
بسم الله الرحمن الرحیم
به نام خدای بخشنده مهربان

Extracorporeal Membrane Oxygenation and poisoned patient

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Cardiac anaesthesiologist
Associated professor
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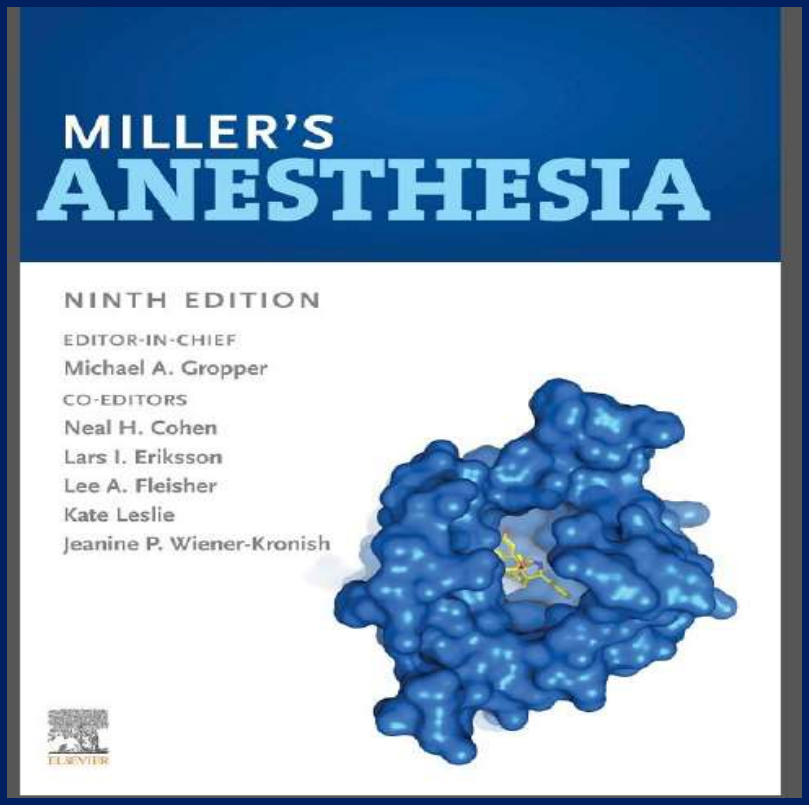
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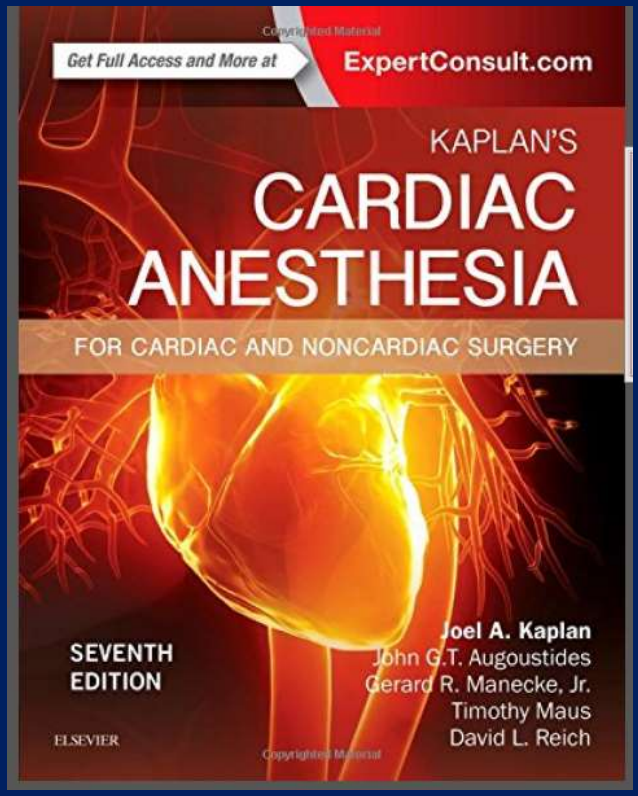
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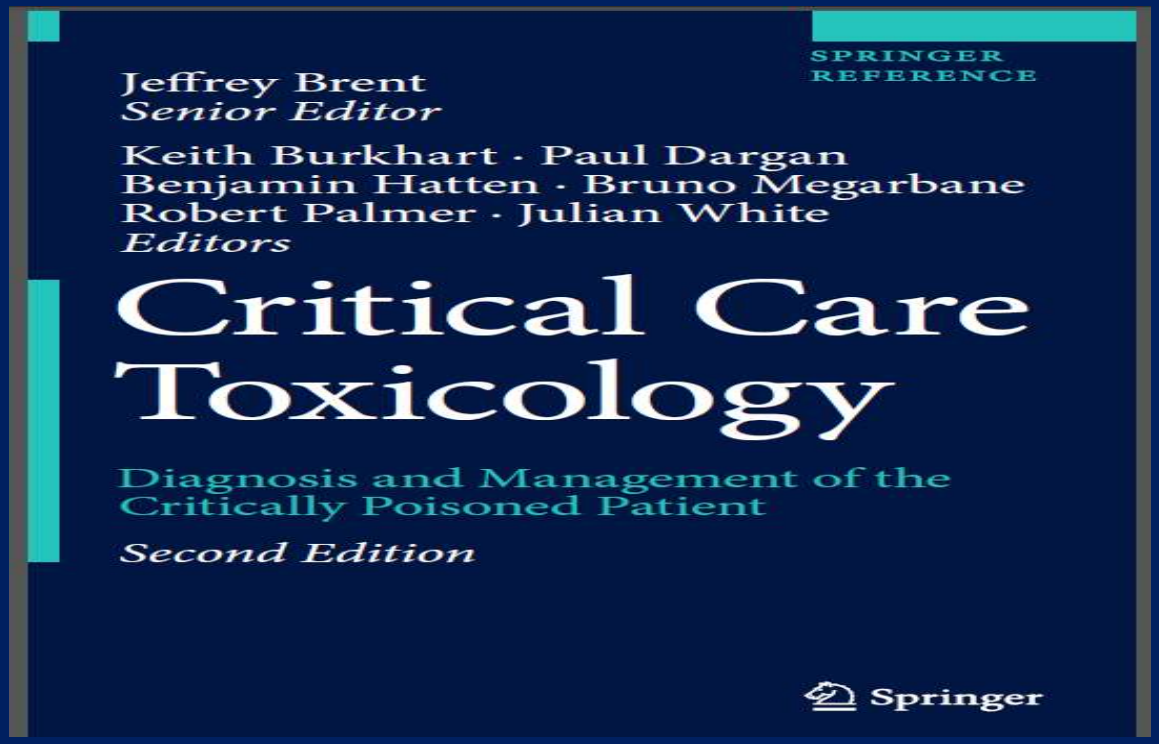
Extracorporeal Membrane Oxygenation and Cardiac Devices

James G. Ramsay, Kenneth Shelton, and Gaston Cudemus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He conducted several clinical and experimental studies in clinical toxicology management of refractory cardiotoxicant poisonings use in ECMO.

Extracorporeal Membrane Oxygenation and Cardiopulmonary Bypass in the Poisoned Patient

4

William P. Kerns II and Alan C. Heffner

ECMO in Poisoning

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J Card Crit Care TSS 2017:1:82–88

Abstract

Severe poisoning may lead to life-threatening situation or death due to cardiovascular dysfunction, arrhythmia, or cardiogenic shock. The poisoning substance varies in different parts of world; in the Western world, the drugs with cardiotoxic potential are more common, while pesticides and other household toxins are common in the rest of the world. However, most of these patients are relatively young and otherwise healthy irrespective of poisoning substances. Extracorporeal membrane oxygenation (ECMO) has regained interest in recent past and now its use is being explored for newer indications. The use of ECMO in poisoning has shown promising results as salvage therapy and can be used as bridge to recovery, antidote, and toxin removal with renal replacement therapy or transplant. The ECMO has been used in those poisoned patients who have persistent cardiogenic shock or refractory hypoxemia despite adequate supportive therapy. ECMO may be useful in providing adequate cardiac output and maintain tissue perfusion which helps in the redistribution of toxins from central circulation and facilitate the metabolism and excretion. However, the available literature is not sufficient and is based on case reports, case series, and retrospective cohort study. In spite of high mortality with severe poisoning and encouraging outcome with use of ECMO, it is an underutilized modality across the world. Though evidences suggest that early consideration of ECMO in severely poisoned patients with refractory cardiac arrest or hemodynamic compromise refractory to standard therapies may be beneficial, the right time to start ECMO in poisoned patients, criteria to start ECMO, and prognostication prior to initiation of ECMO is yet to be answered. Future studies and publications may address these issues, whereas the ELSO (Extracorporeal Life Support Organization) data registry may help in collecting global data on poisoning more effectively.

