologic abnormalities are seen at some stage in approximately 90% of patients with sarcoidosis, and an estimated 20% develop chronic lung disease leading to pulmonary fibrosis.

If the nervous system is involved as it is in about 5-13% of cases, that involvement is termed “neurosarcoidosis”.(3,6) Spontaneous improvement or remissions occur in about 60% of patients with neurosarcoidosis.(9) The mortality rate in all forms of sarcoidosis is from 1-5% and is due to severe pulmonary, cardiac or neurologic diseases(10).

Case Report

A 70 years male presented with 3 months history of ARDS with recurrent fever, dry cough, tachypnoea. He diagnosed as sarcoidosis involvement of lung and
central nervous system which is defined as pulmonary and neurosarcoid. He was operated in 2015 for VP shunt in hydrocephalus and discharged from hospital. In 2018 he came with complaints of drowsiness, chest discomfort and quite irritable, saturation was 80-90% on maximum oxygen he put on non-invasive ventilation (BIPAP, CPAP) in ward. After 3 days the patient dropped oxygen saturation to 70%. He was shifted to neurosurgery ICU, while in Neurosurgery ICU he was tachypnoeic with spo2 of 85-90% on maximum oxygen. Where bilateral chest X-ray (CXR) and computed tomography (CT) chest was done it shows few pleural thickening with barrel atelectasis with sub pleural opacities. On the basis of symptoms, clinical examinations and previous investigations reveals possibilities of acute ARDS. On 4th day he was on normal ventilation (PRVC) he suddenly became tachyarrhythmic with saturation of 70% on arterial blood gas pH was 6.32, po2 =55mmHg, pco2=50mmHg BE= -8 mEq/L, SaO2= 80% He becomes haemodynamically unstable. In view of persistent hypercarbia the patient underwent sepsis and ARDS, to support respiratory system emergency Veno-venous ECMO support is established.

ECMO chest x-ray showed remarkable improvement in the lung opacities. The drainage and return cannulae were clamped for 3 hrs and patients hemodynamic and ABG remains stable so patient was weaned off from ECMO support. Inotropic support was gradually tapered and stopped over next 48 hrs. Patient was shifted to ward for further management.

**Discussion**

Our patient presented with 3 months history of pulmonary and neurosarcoid. As he was operated for VP shunt so he was admitted in Neurosurgery ward and initially managed with non-invasive ventilation with medications.
Our patient developed acute sepsis with ARDS with haemodynamic instability, emergently using VV-ECMO support. We established VV-ECMO rather than VA-ECMO because cardiac functions were normal and it was challenged to achieve lung support in 70 year old patient. We used miniaturised circuit to avoid extra blood and blood products. It would have been better if we have used Use of double lumen cannulae (Avalon®) placed thorough the internal jugular vein into the SVC & IVC juction, with the proximal lumen serving for venous return and the second distal lumen positioned near the tricuspid valve may provide better perfusion for ECMO support, but are expensive and were not available for our case.

VV-ECMO support can be use for pulmonary sarcoid distress acute ARDS and sepsis in haemodynamically unstable patient to support respiratory system and refractory hypoxemia and hypercarbia.

The approach to diagnosis is dependent on the presumed localization of the neurologic lesion whether it is present or not the patient has known evidence of systemic sarcoidosis which is leading in this patient as pulmonary sarcoid.

Mutual understanding between two different departments [Neurosurgery & Cardiothoracic surgery] can also be treat/serve the patients very well with golden supportive techniques like ECMO.

Instead of transferring the patient from one department to another department, we transport the machine from our department to another department this is beneficial for the patient.
Effect of anaesthetic drug used in CPB on the health of the perfusionist

Dharini Srinivasan, Roythankachen, Sankar.M, Raj Sahajanandan, Roy Gnanamuthu, Korah Kuruvilla
Dept of CTVS, CMCH Vellore

Abstract
Exposure of workers to waste anaesthetic gases in the operating and recovery rooms of hospitals is of concern because of the reported adverse effects of such gases on the health of personnel in this occupational group [1].

In contrast to Halothane, an agent likely to cause mutagenic effects and proven to be teratogenic — Isoflurane and Enflurane have not so far been proved to have adverse effects on the health of personnel exposed long term[2]. The sole use of intravenous drugs such as Propofol instead of volatile agents, were this possible, would eliminate occupational exposure.

