

EDITOR'S NOTE



Dr Manoj Durairaj

Heart Transplant Surgeon, MS, MCh. (AIIMS, New Delhi), FACC.

Director, Marian Cardiac Centre and Research Foundation.

Program Director, Department of Heart and Lung Transplantation, Sahyadri Hospitals, Pune.

Dear Colleagues,

Greetings to you from the Editor's desk. The April 2022 issue features a very niche article on Awake and Ambulatory ECMO by Dr Jumana Yusuf Haji, an ECMO specialist at the Sir H N Reliance Foundation Hospital, Mumbai. The concept of "Awake ECMO" centres around the paradigm of maintaining a patient awake and breathing spontaneously. This allows active ambulation and early rehabilitation of patients who can potentially become dependent on mechanical ventilation and prone for ventilator related complications. Patients in cardiogenic shock stabilised on VA ECMO should be awakened early and considered for early extubation. Awake ECMO helps in stabilising the end organ functions, down grading the disease for better outcomes, and work as a bridge for transplant. This strategy needs to be practised by an appropriately trained ECMO multi-disciplinary team and has a superior edge as compared to mechanical ventilation or conventional ECMO strategy in terms of facilitation of physical and nutritional rehabilitation. Any important facet of this modality is that patient verbal and physical communication is possible, and they can actively participate in the decision making process.

I thank Dr Haji for a very well written and illustrative article.

We are happy to introduce for the first time "The Revival" with a Video link. Please do press the link to see a video on Awake ECMO. Wishing our dear readers, a Happy Reading!

- Dr Manoj Durairaj
Editor "The Revival"

SUB EDITOR



Dr Talha Meeran

MBBS, MD, FACC, Consultant Cardiologist, Dept of Advanced Cardiac Sciences and Cardiac Transplant, Sir HN Reliance Foundation Hospital, Mumbai.

Dear Colleagues,

The April edition of REVIVAL has an elaborate and well written review on "Awake ECMO" by Dr Jumana Haji who is an ECMO and MCS specialist anaesthetist and Intensivist. Dr Haji tours around the country to speak and educate everyone on ECMO as part of the coveted ELSO group. The concept of awake ECMO was novel to me but after reading this informative review, I am excited about its applications in my clinical practice. The images and succinct tables included in the review make the article extremely easy to read.

Sincerely,
Dr Talha Meeran
Sub Editor "The Revival"

PRESIDENTIAL MESSAGE



Prof. (Dr) V. Nandakumar

Director & Chief, Division of Cardio Vascular/Thoracic Surgery & Cardiac Transplantation, Metromed International Cardiac Centre, Calicut, Kerala.

Dear Colleagues,

During the last 2 years the entire world has been under the clutches of Covid -19 . Now apparently it has subsided after it has shown the extent of devastation it could make. During this pandemic ECMO received much more attention than ever, since there were quite a number of patients needing this life support. Awake and ambulatory ECMO is a novel concept. Dr Jumana Yusuf Haji explains

in this article the rationale, challenges faced and how to take it forward. Need for an ECMO in an awake patient warrants critical evaluation. Dr Jumana stresses the importance of instituting awake ECMO before the onset of secondary respiratory failure. This exhaustive article covers protocols, strategies, precautions and rules for safe mobilization during ambulant ECMO. I am sure, this article will be of great help in decision making to use it when ECMO is prolonged .

Best wishes,

- Prof. (Dr) V. Nandakumar
President

Please call or write to us: Call: 9822322072, 9167048815, manojdurairaj@hotmail.com, talha.meeran@gmail.com

Link for membership,
<http://www.sfht.org/application.html>

Special thanks to Dr Jumana Yusuf Haji for authoring this month's article.

Designed by Maithili Kulkarni

AWAKE AND AMBULATORY ECMO



Dr Jumana Yusuf Haji

MBBS, MD(Anesthesia)

Consultant cardiac critical care in the Department of Heart Lung transplant and Advanced Cardiothoracic Surgery Sir HN Reliance Foundation Hospital Mumbai.