Keywords
- ECMO
- ECLS
- ECPB
- intoxication
- poisoning

ALL CONFERECES

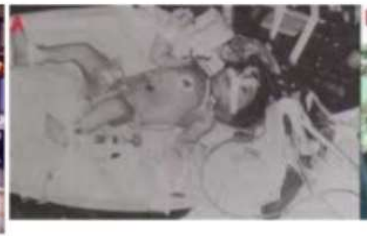
- 1-Introduction
- 2-History
- 3-Role of ECMO in Poisoning
- 4-ECMO for Respiratory Failure (VV ECMO)
- 5-ECMO for Circulatory Failure (VA ECMO)
- 6-Indications AND Contraindications(VA-VV)
- 7-The Mechanics of ECMO
- 8-Vascular Access for ECMO
- 9-Monitoring on ECMO
- 10-Weaning from ECMO

Introduction

- A form of extracorporeal life support where an external artificial circuit carries venous blood from the patient to a gas exchange device (oxygenator) where blood becomes enriched with oxygen and has carbon dioxide removed.
- The blood is then returned to the patient via a central vein or an artery.

History of Extracorporeal Life Support

1950s	Development of membrane **oxygenator** in laboratory
1971	**First successful case**
1972	**First successful paediatric cardiac case**
1975	**First neonatal case** (Esperanza)
1975-89	Trial in **ARDS**, 10% survival
1990	**Standard practice for neonates and paediatrics** in some centres
2000	**Standard practice for adults** in some centres
2009	Publication of the **CESAR** trial which led to a significant growth in the use of ECMO for ARDS cases

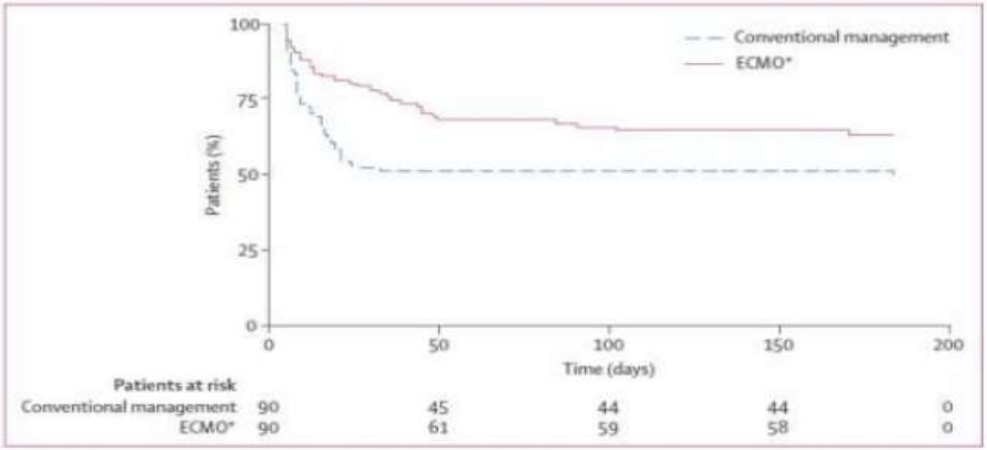


Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial

Giles J Peek, Miranda Mugford, Ravindranath Tiruvoipati, Andrew Wilson, Elizabeth Allen, Marianne M Thalanany, Clare L Hibbert, Ann Truesdale, Felicity Clemens, Nicola Cooper, Richard K Firmin, Diana Elbourne, for the CESAR trial collaboration

ST VINCENTS & MATER HEALTH SYDNEY

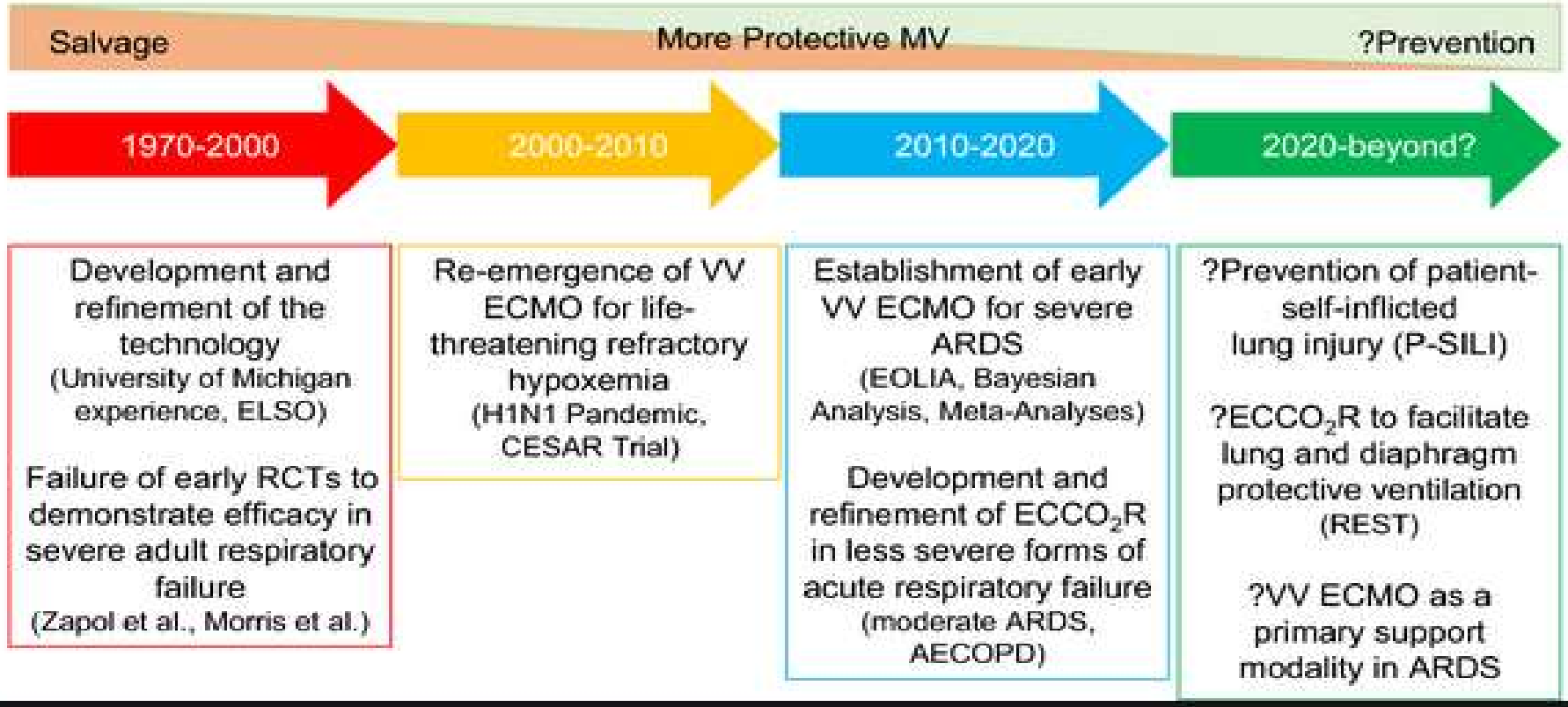
- ECMO (n=90 patients)
- Conventional management (n=90)
- 68 (75%) patients actually received ECMO
- 63% of patients consideration for treatment by ECMO survived
- 47% of patients on conventional management survived
- Relative risk 0.69; 95% CI 0.05–0.97, p=0.03
- Quality-adjusted life-year: £19 252



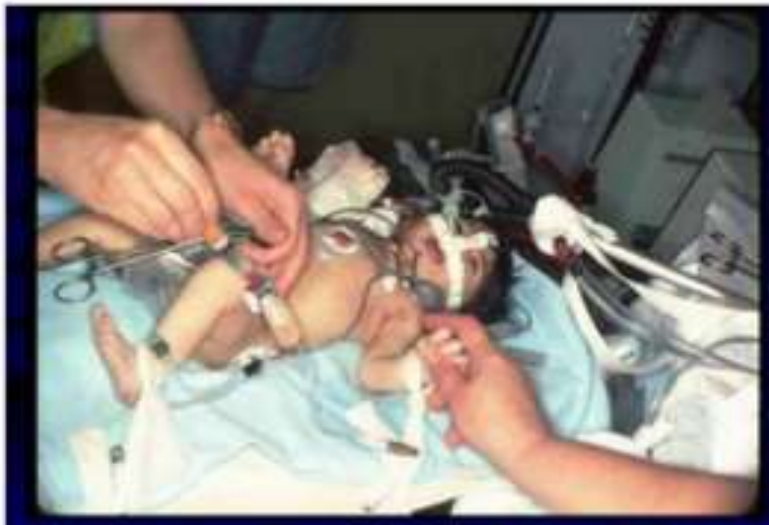
RESULT OF CESAR TRIAL

- Referral to consideration for treatment by ECMO led to a gain of 0.03 quality-adjusted life-years (QALYs) at 6-month follow-up.
- (relative risk 0.69; 95% CI 0.05-0.97, p=0.03).
- A lifetime model predicted the cost per QALY of ECMO to be pound 19252 (95% CI 7622-59 200) at a discount rate of 3.5%.

The Evolving Paradigm of Extracorporeal Support for Adults with Acute Respiratory Failure



First Neonatal ECMO survivor..