Aim
The Aim of this study was to compare the effects of inhalational & intravenous anaesthetic agent on the health of the Perfusionist & other members of the cardiac surgical team
To increase the awareness among the health care professionals about the effects of inhalational anesthetic agents & to make Health care professionals aware of the Green OT concept

Green OT Concept
In an initiative to promote sustainable healthcare delivery and create a benchmark for performance in operation theatres (OT) across India, Abbott India joins hands with Bureau VERITAS Certifications (India) Pvt. Ltd. to provide a first of its kind accreditation for using green and safe practices in operation theatres.

The Green OT certification project is a first in the world certification and also the first 'Make in India' certification protocol developed by Bureau VERITAS in conjunction with Abbott India and multi hospital stakeholders like clinicians, bio-medical, hospital QA, Green House Gas surveyors, administrators etc.

Surgical care is an integral part of health care throughout the world, with an estimated 234 million operations performed annually. Every year, many millions of people undergo surgical treatment, and surgical interventions account for an estimated 13% of the world's total disability-adjusted life years (DALYs). While surgical procedures are intended to save lives, unsafe surgical care can cause substantial harm.

Green from an OT perspective covers all parameters like air flows, OT set up, anesthesia machines, types of volatile agents used, filling systems adopted and scavenging systems in place. Green connotes cleaner techniques using modern technology and processes with a sensitive approach to environment.

As a part of the process Bureau Veritas conducted independent assessments/ audits of the hospitals that focused on prevention of surgical site infections, safe anesthesia, safe surgical teams and equipment and a measurement and quality assurance mechanism. The process will conclude with a “Green Score” based on a 5 point scale that would be rewarded to the certified hospitals who meet the requisite quality and safety standards. [3, 4]
Introduction
Inhalation anesthetics are substances that are brought into the body via the lungs and are distributed with the blood into the different tissues. The main target of inhalation anesthetics (or so-called volatile anesthetics) is the brain. Inhalation anesthetics act either by amplifying inhibitory function or decreasing excitatory transmission at the nerve endings in the brain. The role of inhalation agents in general anesthesia is changing. Volatile anesthetics are seldom used alone in our days. A combination of inhalation anesthetics and intravenous drugs is called balanced anesthesia [5].

Currently used inhalation anesthetics include enflurane, halothane, isoflurane, sevoflurane, desflurane, and nitrous oxide. Older volatile anesthetics include ether, chloroform, and methoxyflurane (Wenker, 1999). Exposure to high concentrations of anesthetics has been reported to affect health.

NIOSH (National Institute of Occupational Health & Safety) reports that there are documented adverse health effects (e.g., headaches, fatigue, irritability, birth defects, miscarriages, liver and kidney disease, cancer) from excessive exposure to anesthetic gases.

Methodology
This study conceptualized when a feeling of malaise, tiredness spread across the theatre in every member of the team.

When discussing about the common causes of sudden onset of increased tiredness, an idea struck that it could be probably because of the circulating gases. Thus the study was undertaken by the investigator to find out the actual cause of tiredness, sleepiness and irritability. It was a prospective study done over a period of one month in the month of December 2017 – January 2018. Two randomized cardiac theatres were used for study purposes. One theatre used Propofol anaesthesia and other theatre used Sevoflurane anaesthesia.

At the End of the day a questionnaire regarding degree of tiredness, somnolence, headache and irritability circulated. 10 people were questioned, it included 2 Surgical Assistants, 2 Anaesthetists, 2 Nursing Personnel, 2 Perfusionists & 2 Students. Posters in the respective OT

There was Passive Scavenging system available in the OT. Dosage of Propofol used during CPB was 4 – 6 mg/kg/hr Infusion & Dosage of Sevoflurane used during CPB was 1 – 2 MAC (1.8 Vol%). Elective CABG & MVR procedures were taken in the study with an average time of 3 hours for each procedure.

A proforma was given to all the staff and students posted in each theatre. They were asked to score a scale of 0 – 10 for each parameter (Headache, Tiredness, Irritability, ability to work further etc.)

The total score was compiled and the study was done for 1 month.