Mechanical circulatory support provider ECMO specialist.

Experience with setting up the ECMO program with ELSO registration at Aster CMI hospital and HN Reliance Hospital.

18 yrs post MD from KEM Hospital Mumbai. Trained for ECMO at National University Hospital (NUHS) Singapore.

ECMO Trainer for the ELSO recognized ECMO certification course in India.

Managed 60 + ECMO cases (VV VA VAV) with gratifying results.

Specialized in mobilization on ECMO and awake ECMO for early recovery and rehabilitation.

Publications on Awake ECMO, ECMO in organ donation and ECMO as bridge to transplant.

Extracorporeal membrane oxygenation is a type of Extracorporeal life support which takes over the function of the heart or lung or both heart and lung. It is indicated in acutely ill patients who are unable to maintain their end organ perfusion and gas exchange and in whom there is a possibility of reversal of heart / lung failure or who can be bridged to a definitive treatment for the failure by buying time on ECMO.

ECMO is often offered in a late desperate window only to patients who are failing all conventional treatment. Hence most of these patients are critically ill at the time of ECMO initiation and are already suffering from some of the critical illness issues such as neuropathy, muscle wasting, high inotrope/ventilator damage, nutritional deprivation. ECMO, once initiated, should therefore serve as a safety net in these patients to facilitate rehabilitation of the patient.

The indications for ECMO are many but the configuration should solely depend on the clinical parameters which differentiate between circulatory or gas exchange failure. (fig1, fig2, fig3, fig5)

Venovenous (VV) ECM:

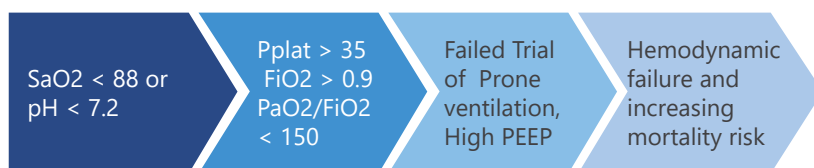


fig 1 Respiratory failure indicators for VV ECMO

Murray score	0 points	1 point	2 points	3 points	4 points
Chest Xray (Quadrants with consolidation)	n.0	n.1	n.2	n.3	n.4
Hypoxaemia (PaO ₂ /FiO ₂)	> 300	225–299	175–224	101-174	<100
PEEP (cm H ₂ O)	< 5	6–8	9–11	12–14	>15
Compliance (mL/cm H ₂ O)	> 80	60–79	40–59	20–39	<19