Esperanza, Age 1 day 1975

Esperanza, age 21

First successful ECMO patient in1971

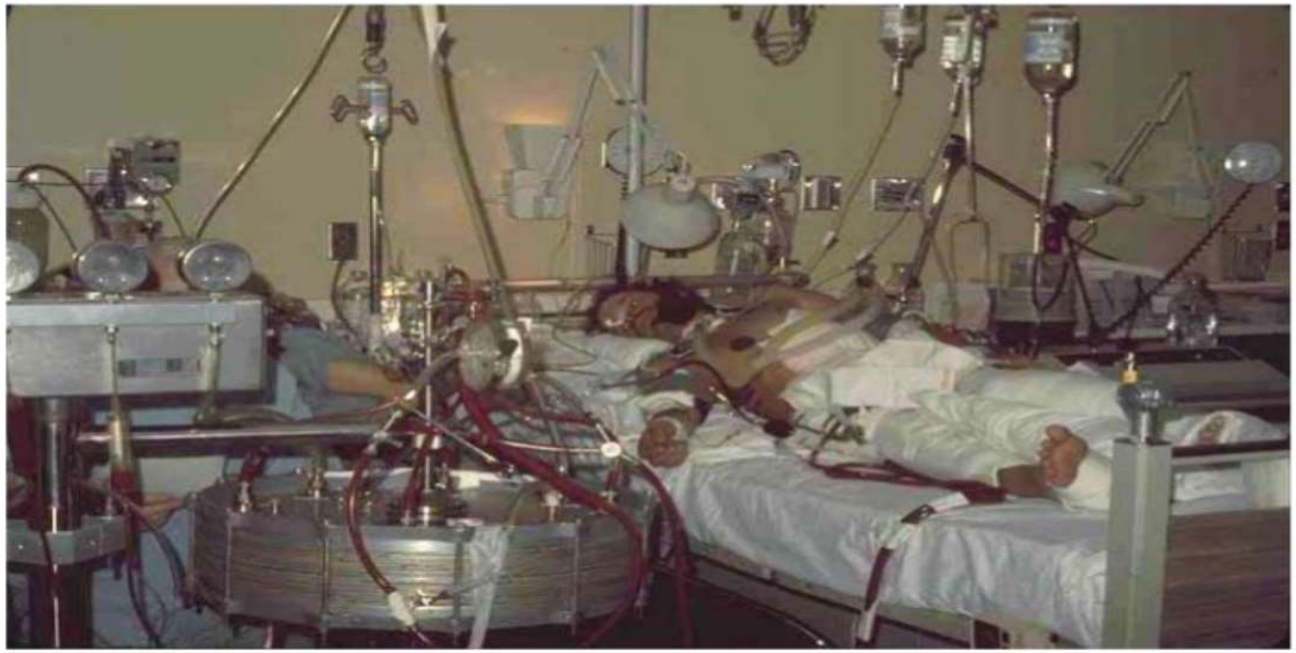
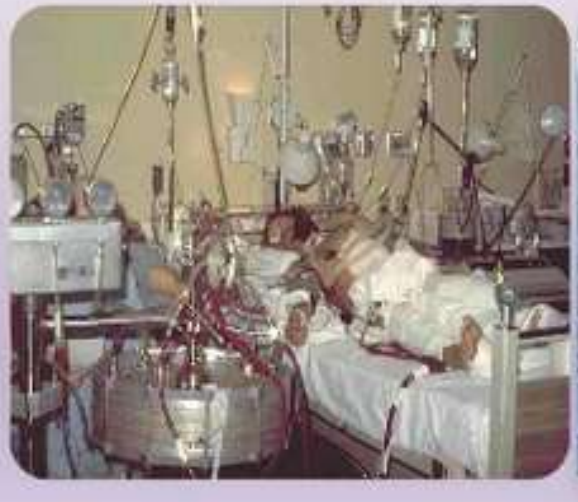


Figure 3.4. The first successful extracorporeal life support patient, treated by J. Donald Hill using the Bramson oxygenator (foreground), Santa Barbara, 1971.

1972



2014

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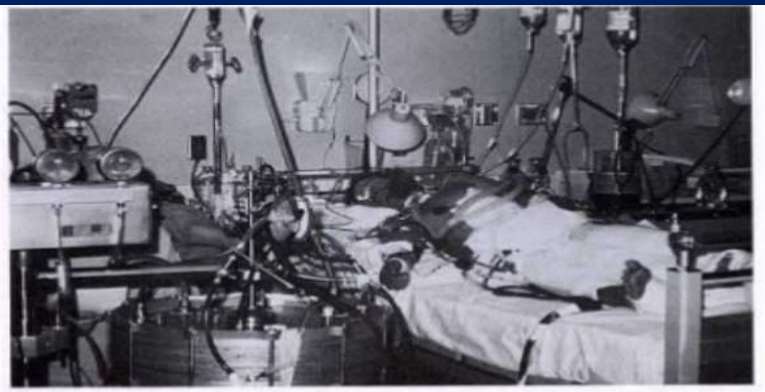
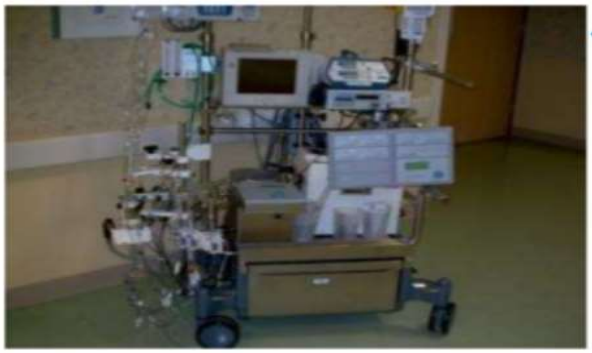


FIGURE 3.4 The first successful extracorporeal life support patient, treated by J. Donald Hill using the Bramson oxygenator (foreground), Santa Barbara, 1971.



TO THIS →

History of Extracorporeal Cardiorespiratory Support

- The history of ECMO is related to the development of CPB.
- The first successful use of CPB in a human was by Gibbon in 1953, to repair an atrial septal defect in an 18-year-old patient.
- Warden USE of cardiac surgery with CPB,to many centers.(next years).
- During this period the Extracorporeal Life Support Organization or ELSO was founded, first at the University of Michigan in 1989, then a European ELSO group formed in 1991.
- This organization has played a key role in documenting worldwide ECMO use.

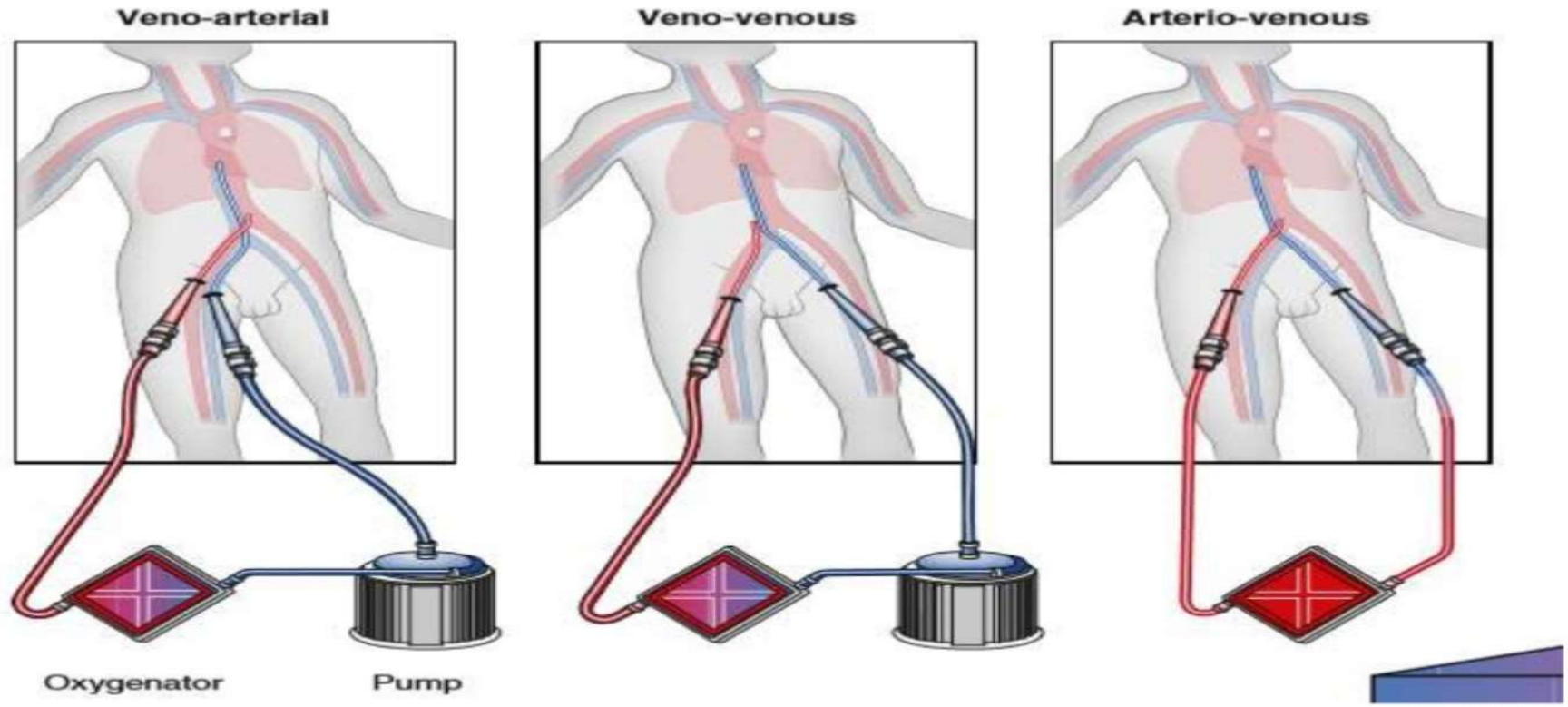
	VV ECMO	CPB
Duration	Days to weeks	Minutes to hours
Anticoagulation	+/- low dose heparin	High-dose heparin
Reversal of anticoagulation	Rarely	Protamine
Hemodilution	Minimal	Deliberate
Hypothermia	No	Yes
Air-blood interface	No	Yes
Pulsatility	Yes	No
Ischemia-reperfusion	Variable	Yes

Introduction

- Extracorporeal membrane oxygenation or ECMO refers to a number of configurations of extracorporeal circulatory and/or respiratory support.
- Other instrument such:
- MCS (mechanical circulatory support).
- ECLS (extracorporeal life support) have been used.
- But in North America ECMO most commonly used for work of the heart and lungs by adding oxygen and removing carbon dioxide from circulating blood for prolonged intervals.