Scavenging system in OT
Perfusionist - The first victim

the first picture in the collage, shows the vaporiser being attached to the circuit

The second picture in the collage shows the gas exhaust

The Third pictures points the gases condensing on the gas outlet

The fourth picture in the collage describes the perfusionist, who sits in close vicinity to the gas exhaust. The Perfusionist succumbs to being the first victim as he inhales the exhaust gases first.

This Collage describes the ventilator being connected to a scavenger, but howsoever during CPB, the mechanical ventilator is switched off and its functioning is being taken over by the HLM.

There are no scavenging system found for the HLM.
Data Analysis

Our Data was analysed with SPSS software and we found out that the percentage of Tiredness, Irritability, Somnolence and Headache were lower in the theatre which used Propofol anaesthesia.

The study results indicate that more of the operative room health staff personnel exposed to sevoflurane are suffering from headache and dizziness more than those staff who are exposed to Propofol.


Another Study was done by Gao, 2011, their results indicate that there is a significant effect of the operative rooms workers and their degree of headache. Also a highly significant effect of the suffering of dizziness on the headache perception. This result is supported with Brantberg, et al. (2005), they mentioned that there is an association between the dizziness and headache perception.

The % of Headache was 64% in Sevoflurane anaesthesia, while it was 36% in propofol usage.
TIREDNESS (mean score /10) | IRRITABILITY (mean score /10) | SOMNOLENCE (mean score /10) | HEADACHE (mean score /10)
---|---|---|---
SEVOFLURANE | 6.25 | 5.92 | 6.84 | 5.42
PROPOFOL | 4.59 ($p<0.001$) | 4.94 | 4.81($p<0.001$) | 3.02($p<0.001$)

Thus the Results proved that there was an increased percentage of associated adverse health effects with Sevoflurane anaesthesia which was statistically significant.

**Conclusion**
The researcher concluded that the healthcare staff in operative rooms are more prone to have headache and dizziness than those who working in other wards.

There is a significant effect of the age, and the job title on the suffering of headache and dizziness among operative rooms health staff

**Recommendations**
The researchers recommend further studies should be employed to involve a large number of health staff with a national level. Educational programs focusing on effective management these gases to reduce its effects on health of OR personnel should be implemented on regular basis.

**Review report**
1. The article is interesting as it reveals an important and hidden aspect of the many hazards faced by Operating room personnel.
2. Adding reference citations at the points mentioned will improve the information conveyed in the article.
3. Certain statements need correction to preserve grammatical propriety.

The article can be considered for publication, following implementation of the recommendations mentioned.

**References**
Comparison of Del Nido cardioplegia
St. Thomas cardioplegia in adult coronary artery bypass surgery: our early experience

Dr Sunil Dixit
Department of CT surgery,
S. M. S. Medical College, Jaipur

Abstract
The convenience offered by a single-dose cardioplegia strategy is the avoidance of interruption of the flow of surgery and, more importantly, a significant reduction in the cross-clamp time. Del Nido cardioplegia is an extracellular cardioplegic solution which serves these purposes and has been used successfully in paediatric cardiac surgery. In recent literature many reports showed their clinical experiences with Del Nido (DN) cardioplegia in adult cardiac surgery with good outcomes.

Material and methods:
Our study comprises of 100 patients who underwent elective coronary artery bypass grafting (CABG) surgery since January 2017. These patients were divided equally into two groups based on the type of cardioplegia used. We compared the aortic cross-clamp (ACC) time, cardiopulmonary bypass (CPB) time, total surgical time, requirement of intraoperative DC shocks, and postoperative behaviour in the two groups.

Results
The ACC time, CPB time, total surgical time were shorter with DN group (82 vs 104 min; 104 vs 138 min, and 2.4 vs 3.2 hrs respectively). In all cases of DN group single dose was used while in ST group 4-6 cardioplegia doses were used. Intraoperative and Postoperative behaviour was good in DN group patients.

Conclusions
The DN cardioplegia can and should be used in adult CABG surgery as it can lead to shorter ACC, CPB and surgical time, and may be better and better postoperative behaviour.

Key words
Del Nido cardioplegia, St. Thomas solution

Introduction
In the early 1990’s Dr Pedro Del Nido and his team at the University of Pittsburgh developed a cardioplegic solution for the specific needs of immature myocardium in congenital cardiac surgery. This solution is now called as Del Nido (DN) solution.