The final score is calculated as the sum of the component parts divided by 4

Fig 2 Murray score for patient selection

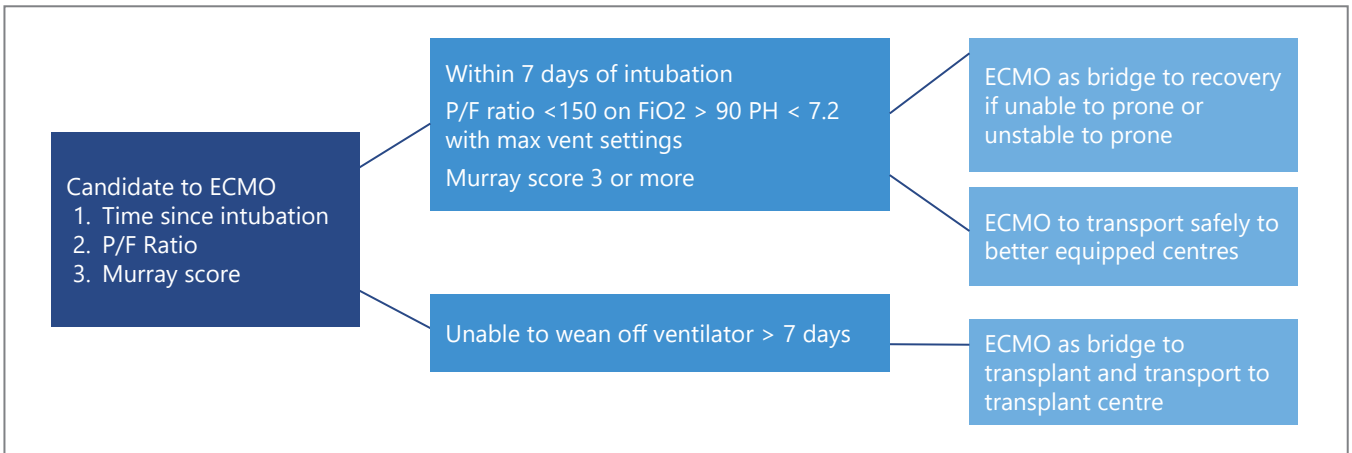


fig 3 ECMO for respiratory failure

Awake ECMO is maintaining a patient awake, breathing spontaneously, ambulating and rehabilitating the patient. These patients may never have been intubated, or may have been extubated or tracheostomised post ECMO initiation once the patient is stabilised.

Most patients with respiratory failure would get intubated, ventilated, with heavy sedation and paralyzing agents prior to initiating ECMO. Question is should ECMO be offered in lieu of conventional treatment.

There are a few indications of ECMO in an awake patient as first line of stabilisation instead of intubation and ventilation. Awake ECMO pathophysiology in ARDS has been well described by Thomas Langer ET al [1] (fig 4)

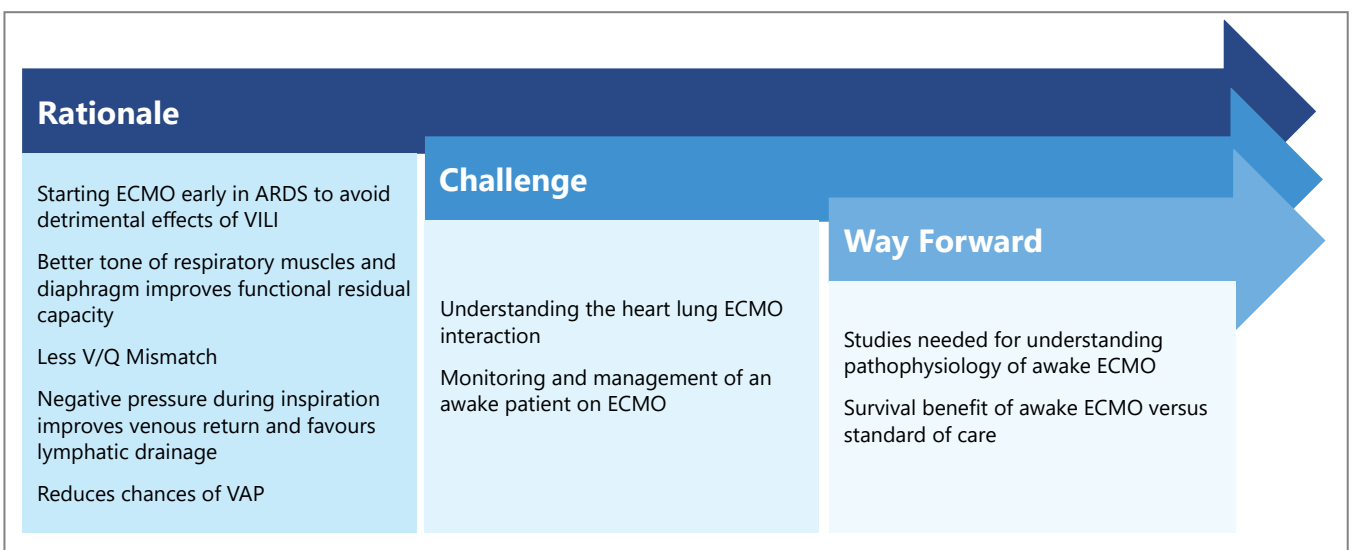


fig 4 Awake ECMO pathophysiology in ARDS by Thomas Langer ET al [1]

Venoarterial (VA) ECMO:

Progressive circulatory failure as suggested by



fig 5- Circulatory failure indicators for VA ECMO

The prognosis in patients with cardiogenic shock, who are candidates for mechanical circulatory support, is very guarded unless being considered for early ECMO. These patients are suitable candidates for awake ECMO before the onset of secondary respiratory failure. Patients with cardiac failure stabilised with veno-arterial (VA) ECMO, should be awakened and considered for early extubation. Good indications for bridge to recovery are refractory arrhythmias, cardiotoxic drugs such as Aluminium phosphide poisoning, amlodipine poisoning need ECMO (till these nondialyzable drugs are cleared from the system) and viral myocarditis which is a self-limiting condition. Preoperative/ peri procedure support in patients with acute MI for PTCA/CABG can be initiated on awake ECMO as a safety net till the culprit vessels can be bypassed or revascularized. It offers complete cardio respiratory support in unstable patients. [2]

Awake VA ECMO in patients presenting with acute on chronic heart failure works as a means for assessing patients suitable for ventricular assist devices (VADs) while temporarily supporting biventricular functions [3]. Awake ECMO may thus help to stabilise end-organ functions, downgrade the disease for better outcomes, or work as a bridge to heart transplant [4,5]. Su Huan Lee concluded that cases requiring ECMO or mechanical ventilation due to unavoidable exacerbation in awaiting LTx patients, awake ECMO strategy performed by an appropriately trained ECMO multi-disciplinary team can be useful compared with mechanical ventilation or conventional ECMO strategy. [6]

Patients bridged directly to heart transplant were younger, more likely to have severely disabled functional status but had shorter waitlist time as they are listed as supra urgent and get priority (as per Shinichi Fukuhara MD paper read at the 97th Annual Meeting of The American Association for Thoracic Surgery, Boston, Massachusetts, April 29-May 3, 2017). However, they were more frequently mechanically ventilated than were patients in the continuous-flow left ventricular assist device group. This needs to change as with better ECMO equipment and expertise it is important to use a window to initiate awake ECMO for such patients.

Awake ECMO pros and con

Pros	Cons
Reduce risk of VILI VAP	High work of breathing which may increase oxygen demand and CO2 production
Better tone of respiratory muscles and diaphragm improves functional residual capacity	Transpulmonary pressure may be high leading to spontaneous induced lung injury. (P-SILI)
Less V/Q Mismatch	Difficulty in monitoring ventilation and airway pressures
Negative pressure during inspiration improves venous return and favours lymphatic drainage	Interference with ECMO flow due to collapse in IVC over cannula during deep inspiration
Increased Comfort, Improved delivery of inhalational medicines, Patient engagement in spirometry	Decreased clearance of secretions
Facilitation of physical rehabilitation	Equipment failure may be catastrophic as patient more ECMO dependent. Monitoring lines and managing an awake patient
Facilitation of patient communication, Participation in decision making	Needs to be kept engaged. Maybe difficult to withdraw if the native organ doesn't improve
Lesser ICU psychosis	
Better Nutrition	

Awake ECMO helps with facilitation of physical rehabilitation. Patient can be engaged in spirometry. Patient communication is possible helping with participation in decision making. Nutritional rehabilitation is much easier and patients suffer lesser ICU psychosis. [7] In order to maintain patient awake and reverse the adverse effects of conventional treatment it is important to plan right from initiation of ECMO. Window of initiation, cannulation strategy, airway management sedation strategy and manpower allocation all help in improving the quality of ECMO runs. Early elective awake ECMO has much better outcomes than late ECMO in a moribund patient on high supports. Patient factors such as PEEP dependance, obesity and inotrope/

pressor support determine the ease speed and feasibility of initiation of ECMO on an awake patient. Awake ECMO may not be possible in septic hemodynamically unstable patients or patients with high PEEP requirement. Ambulation can only be attempted in presence of trained expert team. However, it should be mandatory to attempt physiotherapy and rehabilitation on all ECMO patients as ECMO acts as a safety net and provides a window to undo the adverse effects of conventional therapies. Spontaneously breathing patient may have high work of breathing which may increase oxygen demand and CO₂ production. Transpulmonary pressure may be high leading to spontaneous induced lung injury. (P-SILI). Difficulty in monitoring ventilation and airway pressures and decreased clearance of secretions. This can be circumvented by choosing tracheostomy in such individuals over extubation to maintain awake. Interference with ECMO flow due to collapse in IVC over cannula during deep inspiration. Equipment failure may be catastrophic as patient more ECMO dependent. [8]