Introduction

- Venovenous (VV) ECMO withdraws venous blood and returns oxygenated blood to the right side of the heart supporting only respiration.
- venoarterial (VA) ECMO withdraws venous blood and returns oxygenated blood to the arterial system, thereby supporting both respiration and circulation.
- Another configuration is venous-pulmonary artery (VPA) ECMO used to support the right heart and the lungs when there is right heart failure and respiratory failure but the left heart is not supported.



Introduction

- This is a closed system without a reservoir, with some or all of the circuit components surface bonded with heparin, and is designed for extended use, such as days or weeks.
- This is in contrast to the extracorporeal circuit used for (CPB) in the operating room that uses larger-diameter and longer tubing(larger “prime” volume), and is an open system with a reservoir designed to receive input not only from the venous cannula but also from the operative field.
- There is some evidence in the lung transplant literature that use of ECMO during the surgical procedure may be associated with a smaller systemic inflammatory response than the use of the traditional CPB.

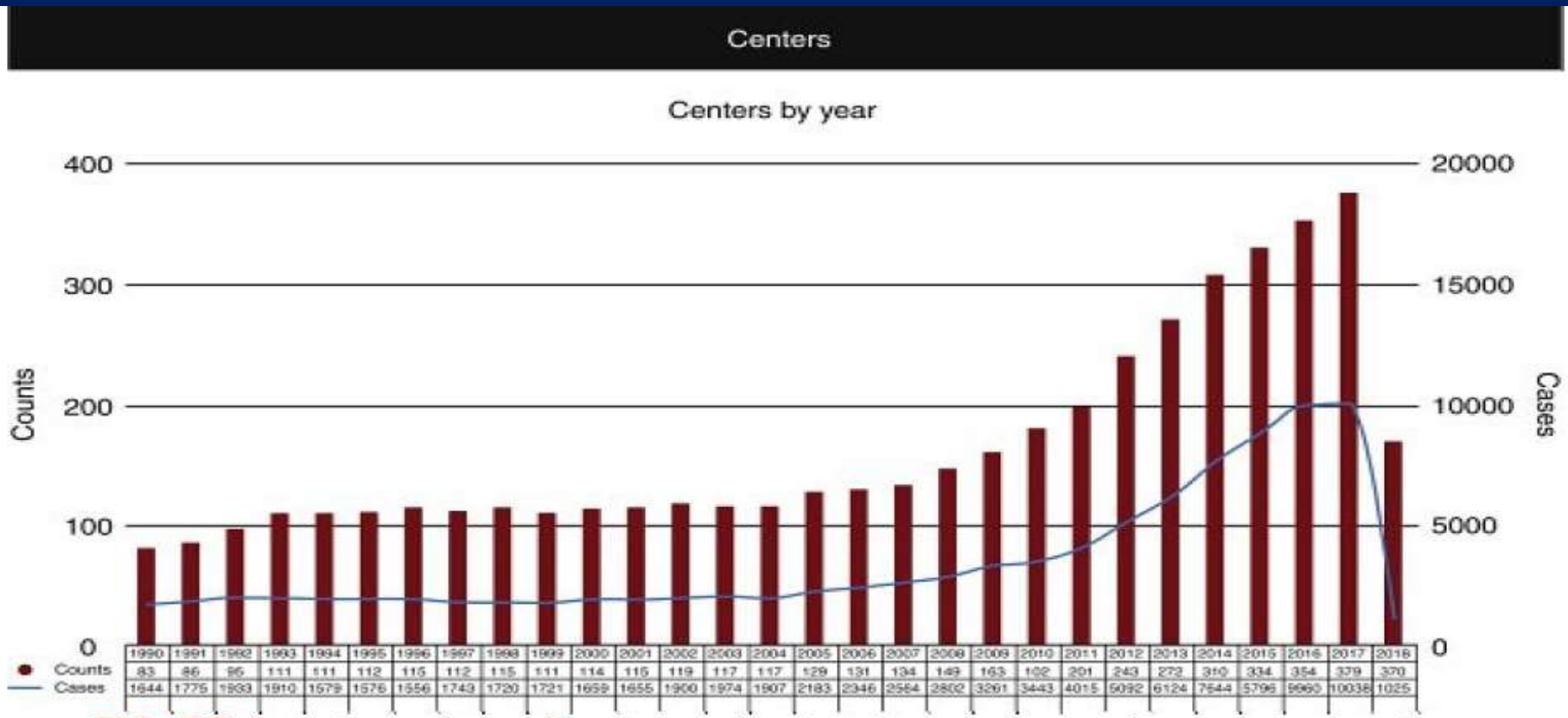


FIG. 85.1 International Registry of extracorporeal membrane oxygenation cases and centers, from the Extracorporeal Life Support Organization (*red bars*: cases, Y axis on right; *blue line*: centers, Y axis on left) from 1990–2018 (first 6 months).
From ELSO website, www.ELSO.org.

Perfusion. 2019 Jan;34(1):22-28. doi: 10.1177/0267659118786830. Epub 2018 Jul 16.

Extracorporeal membrane oxygenation in acute massive pulmonary embolism: a case series and review of the literature.

Al-Bawardy R[1], Rosenfield K[1], Borges J[1], Young MN[1], Albaghdadi M[1], Rosovsky R[2], Kabrhel C[3].

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Extracorporeal membrane oxygenation in the treatment of poisoned patients

ACC Acute and Critical Care
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Acute and Critical Care 2019; 34(2): 148-154.
Published online: May 31, 2019
DOI: https://doi.org/10.4266/acc.2019.00500

Use of extracorporeal membrane oxygenation in patients with acute high-risk pulmonary embolism: a case series with literature review

You Na Oh[1], Dong Kyu Oh[1], Younsuck Koh[1], Chae-Man Lim[1], Jin-Won Huh[1], Jae Seung Lee[1], Sung-Ho Jung[2], Pil-Je Kang[2], Sang-Bum Hong[1]

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ECMO in the treatment of poisoned patients

- **Abstract:**
- ECMO in the influenza A/H1N1 pandemic of 2009 low mortality in patients with ARDS so it very interested device for poisoning PATIENT.
- **Methods:**
- We searched Pubmed,from 1966 to September 2012 using the search terms(ECMO)
- These searches identified 242 papers of which 116 described ECMO in conditions other than intoxications.
- In total 46 publications selected for these were case reports or case series involving poisoned patients.
- ECMO TECHNIQUES:Two types of ECMO are used:veno-venous ECMO(VV-ECMO)or veno-arterial ECMO (VA-ECMO).
- Conclusions:
- ECMO equipment has improved considerably.
- ECMO is considered a good salvage therapy for patients who are severely poisoned with ARDS or refractory circulatory shock.

Extracorporeal Membrane Oxygenation

- ECMO is indicated in poisoned patients in refractory shock that are failing conventional treatment. (Level III recommendation).
- There are multiple reports of poisoned patients successfully resuscitated with ECMO.
- In a retrospective review of poisoned patients in arrest or shock, mortality was improved in those that received ECMO compared to those that did not(23/48) (86%vs. 48%, $p<0.02$).
- In many cases, poisoned patients are ideal candidates for ECMO In these patients,ECMO serves as a bridge until the toxic xenobiotic is metabolized or eliminated, until patient should regain normal cardiovascular function.

Experimental Evidence

- Three preclinical studies evaluated the efficacy of ECMO for toxin-induced shock (level III evidence).
- Each study utilized the veno-arterial ECMO technique that proved superior to other experimental treatments.
- One study involved lidocaine toxicity and two investigated cyclic antidepressants.
- In the lidocaine study, canines were poisoned with a large intravenous bolus (30 mg/kg) until animals developed cardiovascular collapse and then received either standard pharmacological resuscitation or ECMO for 90 min.
- All animals receiving ECMO treatment survived compared with only25 % for those receiving treatment.

Experimental Evidence

- Swine infused with amitriptyline to induce severe shock were treated for 90–120 min with ECMO or standard pharmacological therapy.
- As in the first two studies, there was impressive survival in the ECMO group (100 vs. 10 %) at 6 h.