St. Thomas cardioplegic solution (ST) has already been popularized among all cardiac surgeons. ST solution is to be given at regular short intervals during surgery while DN solution is usually given as a single dose for about 90 mins. DN solution has less calcium and contains lidocaine. Myocardial acidosis occurs between the doses of cardioplegia which affects the postoperative outcome in any long surgery.
Our aim of this study is to evaluate the potential advantages of DN solution in adults undergoing coronary artery bypass surgery (CABG).

**Material and Methods:**

This prospective study was conducted in the department of cardiothoracic of S M S Medical College Jaipur. Consecutive patients undergoing CABG surgery were prospectively studied since January 2017. They were divided into two equal groups based on the cardioplegic solution – 1st DN group and 2nd ST group. The demographic details, preoperative and postoperative clinical data were collected and analysed including age, sex, comorbidity, pre and postoperative left ventricular ejection fraction (LVEF), aortic cross-clamp time (ACC), cardiopulmonary bypass time (CPB).

Tab. 1 Composition of St Thomas (ST) and Del Nido (DN) cardioplegia solutions

<table>
<thead>
<tr>
<th>DN cardioplegia</th>
<th>ST Cardioplegia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannitol</td>
<td>20%, 16.3 ml, 3.26 gm</td>
</tr>
<tr>
<td>Magnesium sulphate</td>
<td>50%, 4 ml, 2 gm</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>8.4%, 13 ml, 13 mEq</td>
</tr>
<tr>
<td>lidocaine</td>
<td>1%, 13 ml, 130 mg</td>
</tr>
<tr>
<td>Potassium chloride( 2 mEq/ml)</td>
<td>13 ml, 26 mEq</td>
</tr>
<tr>
<td>Na++</td>
<td>110 mmol/l</td>
</tr>
<tr>
<td>K+</td>
<td>16 mmol/l</td>
</tr>
<tr>
<td>Mg++</td>
<td>16 mmol/l</td>
</tr>
<tr>
<td>Ca++</td>
<td>1.2 mmol/l</td>
</tr>
<tr>
<td>NaHCO3</td>
<td>10 mmol/l</td>
</tr>
</tbody>
</table>

All surgeries were performed using a standard median sternotomy approach and CPB with mild hypothermia with either ST or DN cardioplegia both via antegrade route. ST was repeated at every 20 min and in all DN cases single dose was given.

All the data were analysed using SPSS and sample t-test; variables were reported as mean± standard deviation and as percentage(%).

**Results**

A total 100 patients were studied, 50 patients each in both groups. The demographic characteristics of both groups were almost similar as shown in table no. 2.

Table II: Baseline demographics

<table>
<thead>
<tr>
<th>variables</th>
<th>ST group</th>
<th>DN group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total no.</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Age (mean±SD)</td>
<td>62.6 ± 8.2</td>
<td>60.9 ± 9.3</td>
</tr>
<tr>
<td>Gender- male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- female</td>
<td>31</td>
<td>29</td>
</tr>
<tr>
<td>Comorbidity-D.M.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- HTN</td>
<td>11 (22%)</td>
<td>12 (24%)</td>
</tr>
<tr>
<td>- PVD</td>
<td>9 (18%)</td>
<td>10 (20%)</td>
</tr>
<tr>
<td>- Thyroid profile</td>
<td>4 (8%)</td>
<td>5 (10%)</td>
</tr>
<tr>
<td>LVEF (%) ( mean ± SD)</td>
<td>47 % ± 12.3</td>
<td>46 % ± 11.1</td>
</tr>
<tr>
<td>Mild to moderate MR</td>
<td>5 (10%)</td>
<td>6 (12%)</td>
</tr>
</tbody>
</table>
Comparison of Del Nido cardioplegia St. Thomas cardioplegia in adult coronary artery bypass surgery: our early experience

The intraoperative and postoperative outcome details are presented in table no.3.