Timing of rehabilitation

Once ECMO goals are met within first 24 hrs - aim sedation vacation should be given. If waking up appropriately, maintain orientation to maintain day night reorientation and organize a sedation-based rehabilitation plan. [6]

Explain intervention whenever attempting any rehabilitation. Strive for sedation levels where patient comfortable but arousable. Using adequate amount of fentanyl (3-4 times higher for patients on ECMO) helps to maintain patient arousable, interactive and comfortable.

If the recovery is anticipated to be prolonged, an early planning of airway management may help (Extubation, Tracheostomy). This is because it is difficult to decrease sedation in a patient who has an oral endo tracheal tube.

ELSO guidelines on extubation [7]

Assessing readiness	Gas exchange criteria	Extubation
<ul style="list-style-type: none"> Absence of multiorgan failure, shock The patient is awake and cooperative enough to at least maintain the airway and not pull out the lines Secretions are manageable (consider bronchoscopy prior to extubation) PEEP dependent individuals (obese, Pulmonary oedema) should not be included 	<ul style="list-style-type: none"> The patient should have an acceptable arterial blood gas on minimal ventilator settings, e.g.: FIO₂ 0.4, PEEP 5. Goal PaO₂ >80 on FIO₂ of 0.4 and FDO₂ 1.0 Goal pH >7.35 with minute ventilation <10 L/min while receiving a sweep gas flow <6 L/min 	<ul style="list-style-type: none"> Take an informed consent from kin Perform chest physio and suctioning Prepare supplemental Oxygen Consider extubating to non rebreather mask / HFNC / NIV Keep emergency intubation equipment ready for failure Check ABG and adjust sweep post extubation

Tracheostomy maybe a good option over extubation as it is comfortable hence minimal sedation needed. Safer than extubation as patient is easier to suction and maintain optimal PEEP. Additionally, patient can eat orally. However, tracheostomy maybe technically difficult as the neck has cannulae and access lines. Anticoagulated ECMO patients are always at risk of bleeding. [8]

Cannulation strategies:

A dual lumen single cannula for VV ECMOs (fig6a) or an axillary cannula (fig 6b) for a VA ECMO may be preferred by most to facilitate ambulation on ECMO as it keeps the lower limbs free of cannulae. However, these cannulae are technically difficult to insert and need surgical technique and move to either cath lab or operation theatre to achieve. Dual lumen single cannula if dislodged or slightly displaced can have catastrophic consequences as it needs to be positioned under TEE guidance in Cath lab. Axillary cannulae tend to bleed.



Fig 6a – Dual lumen single cannula

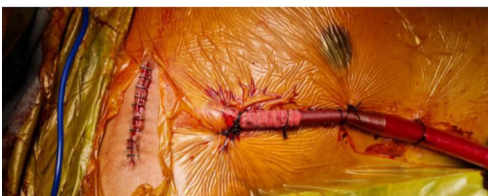


Fig 6b – Axillary artery return cannula with an axillary graft



Fig 8 - Team

Femoral cannulation can be done easily in an unstable patient bedside by Seldingers or semi open technique with minimal comfort sedation or under local anaesthesia. Most peripheral ECMO configurations will have at least 1 femoral cannula.

Femoral cannulae are not a contraindication for mobilisation if they are well secured. (fig 7)



Fig 7- Fixation of femoral cannulae

ECMO Specialist - Monitor the haemodynamics and troubleshoot clinical situations.