Experimental Evidence

- Although all three preclinical studies provide positive evidence for ECMO use in cardiogenic shock and cardiac arrest,
- There are critical limitations to translating the impressive results in these models to the human experience:
- 1-Foremost, there was no delay to ECMO in the Animals models.
- 2-Secondly, these studies were conducted over relatively short durations(hours) and did not assess for long-term clinical outcomes such as neurological outcome or complications due to therapy itself.
- 3-Lastly,the trials evaluated one local anesthetic and two cyclic antidepressants.

Case Reports

Successful extracorporeal life support in a case of severe flecainide intoxication

Georg M. Auzinger, MD; Carlos D. Scheinkestel, MB BS, FRACP

Crit Care Med 2001 Vol. 29, No. 4

- The first reported case for the use of ECMO in poisoning
- A 30-yr-old male with a history of depression presented after a severe flecainide overdose
- Plasma concentrations exceeding 20 times the upper limits
- Refractory cardiocirculatory collapse successfully treated with ECMO

Hong Kong Journal of Emergency Medicine

Review on Flecainide poisoning

ITF Cheung and CY Man

Flecainide acetate is a Vaughn-Williams class IC antiarrhythmic. It is used mainly for treatment of supraventricular arrhythmias due to reentry and is highly effective in suppressing frequent premature ventricular depolarization and nonsustained ventricular tachycardia (VT). Although less than 1% of drug overdoses are fatal, severe intoxication with Vaughn-Williams class IC antiarrhythmics is associated with average mortality of 22.5% and the rate of mortality after flecainide overdose is approximately 10%. Severe flecainide overdose is frequently fatal because of the rapid onset of hypotension and ventricular arrhythmias. Its cardiotoxicity is mainly due to its sodium and potassium channels blocking effects. Commonly recommended therapies like haemolysis or haemoperfusion is not helpful because of its large volume of distribution. As a result, the treatment goals are to decrease the amount of blockade; correct aggravating conditions for arrhythmias, such as electrolytes disturbances or hypoxia; avoid drugs with sodium channels blocking effects. Recently, there are some successful data on using peripheral cardiopulmonary bypass technique in the treatment of severe flecainide intoxication. This may be a promising treatment option in this type of drug overdose. (*Hong Kong j.emerg.med.* 2002;9:150-153)

Keywords: Class IC antiarrhythmic, flecainide, overdose, poisoning

Treatment

As an emergency physician, the paramount initial treatment is supportive, which includes the basic Airway, Breathing and Circulation. The aim is to prevent hypoxia and maintain fluid balance, which will aggravate the toxicity.

Secondly, we should decrease further drug absorption. Gastrointestinal decontamination like gastric lavage should be considered in all patients who are unconscious and presented within 1 hour after ingestion of more than two times the recommended daily dose. However, atropine or pacing should be given prior to intubation and lavage, in order to prevent vagal stimulation. Activated charcoal should be given to ALL patients unless contraindicated.[8]

Thirdly, we need to minimize cardiac toxicity by 1) decreasing the amount of blockade (e.g. $NaHCO_3$ for sodium channel blockade); 2) correct aggravating conditions for arrhythmias, such as electrolytes disturbance or hypoxia; 3) avoid drugs with sodium channel blocking effects. (Table 2)

Early and large doses of $NaHCO_3$ should be given. Total doses of 3-6 mEq/kg $NaHCO_3$ showed efficacy in animal studies.[9-12] We should aim at maintaining a pH of 7.5-7.55. Some authors recommended that $NaHCO_3$ should be given in patients with QRS>160 ms or any arrhythmias.[10]

Lastly, we need to increase the elimination of the drugs. Forced diuresis should be avoided because this

poisoning,[15,16] there are two recently published cases of successful use of CBS in the treatment of flecainide overdose. In May 1997 Annals of Emergency Medicine published the first reported use of CBS in flecainide overdose.[17] The patient had an agonal rhythm and a flecainide level of 5.4 mug/ml (normal range 0.2-1.0 mug/ml). After 10 hours of CBS, the level dropped to 1.4 mug/ml and the patient had a stable rhythm and blood pressure. However, treatment was discontinued because the patient already sustained an irreversible neurologic damage before effective circulation was restored. In 2001 Crit Care Med published a successful case of using extracorporeal membrane oxygenation (ECMO) in treatment of flecainide overdose.[18] The patient had a pulseless electrical activity after a fatal dose of flecainide intoxication. After 26 hours of ECMO, the patient had a stable cardiac function with decreasing pump flow and an almost normalized conscious state. This patient finally survived without neurological sequelae upon hospital discharge.

For treatment of arrhythmias, ALL class 1A antiarrhythmics are contraindicated. Class 1B (lignocaine and phenytoin), which may be used, may still exacerbate sodium channel blockade and potentially exacerbate arrhythmias. Therefore, they should be avoided. Magnesium is normally the drug of choice for treating Torsade de pointes, however, its calcium channel blocking activities may aggravate the hypotension and heart block. For these reasons, isoprenaline or over-drive pacing should be preferred.

Second or third degree heart block should be treated with atropine, $NaHCO_3$ and isoprenaline followed by

Intensive Care Med (2006) 32:1409–1413
DOI 10.1007/s00134-006-0257-8

BRIEF REPORT

Bruno Mégarbane
Pascal Leprince
Nicolas Deye
Gilles Guerrier
Dabor Résière
Vanessa Bloch
Frédéric J. Baud

Extracorporeal life support in a case of acute carbamazepine poisoning with life-threatening refractory myocardial failure

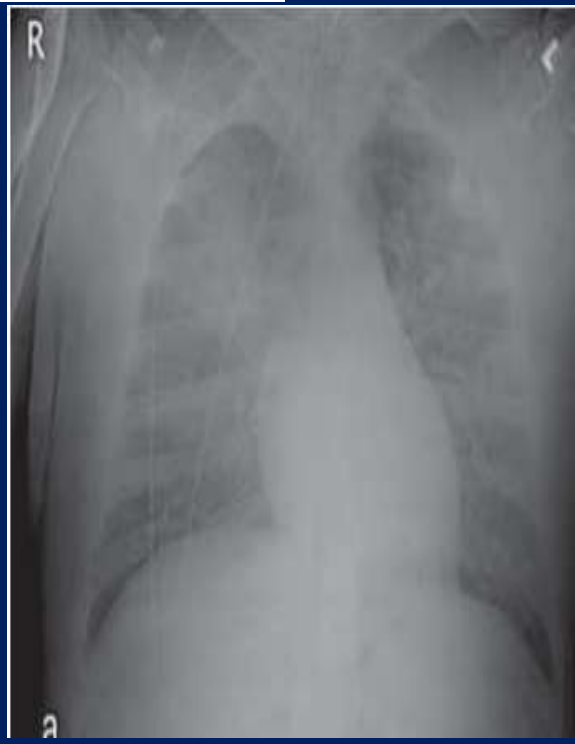
- 26/ M had myocardial failure & conduction disturbances due to carbamazepine toxicity.
- Unresponsive to very high inotropic support.
- VA- ECMO was instituted for 6 days
- Patient recovered without any neurological sequale.

J Med Sci 2010;30(3):101-105
http://jms.ndmctsgh.edu.tw/3003101.pdf

Extracorporeal Membrane Oxygenation for Management of Carbon Monoxide Intoxication

Yin-Tang Wang[1], Chien-Wen Chen[1], Chih-Feng Chian[1], Wann-Cherng Perng[1,2], Gou-Jieng Hong[1], and Wen-Lin Su[1,2*]

- 23 Yr old male found unconscious in bathroom
- Had h/o closed room smoking & heavy alcohol
- Developed stunned myocardium induced pulmonary oedema
- Mechanical ventilation with High PEEP were failed to improve
- .
- VA ECMO instituted for 3 days
- Recovered completely



Case Reports > Clin Toxicol (Phila). 2015 Nov;53(9):908-13. doi: 10.3109/15563650.2015.1082183. Epub 2015 Aug 28.