<table>
<thead>
<tr>
<th>Table III: Intra and Postoperative Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ST group</strong></td>
</tr>
<tr>
<td>A.C.C. time (mins) (mean + SD)</td>
</tr>
<tr>
<td>C.P.B. time (mins) (mean + SD)</td>
</tr>
<tr>
<td>No. Of cardioplegia doses</td>
</tr>
<tr>
<td>Total surgical time</td>
</tr>
<tr>
<td>No. Of grafts</td>
</tr>
<tr>
<td>- LIMA use (%)</td>
</tr>
<tr>
<td>Intraoperative DC shocks required</td>
</tr>
<tr>
<td>Inotropic use - Mild</td>
</tr>
<tr>
<td>- Moderate</td>
</tr>
<tr>
<td>- Heavy</td>
</tr>
<tr>
<td>IABP use</td>
</tr>
<tr>
<td>In-Hospital Mortality</td>
</tr>
<tr>
<td>Postoperative EF (%) (mean + SD)</td>
</tr>
</tbody>
</table>

A single cardioplegia was given in DN group with overall uninterrupted surgery while 3-5 doses were given in ST group. DN group required less intraoperative DC shocks, and less postoperative inotropic support. In the ST group, 3 patients were required intra-aortic balloon counterpulsation (IABP), compared to only one in DN group.

Postoperative LVEF showed a significant difference in both groups. In-hospital mortality and infection difference were not found significant.

**Discussion:**

The DN solution has been used successfully in paediatric cardiac surgery in last 2 decades (1,2,3); however its use in adult cardiac surgery has only been recently described (4,5).

Uninterrupted surgery with short ACC and CPB times and better postoperative outcome by using DN solution were primary findings of our study, which is consistent with other studies (4,5,6).

Superior myocardial protection of DN solution over ST solution can be predicted by the less requirement of intraoperative DC shocks, postoperative inotropic supports including IABP, postoperative LVEF.

The DN contains lidocaine, a membrane stabilising agent which increases Na+ channel blockade which with magnesium content act as a Ca++ antagonist, protects the myocardium from high intracellular Ca++. So less accumulation of intracellular Ca++ during arrest prevents reperfusion injury (7).

Govidaripillai et al and O’Blennes et al studies showed that lower diastolic Ca++ during ischemia and reperfusion, avoidance of Ca++ induced hypercontraction during early reperfusion, superior calcium handling of cardiomyocytes, reduced myocardial injury and improved functional recovery.(8,9)

The limitations of our study is its descriptive nature and small sample size. Also no long-term follow-up is available.

**Conclusion**

Our study showed that the use of DN cardioplegia in adult CABG surgery has many advantages including ease of doing surgery uninterrupted, shorter ACC and CPB time, and better postoperative outcome probably may be due to better myocardial protection.

**References**

2. Khuri SF, Healey NA, Hossain M, Birjiiniuk V, Crittenden MD, Josa M, Treanor PR, Najjar SF,


The Indian Journal of Extra-Corporeal Technology (IJECT) is the official journal of the Indian Society of Extra-Corporeal Technology (ISECT). We welcome the original articles and papers on, topics interest to perfusionists, pertaining to clinical perfusion and extracorporeal-circulation.

Types of Papers

- **Original article**: word limit 5000 (excluding references), 40 references maximum, not more than 10 tables/figures
- **Mini review article**: word limit 2500 (excluding references), 20 references maximum, not more than 5 tables/figures
- **Review article**: word limit 6000 words (excluding references), 60 references maximum, not more than 10 tables/figures
- **Case report**: word limit 2000 words (excluding references), 10 references maximum, not more than 3 tables/figures
- **Innovations**: word limit 2000 words, 3 figures, 10 references (these articles describe new techniques or instrumentation)
- **Technical Challenges**: word limit 2000 words, 3 figures, 10 references
- The following are by invitation only
  - **Invited commentary**: word limit 1500 words, 0 references (this is an invited discussion on an original article that is of significance and will accompany the article when published)
  - **Book review**: word limit 1000, no references or figures.
  - **Editorial**: word limit 1500 words (excluding references), 10 references maximum.

Manuscript Submission

Manuscript must be in MS Word in .doc or .rtf only. Layout in single column and double space and 12 point Times Roman lettering. Charts may be patterned in black & white. Pictures should be 300 dpi JPEG or TIFF. Legends to figures with picture number, illustrations and photographs etc. should be neatly given in a separate sheet. The manuscript should be submitted on CD to the editorial office. Alternatively, data may be sent as e-mail attachment to: muktatiwari2@gmail.com

Manuscripts should be organized as follows: (a) Title page; (b) Abstract and Key words; (c) text with the following sections: Introduction, Materials and methods, Results, Discussion, Acknowledgements; (d) Tables; (e) Figure legends; and (f) References. Case reports should be divided into abstract, keywords, introduction, case history, disclosure (if sponsored), acknowledgements, and references.