Bedside nurse - Watch patient and cannula sites monitor functioning and emergency drugs comfort drugs

Expert physiotherapist with assistant - plan the exercise mobilisation with devices

Respiratory therapist - arrange the ventilator, oxygen back up, suction, Airway devices

Perfusionist - To troubleshoot machine malfunctions ensure length of tubing's adequate for the motions planned

Hence awake and ambulatory ECMO is resource intensive and needs experts on the team who can trouble shoot machine and patient pathology related mishaps and who understand the ECMO-Heart Lung interactions

Precautions and rules of safe mobilisation:

Baseline vitals should be documented. Patient should be connected to monitoring equipment at all times

Any changes in haemodynamics saturation and flow variations should be dealt with appropriately.

There may be a need for increase in fio2 and mechanical ventilation. Any changes should be by ECMO trained physician. Teamwork with responsibility delegation to see different parameters and each member has right to stop activity if any risk noticed.

Challenges include equipment failure which may be catastrophic as patient may be ECMO dependent. Loss of cannula maybe prevented by proper fixation. Monitoring lines and managing an awake patient needs a lot of eyes on the patient for observing and managing the different parameters.

Care of awake patient:

Needs 1:1 nursing care, periodic psychological counselling as psychological burden for patient and relatives is high. Specific physiotherapy needs to be tailor-made as per requirement of each patient depending on their ECMO configuration participation and haemodynamics. These patients need activities to fill spare time like frequent visits from relatives, books, television, internet, excursions. Hence such patients need better mobile ECMO devices and customized wheelchairs.

Steps of physiotherapy:



Fig 9- Incentive spirometry in a patient of awake Veno-arterial femorofemoral ECMO

If heavily sedated- passive limb movements and chest physio with postural drainage and side changes.

If awake but critical illness neuropathy and muscle wasting is present then electrical stimulation along with the above-mentioned physiotherapy.

If extubated incentive spirometry especially in the VA ECMO patients who have a tendency to develop pulmonary oedema due to their poor LV function. (fig 9)

If awake work on muscle power by active limb movements with careful physiotherapy planning by expert physiotherapist in sync with the ECMO specialist (fig 10a,10b,10c).

Ambulation activities include sitting edge of bed with head and upper trunk holding(11a). Sitting out of bed in a chair(11b), standing and walking depending on patients' haemodynamic stability (11c).

(Fig 11a edge of bed and trunk control, Fig11b out of bed in a chair, Fig11c walking with femorofemoral Veno arterial ECMO in a case of aluminium phosphide poisoning awake ECMO)

Activities to engage an awake patient with single organ failure on ECMO awaiting organ recovery or transplant are eating independently (fig 12a), watching movies (fig 12b), interactive games that test fine motor gross motor skills as well as need concentration and focus (fig 12c).



fig 10a - active leg raising



fig 10b-hand cycling



fig 10c- leg cycling



Fig 11a edge of bed and trunk control



Fig 11b out of bed in a chair



Fig 11c walking with femorofemoral Veno arterial ECMO in a case of aluminium phosphide poisoning awake ECMO)



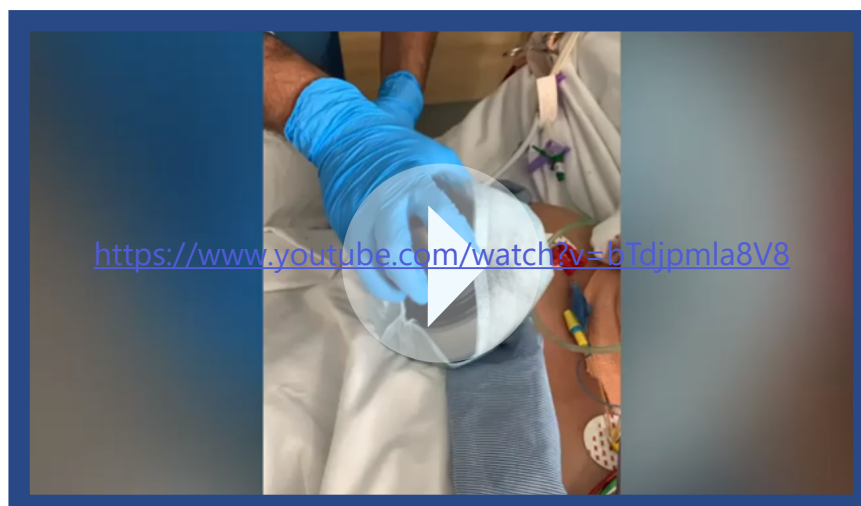
Fig 12a eating and working on tab Covid ECMO as bridge to recovery/transplant