Successful extracorporeal membrane oxygenation therapy as a bridge to sequential bilateral lung transplantation for a patient after severe paraquat poisoning

Xiao Tang [1], Bing Sun [1], Hangyong He [1], Hui Li [2], Bin Hu [2], Zewu Qiu [3], Jie Li [1], Chunyan Zhang [1], Shengcai Hou [2], Zhaohui Tong [1], Huaping Dai [1]

Affiliations + expand

PMID: 26314316 DOI: 10.3109/15563650.2015.1082183

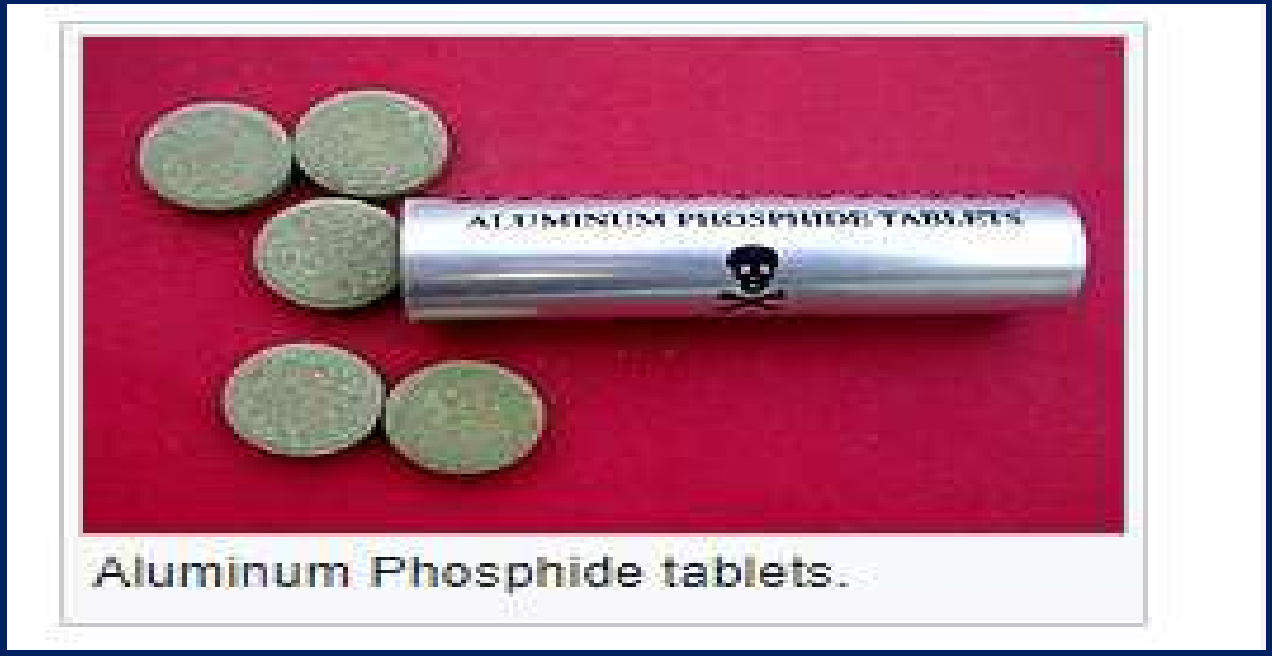
پاراکوات

- پاراکوات (۱و۱-دی متیل ۴و۴بی پیریدیلیوم کلرید)

مهم ترین علف کش از دسته بی پیریدیل ها است که به طور گسترده در بخش کشاورزی به عنوان یک علف کش غیر انتخابی استفاده می شود.

مرگ و میرهای اولیه مربوط به این سماتفاقی و ناشی از نوشیدن محلول های غلیظ از ظروف بدون بر چسب و ظرفبه ظرف کردن های غیر مجاز بود که به دنبال انتشار این اخبار زمان زیادی نگذشت که مرگ و میر به علت خودکشی با این ماده نیز گزارش شد

Aluminium phosphide poisoning



Aluminum Phosphide tablets.

مسمومیت با قرص برنج

- **مسمومیت با آلومینیوم فسفید**

معضلی بزرگ و کم‌پرداخته در سراسر جهان، به‌ویژه در شبه‌قاره هندوستان است

از آن برای ضدعفونی و حفاظت از دانه‌های غلاتی همچون برنج استفاده می‌شود

مرگ با قرص برنج از نوع مرگ سلولی است؛ و این بدان معنی است که در این مرگ هر یک از بافت‌ها و سلول‌ها که عناصر تشکیل دهنده جسم می‌باشند میمیرند.

خاصیت سمی آلومینیوم فسفید به خاطر گاز فسفین (که دارای ویژگی سیتوتوکسیتی است) است که باعث جراحات رادیکال آزاد می‌شود که از فعالیت آنزیم‌های سلول‌های حیاتی جلوگیری و بافت‌ها را نابود می‌کند

مدیرکل پزشکی قانونی استان اصفهان:

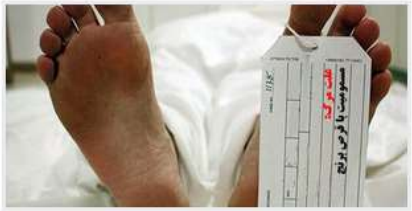
قرص برنج هفت اصفهانی را به کام مرگ کشاند

اصفهان – مدیرکل پزشکی قانونی استان اصفهان گفت: در شش ماهه نخست امسال هفت اصفهانی بر اثر مسمومیت ناشی از قرص برنج جان خود را از دست داد.

علی سلیمانی‌پور در گفت‌وگو با خبرنگار مهر با بیان اینکه مسمومیت‌های ناشی از مواد شیمیایی یکی از دلایل مرگ و میر در سطح کشور و به ویژه استان اصفهان است، اظهار داشت: از این رو قرص برنج نیز یکی از انواع این مسمومیت‌هاست که در سال جاری نیز جان تعدادی از همشهریان را گرفته است.

وی با اشاره به اینکه در شش ماهه اول سال جاری آمار اجساد معاینه شده در مراکز پزشکی قانونی استان با تشخیص علت مرگ مسمومیت با قرص برنج هفت نفر بوده است، ابراز داشت: این در حالی است که در مدت مشابه سال گذشته تنها یک نفر بر اثر مسمومیت ناشی از قرص برنج جان خود را از دست داد.

کدام استان‌ها رکوردار استفاده از قرص برنج هستند؟



فارس نوشت: رئیس گروه تجویز و مصرف منطقی و اطلاع رسانی فرآورده‌های سلامت سازمان غذا و دارو به قاچاق قرص برنج اشاره کرد و گفت: تهران، گیلان و مازندران رکوردار مصرف قرص برنج هستند.

Aluminium phosphide poisoning

- **Acute aluminium phosphide poisoning** (AAlPP):
- Problem throughout the world,
- Particularly in the Indian and Nepalese subcontinent.
- Which is readily available as a fumigant for stored cereal grains.
- **Signs, symptoms, and diagnosis:**
- The major lethal consequence of aluminium phosphide ingestion is profound circulatory collapse(few minute).
- Other features may include dizziness, fatigue, tightness in the chest, headache, nausea, vomiting, diarrhoea, ataxia, numbness, paraesthesia, tremor, muscle weakness, diplopia and jaundice.
- If severe inhalation occurs, the patient may develop acute respiratory distress syndrome (ARDS), heart failure, arrhythmias, convulsion and coma.
- Late manifestation include liver and kidney toxicities.

Aluminium phosphide poisoning

- Mechanism of toxicity:
- The toxicity of aluminium phosphide is attributed to the liberation of phosphine gas, a cytotoxic compound that causes free radical mediated injury, inhibits vital cellular enzymes and is directly corrosive to tissues.
- Management and outcome:
- The management of AAlPP remains purely supportive because no specific cure exists.
- Mortality rates approach 60%.
- Correction of metabolic acidosis.
- The role of magnesium sulfate as a potential therapy

Incidents

- It has been reported to be the most common method of suicidal death in North India.
- Deaths have also been reported in Iran
- Aluminium Phosphide is a highly effective insecticide and rodenticide.
- However, it is highly toxic with high mortality rate if ingested.
- It produces severe metabolic acidosis and cardiogenic shock with no available antidote, so management may be the only supportive treatment.
- Early decontamination and interventions may be helpful.
- Restricted use and awareness programs to farmers may be beneficial in prevention of toxicity.

Severe reversible myocardial injury associated with aluminium phosphide toxicity: A case report and review of literature

J Saudi Heart Assoc
2014;26:216–221

Accidental inhalation of aluminium phosphide fumes lead to severe myocardial dysfunction

[a] Department of Cardiology, Al Qassimi Hospital, Sharjah; [b] Department of Internal Medicine, University of Toledo, OH

Inspite of very high inotropic support & IABP haemoynamics did not improve

interfering with mitochondrial energy metabolism. We report on three cases of severe aluminium phosphide cardiotoxicity, resulting in severe decrease in both ventricular heart functions. The first case succumbed to intractable ventricular arrhythmias complicated by multi-organ failure before she died; while the other two cases required invasive hemodynamic support and eventually improved over the course of 10–14 days. We describe our experience and the

ECMO was continued for 10 days & patient recovered

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Journal of Pharmacology & Clinical Toxicology

Case Report

Successful Treatment of Cardiotoxicity of Aluminium Phosphide Poisoning with Extracorporeal Membrane Oxygenation (ECMO): A Case report

Munish Chauhan[1]*, Sandeep Dewan[1], Sandeep Attawar[2], Sahish Kamat[1], Vishal Kumar[1], Vitul Manhas[1], Nitin Jain[1], Milind V. Talegaonkar[1], Pooja Wadwa[1]

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Submitted: 30 April 2015
Accepted: 10 August 2015
Published: 12 August 2015
ISSN: 2333-7079

Keywords
- Extracorporeal Membrane Oxygenation (ECMO)
- Poisoning
- Toxicology
- Cardiovascular
- Aluminium phosphide

- 17 year old boy with severe LV dysfunction was treated successfully with VA ECMO
- ECMO was continued for more than 5 days.