Title page

The title page should include a brief and descriptive title of the article (no abbreviations allowed), the first name and surname(s) of the author(s) the name of the department(s) to which the work should be attributed; disclaimers, if any; the name and address of the author responsible for correspondence about the manuscript; should be typed at the bottom of the title page. If the manuscript was presented at a meeting, the meeting name, venue and the date on which it was read should be indicated.

Abstract

The abstract is an essential and the most read part of the paper. It should be factual and free of abbreviations except for SI units of measurement. All original articles must have a structured abstract with Background, Methods, Results and Conclusions, written on a separate page. A short abstract (not exceeding 100 words) must accompany all case reports and how to do it articles.

Keywords

Following the abstract, 3–6 key words should be given for subject indexing. They should be taken from Index Medicus or composed on similar lines.

Text

**Introduction**: should state the purpose of the investigation and give a short review of pertinent literature.

**Materials and methods**: must indicate clearly the steps taken to acquire the information. It should be detailed and may be separated into subsections. Generic names of drugs and equipment should be used throughout the manuscript, with brand names (proprietary name).
Results: should be reported concisely and regarded as an important part of the manuscript. Should be presented either in tables and figures and briefly commented on in the text or in the text alone. For statistical analysis, numbers of patients or subjects should be given, with percentages in brackets. Results of statistical tests should be reported as well as the p values.

Discussion: is an interpretation of the results and their significance with reference to pertinent work by other authors. It should be clear and concise. The importance of the study and its limitations should be discussed.

Acknowledgements: of personal assistance should, if appropriate, be placed at the end of the text.

References: should always be relevant; more is not necessarily better. They should be numbered in the order in which they appear in the text, and should be given in the ‘Vancouver style’. Journals should be indexed and their abbreviations confirm to, Index Medicus.

References format should be as follows:

Journal author(s), title of the article, name of the journal, volume number, page numbers (inclusive).

Book — author(s) title of the book, place of publication, publisher, year, page number used.
Greetings to all,

It is our pleasure to announce the 19th Annual Conference of ISECT on February 22-23rd, 2019, to be held in Chennai, Tamilnadu, India.

Chennai holds the colonial past and is an important city of South India. It was previously known as Madras.

Chennai, the capital city of Tamil Nadu is sited on the Coromandel Coast of the Bay of Bengal. It has played a very crucial role in the traditional, historical and academic growth of the country, representing the different elements of the highest variety of the Dravidian civilization. Today, Chennai, the capital city is the 4th largest city of India and is also the leading commercial centre of South India. The credit of the booming economy of the city goes to the leading industries including automobile, software services, petrochemicals, financial services, textiles and hardware manufacturing. Chennai, being an important metropolitan city is very well-connected to all the major cities of India as well as with the countries overseas. And, it is also considered as the cultural hub of South India which is famous for its affluent heritage in classical dance, music, architecture, sculpture, crafts, etc.

Over the past 19 years, the Annual Conference has become the premier gathering for Perfusionist to showcase their success stories, network with peers, develop organizational partnerships and hear from speakers willing to share their tips, techniques, and experiences for the benefit of our profession.

Through the Annual Conference we aim to provide attendees with practical, hands-on experiences so they can return home with relevant, actionable plans to improve their clinical efforts. Speakers will present topics which have real-world application for Perfusionists and which will help all of us address the challenges and shape the future of Perfusion Technology in India.

The Annual Conference on Perfusion Technology also provides an exciting opportunity for sponsoring organizations to showcase their products and services to perfusionists from across the country.

It is a matter of great pride that this would be enriching everyone with adequate knowledge. Moreover, this turns out into an experience both meaningful & memorable for all involved.