Fig 12b Watching TV



Fig 12c Post single Lung transplant to improve physical strength



CONCLUSION:

Every ECMO program should aim to develop goals, methods, and protocols towards ambulation of patients. Scale dangers and advantages individually. Team approach with role and responsibility assigned. Plan cannulation, sedation, airway with objective of early ambulation. Plan for physiotherapy daily with frequent re-evaluation and goal setting.

Awake patient and ambulation and rehabilitation on ECMO is mandatory in bridge to lung/heart transplantation. It is particularly necessary in prolonged ECMO runs waiting for recovery of organ function. Better insight should be developed to understand the ECMO and patient interaction to confidently use it to advantage especially when the runs are long and its single organ failure as bridge to transplant or recovery. Safer more portable devices monitors and methods of fixing cannulae and lines would make it less resource intensive and safer.

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Dr Anvay Mulay and team – Department of Advanced Cardiac Surgery and Heart Lung Transplant – Sir H N Reliance hospital Mumbai

Dr Aashish contractor, Dr Bijal Dodia and team – Department of Rehabilitation medicine sir HN Reliance hospital Mumbai

PRESIDENT

DR V NANDAKUMAR

Mob: 9843015888

Email: drvnandakumar@gmail.com

PRESIDENT ELECT

DR RONY MATHEW

Mob: 9846097812

Email: drronymathew@yahoo.com

VICE PRESIDENTS

DR JULIUS PUNNEN

Mob: 9980072785

Email: jpunnen@hotmail.com

DR AJITKUMAR V K

Mob: 9895153684

Email: ajitkumarvk@yahoo.com

SECRETARY

DR JABIR ABDULLAKUTTY

Mob: 9447011773

Email: drjabi@yahoo.co.in

JOINT SECRETARY

DR RAJAGOPAL S

Mob: 9747606600

Email: srajagovindam@gmail.com

TREASURER

DR PRAVEEN G PAI

Mob: 9847334434

Email: praveen.pai.g@gmail.com

PAST PRESIDENTS

DR GEEVAR ZACHARIAH

(2013-2014 and 2014-2015)

Mob: 9846066816

Email: geevarzachariah@gmail.com

DR SHIV K NAIR (2015-2016)

Email: shivnairmd@gmail.com

DR K VENUGOPAL (2016-2017)

Email: venugopalknair@gmail.com

DR JOSE CHACKO PERIAPURAM

(2017-2018)

Mob: 9847043224

Email: joseperiapuram@hotmail.com

DR P P MOHANAN (2018-2019)

Mob: 9846076006

Email: drppmohanana@yahoo.com

MEMBERS

DR C G BAHULEYAN

Mob: 9447344882

Email: bahuleyan2001@yahoo.co.uk

DR P CHANDRASEKHAR

Mob: 9443047152

Email: chanpad@gmail.com

DR COL JAMES THOMAS

Mob: 9892797060

Email: thomasdrjames@yahoo.in

DR JACOB ABRAHAM

Mob: 9847128123

Email: jacobraham1@gmail.com

DR JAYAGOPAL P B

Mob: 9847023777

Email: jaigopallakshmi@gmail.com

DR KARTHIK VASUDEVAN

Mob: 9845281450

Email: karvasudevan@gmail.com

DR C S HIREMATH

Mob: 9481119646

Email: hiremth.cs@sss.hms.org.in

DR MANOJ DURAIRAJ

Mob: 9822322072

Email: manojdurairaj@hotmail.com

DR RAJESH RAMANKUTTY

Mob: 9846005737

Email: drrajesh_mr@yahoo.com

DR V K CHOPRA

Mob: 9560898900

Email: chopravk@gmail.com

DR TALHA MEERAN

Mob: 9167048815

Email: talha.meeran@gmail.com