The Egyptian Journal of Critical Care Medicine (2016) 4, 33–35

The Egyptian College of Critical Care Physicians

The Egyptian Journal of Critical Care Medicine

http://ees.elsevier.com/ejccm
www.sciencedirect.com

CASE REPORT

Successful use of ECLS in cardiopulmonary failure due to aluminum phosphide poising

M. Mendonca [a,*], C. Tamas [b], L. Kiraly [b], H. Talo [b], J. Rajah [c]

[a] Department of Critical Care, Sheikh Khalifa Medical City, Abu Dhabi, United Arab Emirates
[b] Department of Cardiac Sciences, Sheikh Khalifa Medical City, Abu Dhabi, United Arab Emirates
[c] Department of Pediatrics, Sheikh Khalifa Medical City, Abu Dhabi, United Arab Emirates

- Accidental poisoning with ALP
- Haemodynamically unstable severe LV dysfunction despite very high inotropes & vasopressors
- VA ECMO for 10 days
- Extubated on day 11
- Neurological sequalae
- was treated successfully

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/ihj

IHJ Indian Heart Journal

Original Article

Outcome of patients supported by extracorporeal membrane oxygenation for aluminum phosphide poisoning: An observational study

Bishav Mohan[a,*], *Bhupinder Singh*[a], *Vivek Gupta*[b], *Sarju Ralhan*[c], *Dinesh Gupta*[d], *Sandeep Puri*[d], *Abhishek Goyal*[a], *Naved Aslam*[a], *Rohit Tandon*[a], *Gurpreet Singh Wander*[a]

[a] *Department of Cardiology, Dayanand Medical College and Hospital, Ludhiana, Punjab, India*
[b] *Department of Cardiac-Anaesthesia, Dayanand Medical College and Hospital, Ludhiana, Punjab, India*
[c] *Department of Cardiothoracic Surgery, Dayanand Medical College and Hospital, Ludhiana, Punjab, India*
[d] *Department of Medicine, Dayanand Medical College and Hospital, Ludhiana, Punjab, India*

In the high-risk group (n = 45), the mortality rate was significantly ($p < 0.001$) lower in patients who received ECMO (33.3%) compared to those who received conventional treatment (86.7%).

Article Text
Article info
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Case report

Massive metoprolol overdose requiring ECMO: brief review of the evidence behind recommended treatments

Abstract

A man in his late 60s developed shock after ingesting 7500 mg of metoprolol tartrate that was refractory to all medical treatment including hyperinsulinaemic euglycaemia, intravenous lipid emulsion and dialysis, eventually needing rescue extracorporeal membrane oxygenation. A brief review of the recommended treatments in beta-blocker overdose is therefore warranted.

Critical Care Toxicology pp 79-99 | Cite as

Extracorporeal Membrane Oxygenation and Cardiopulmonary Bypass in the Poisoned Patient

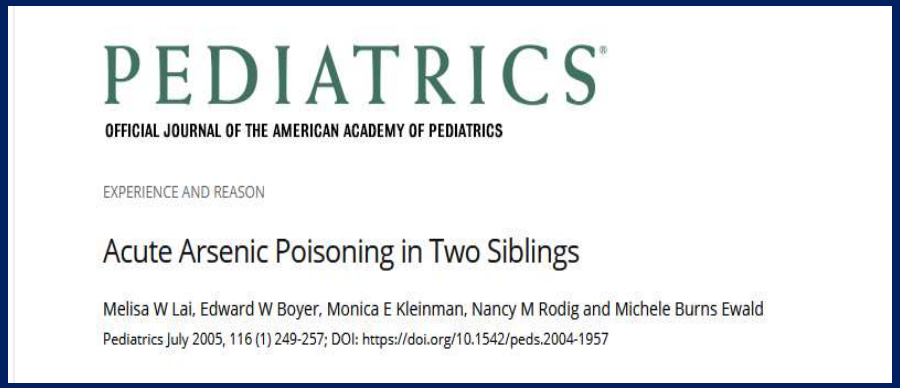
Authors | Authors and affiliations

William P. Kerns II, Alan C. Heffner

Reference work entry
First Online: 25 June 2017

Abstract

Cardiopulmonary deterioration is a final common pathway of many life-threatening conditions, including those induced by toxins. Despite advances in resuscitation and critical care, severe pulmonary and cardiac failures are associated with a high risk of organ failure and death. Extracorporeal membrane oxygenation (ECMO) is a growing rescue modality for patients with acute reversible life-threatening cardiopulmonary conditions.



PEDIATRICS

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

EXPERIENCE AND REASON

Acute Arsenic Poisoning in Two Siblings

Melisa W Lai, Edward W Boyer, Monica E Kleinman, Nancy M Rodig and Michele Burns Ewald

Pediatrics July 2005, 116 (1) 249-257; DOI: https://doi.org/10.1542/peds.2004-1957

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Massive diltiazem overdose treated with extracorporeal membrane oxygenation

Circulation:
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Use of Extracorporeal Membrane Oxygenation for Mechanical Circulatory Support in a Patient With 5-Fluorouracil Induced Acute Heart Failure

Shruti Rateesh, Kiran Shekar, Rishendran Naidoo, Dolly Mittal, and Balu Bhaskar

Originally published 1 Mar 2015 |
https://doi.org/10.1161/CIRCHEARTFAILURE.115.002080 |
Circulation: Heart Failure. 2015;8:381–383

March 2015

Conclusions

Cardiogenic shock is a recognized complication of 5-FU. We present a case where ECMO support enabled short-term extracorporeal life support, allowing the heart to recover from a reversible cause of cardiomyopathy. Together with medical therapy for heart failure, near-complete recovery of cardiac function was possible. Although recent or ongoing immunosuppression per se is a predictor of poor outcome in ECMO patients, early use of ECMO as a bridge to recovery in patients with acute chemotherapy–induced heart failure may be a viable alternative in carefully selected cases.

Role of ECMO in Poisoning

- The standard indication of using ECMO is acute severe heart or lung failure unresponsive to optimal conventional therapy with high mortality risk.
- ECMO should be started in most circumstances at 80% mortality risk,which is similar for poisoned patients.
- Moreover, these patients are relatively young and otherwise healthy.
- One can expect a better outcome once the toxin is either metabolized or completely eliminated from the body.

Role of ECMO in Poisoning

- ECMO may be useful in providing adequate cardiac output and maintain tissue perfusion which helps to facilitate the metabolism and excretion of poison.
- ECMO supports both cardio respiratory function (venoarterial [VA] ECMO) and respiratory function alone (VV ECMO) for a longer duration depending on indication.
- There are no guidelines for the appropriate time for ECMO initiation in severely poisoned patients.
- The decision about initiation primarily depends on the clinical judgment.

Common Poisoning Substances with Cardiotoxic Potential

1-Drugs :

- A-Membrane stabilizing activity:
- 1-Antiarrhythmics (Vaughan Williams class I).
- 2-Betablockers (propranolol, acebutolol, nadoxolol, pindolol, etc.).
- 3-Dopamine and norepinephrine uptake inhibitors (bupropion).
- 4-Antiepileptics (phenytoin and carbamazepine).
- 5-Antimalarial agents (quinine and chloroquin).
- 6-Polycyclic antidepressants (imipramine, desipramine, amitriptyline, doxepin).
- 7-Opioids (dextropropoxyphene).
- 8-Recreational agent (cocaine).
- 9-Amphetaminelike substances

Common Poisoning Substances with Cardiotoxic Potential

- B-Other drugs:
- 1-Calcium channel blockers (nifedipine, nicardipine, verapamil, diltiazem, etc.).
- 2-Meprobamate.
- 3-Colchicine.
- 4-Cardiac glycosides (digoxin).
- 5-H1 antihistaminic.

Common Poisoning Substances with Cardiotoxic Potential

- 2-Pesticides:
- a.Insecticides: Organophosphate, carbamates.
- b-Herbicides: Paraquet.

c.Rodenticides:

- C-1- Aluminum phosphide.
- C-2-Yellow phosphorus.
- C-3-Zinc phosphide.

Common Poisoning Substances with Cardiotoxic Potential

3.Plant toxins:

The most severe form of plant toxins may produce complete heart block, bradyarrhythmia, tachyarrhythmia, or ventricular arrhythmia.

a. Aconite.

b. Taxus.

4.Others:

a. Carbon monoxide.

b. Cyanide.

ECMO for Respiratory Failure (VV ECMO)

- ECMO experience in neonatal and pediatric respiratory failure is benefcial.
- Poor outcomes deterred adult use of ECMO for more than 20 years.
- The results supported the use of ECMO performed in a specialized center to improve survival: 63% versus 43%survival with ECMO versus standard treatment.
- 1-From 2001 to 2006 a large, British trial was performed to evaluate VV ECMO for respiratory failure in adults.
- 2-This study was performed during the H1N1 influenza pandemic.

- Another report(case series) of VV ECMO:
- 1-In adults ARDS due to H1N1was reported from Australia and New Zealand(ANZ ECMO).
- 2-This study found a 79% survival at 30 days in patients who received ECMO.
- Recently a large multicenter trial of VV ECMO
- 1-In adults with severe ARDS, the EOLIA trial, was published in 2018,with
- 2-The authors concluding no difference in mortality between ECMO and conventional therapy at 60 days: 35% versus 46% ($P = .09$).
- 3-Editorial comments on this study have challenged this conclusion, maintaining that it supports the use of early ECMO in adults with severe ARDS.