V. BASKARAN  
Org. Secretary  
ISECT CON 2019  
The Madras Medical Mission  
4A, Dr. J.J.Nagar, Mogappair  
Chennai - 600 037. Tamil Nadu, South India.  
Tel: 91-44-26561801, 26565991  
Fax: 91-44-26565510, 26565859  
Mob: +91 9840347943  
Email: vishybasky@yahoo.com

U. EMMANUEL RAJASINGH  
Org. Secretary  
ISECT CON 2019  
Apollo Main Hospital  
21, Greams Lane, Off Greams Road,  
Nungambakkam, Chennai - 600006  
Tel: 91-44-28296576  
Mob: +91 8056244870  
Email: manszone@outlook.com
With a great pleasure on behalf of organizing committee ISECTCON2020 AHMEDABAD, we extend a warm invitation to the 2020 Annual Scientific Meeting i.e. ISECTCON2020 AHMEDABAD held in “World Heritage City Ahmedabad” from 7 to 8 February 2020, which includes keynote presentations, Oral talks, Poster presentations and Exhibitions.

Our aims is to aggregate researchers, academicians and scientists from the perfusionists community and create an avenue towards robust exchange of information on technological advances, new scientific achievements and the effectiveness of various regulatory programs towards perfusion. Bringing together the professors, researchers and students in all areas of cardiac surgery and to provide an international forum for the dissemination of original research results, new ideas and practical development experiences which concentrate on both theory and practices. Many sessions will concentrate upon innovation, new technologies and the future direction of cardiac surgery. A major feature of the meeting is an inclusive trade and technical exhibition providing delegates with information around technological advances and innovation.

About Ahmedabad, in western India, is the largest city in the state of Gujarat. Ahmedabad situated in the heart of Gujarat and defined by a spirit of enterprise, is a bustling metropolis with reputed institutes and a rapidly growing economy, also deeply rooted in tradition. The city of Ahmedabad was formerly known as Ashaval of Asha Bhil; Karnavati of Karnaodev, Ahmedabad of Sultan Ahmed Shah, Rajnagar, the capital of Jainism, a politico-cultural city of Mahatma Gandhi and Sardar Patel and Amdavad of 'Amdavadis'.

Architecture is obviously not only about palaces, temples and forts built by kings. Building used by the common man are very much a part of architecture too. Residential precincts, known as Pols, are a typical typology of houses in various towns in Gujarat.

The city is known for its association with Mahatma Gandhi and in addition to a complex maze of neighborhood called pols, hosts some of the country's finest medieval Islamic Architecture.

There are hundreds of temples, mosques and other pilgrim spots in the city. Among all, one spot glaringly draws our attention, which is none other than Sabarmati Ashram, offered to the nation by Gandhiji, his humble residence known as “Hridaykunj”.

The 606-year-old walled city of Ahmedabad has become India's first “World Heritage City” declared by the World Heritage Committee (WHC) of UNESCO.

The places of most tourist attraction in India's first “World Heritage City Ahmedabad” are Gandhi / Sabarmati Ashram, Statue Of Unity, Kankaria Lake, Akshar Dham, Sidi Saiyyed Mosque, Jama Mosque, Huthcesingh Jain Temple, Adalaj Stepwell, Dada Hari Stepwell, Calico Museum of Textiles, Sarkhej Roza, Kalupur Swaminarayan Temple, Auto World Vintage Car Museum, Julta Minara, Sabarmati River Front, Bhadra Fort….

The culture of Gujarat is both ancient and modern. Gujarat is a flourishing state with cultural diversity. It is vibrant with its true colors of rich heritage and cultural traditions. Dating back to history with the Harappan civilization, the state becomes a confluence of many religions – Hinduism, Islam, Jainism and Buddhism. The Gujarati culture blends in arts, beliefs, customs, traditions, institutions, inventions, language, technology and values.

The list of most wellknown traditional festivals in Gujarat are Navratri, International Kite Festivals, Rann Utsav, Rath Yatra….

Ahmedabad has been selected as one of the Indian city to be developed as a smart city under the Smart Cities Mission.

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We look forward to seeing you at the ISECTCON2020 AHMEDABAD…… for a feast for eyes & brain

**Organizing President**
Dr. Ramesh R. Rau  
19, Samarpun Bungalows, Opp. Murlidhar Parlour,  
Near Sardar Patel Ring Road, Off HDFC Bank, Bopal,  
Ahmedabad 380058  
Mobile – 09327006325  
drramesh.rau@gmail.com  
drrameshravu@yahoo.com

**Organizing Secretary**
Mr. Chhipa Usmangani Yakubbhai  
5358, Kajimadhaba, Near Patharwali Masjid,  
Astita Chakla, Ahmedabad – 380001  
Mobile – 09327000784  
chhipal180abc@gmail.com

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