EOLIA trialを批判的に吟味する

TAMA ECCM Journal club

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 24, 2018 VOL. 378 NO. 21

Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome

A. Combes, D. Hajage, G. Capellier, A. Demoule, S. Lavoué, C. Guervilly, D. Da Silva, L. Zafrani, P. Tirot, B. Veber, E. Maury, B. Levy, Y. Cohen, C. Richard, P. Kallon, L. Bouadma, H. Mehdaoui, G. Beduneau, G. Lebreton, L. Brochard, N.D. Ferguson, E. Fan, A.S. Slutsky, D. Brodie, and A. Mercat, for the EOLIA Trial Group, REVA, and ECMONet*

EOLIA

ECMO to rescue Lung Injury in severe ARDS

ASSISTANCE PUBLIQUE HÔPITAUX DE PARIS

UPMC PARIS UNIVERSITAS

MAQUET GETINGE GROUP

Box 85.1 Indications for VV ECMO

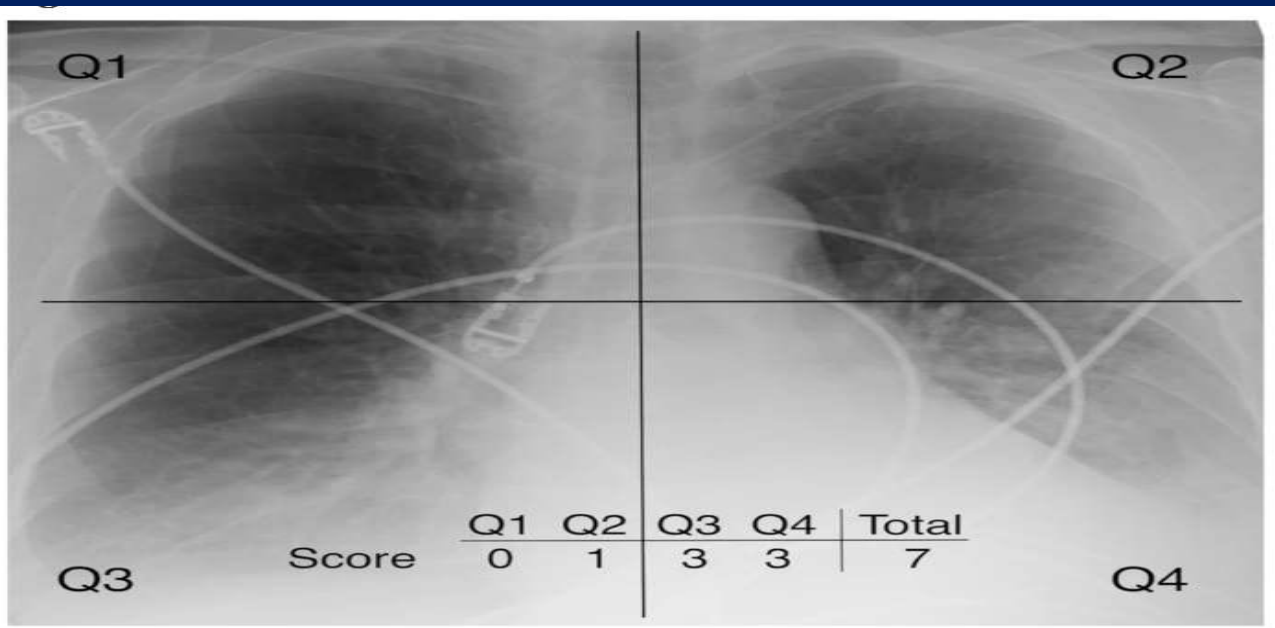
- Severe ARDS
  - Murray score of 2.5 [19]
  - Berlin definition [20]
- Respiratory failure associated with:
  - Refractory hypoxemia despite maximum less invasive therapies
  - e.g., FiO_2 >90%, PEEP >15 cm H_2O, prone ventilation
  - Refractory hypercarbia (e.g., $PaCO_2$ > 80) with acidosis
  - Injurious ventilating pressures (e.g., plateau pressures >30 mm Hg) with lung-protective tidal volumes
- Common clinical conditions
  - Severe pneumonia (viral or bacterial)
  - Aspiration pneumonitis
  - ARDS from any cause
  - Pulmonary contusion
  - Status asthmaticus
  - Severe air leak syndrome
  - Inhalation injury
  - Airway obstruction (e.g., mediastinal mass)
  - Pre and post lung transplant

Indications for VV ECMO in Respiratory Failure

- As VV ECMO supports only respiratory function, if the patient has right- or left-sided cardiac failure then another configuration of support must be used.
- The most common indication is ARDS, most commonly due to viral or bacterial infection.
- As indicated previously, the most studied population is patients with H1N1 viral pneumonia.
- A commonly used assessment for the severity of ARDS is the Murray score, which is based on four standard criteria: PaO_2/FiO_2 gradient for oxygen, degree of PEEP, number of quadrants affected as shown on the chest radiograph, and lung compliance.

Murray Score = Average Score of all 4 parameters					
Parameter/ Score	0	1	2	3	4
PaO2/FiO2 (on 100% FiO2)	< 300 mmHg (> 40kPa)	225-299 (30-40)	175-224 (23-30)	100-174 (13-23)	< 100 (< 13)
CXR	Normal	1 point per quadrant infiltrated			
PEEP	≤ 5	6-8	9-11	12-24	≥ 15
Compliance ml/cm H2O)	≥ 80	60-79	40-59	20-39	≤ 19

number of quadrants affected as shown on the chest radiograph the Murray



An example of a scored chest radiograph. Each image is divided into four quadrants (Q) with each quadrant assigned a score from 0 to 4. The total score, representing the sum of the four quadrants, was used as a predictor in our clinical outcomes models

Indications for VV ECMO in Respiratory Failure

- In 2012, the Berlin criteria were published,where the severity of ARDS is rated as mild, moderate, or severe based on the PaO_2/FiO_2 gradient for oxygen if other criteria are present.
- In general, patients with severe ARDS (PaO_2/FiO_2 gradient of < 100 mm Hg with PEEP > 5) are potential candidates for ECMO as the mortality without ECMO is approximately 40%.
- If a patient being considered for VV ECMO is not at an ECMO center or one with expertise in management of ARDS, transfer to such a facility is likely to provide a better outcome even in the absence of ECMO.
- Many reports indicate that outcomes are better with earlier institution of ECMO.

Berlin criteria

Table 3. The Berlin Definition of Acute Respiratory Distress Syndrome

	Acute Respiratory Distress Syndrome
Timing	Within 1 week of a known clinical insult or new or worsening respiratory symptoms
Chest imaging[a]	Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules
Origin of edema	Respiratory failure not fully explained by cardiac failure or fluid overload Need objective assessment (eg, echocardiography) to exclude hydrostatic edema if no risk factor present
Oxygenation[b]	
Mild	200 mm Hg < PaO_2/FIO_2 ≤ 300 mm Hg with PEEP or CPAP ≥5 cm H_2O[c]
Moderate	100 mm Hg < PaO_2/FIO_2 ≤ 200 mm Hg with PEEP ≥5 cm H_2O
Severe	PaO_2/FIO_2 ≤ 100 mm Hg with PEEP ≥5 cm H_2O

Abbreviations: CPAP, continuous positive airway pressure; FIO_2, fraction of inspired oxygen; PaO_2, partial pressure of arterial oxygen; PEEP, positive end-expiratory pressure.

[a] Chest radiograph or computed tomography scan.

[b] If altitude is higher than 1000 m, the correction factor should be calculated as follows: [PaO_2/FIO_2 × (barometric pressure/760)].

[c] This may be delivered noninvasively in the mild acute respiratory distress syndrome group.

Contraindications to VV ECMO

- Specific patient conditions should also be considered.
- 1-Although no specific age is a contraindication, increased age is considered to increase the risk.
- 2-A body mass index (BMI) of more than 40 to 45 may be associated with technical difficulties and the risk of not being able to achieve an adequate blood flow.

Contraindications to VV ECMO

- In keeping with ELSO guidelines there are no absolute contraindications for VV ECMO in adult.
- There are, conditions known to be associated with a poor outcome:
- These conditions include:
- 1-Injurious mechanical ventilation for 7 days or longer.
- 2-Major pharmacologic immunosuppression.
- 3-Intracranial hemorrhage that is recent or expanding.

Box 85.2 Indications for VA ECMO

- Cardiogenic shock
  - Hypotension/poor tissue perfusion despite maximum medical therapy +/− balloon pump
- Combined cardiorespiratory failure
  - Cardiogenic shock with pulmonary edema and hypoxemia
- Urgent ECMO for respiratory failure
  - As temporizing measure before institution of VV ECMO
- Common clinical conditions
  - Refractory cardiogenic shock (any cause)
  - Failure to separate from cardiopulmonary bypass
  - Bridge to durable ventricular assist device or transplant
  - Intraoperative lung transplant
  - Unstable arrhythmias
  - Anaphylaxis
  - Massive pulmonary embolus
  - Cardiac arrest without return of spontaneous circulation

VA ECMO, venoarterial extracorporeal membrane oxygenation; VV ECMO, venovenous extracorporeal membrane oxygenation.

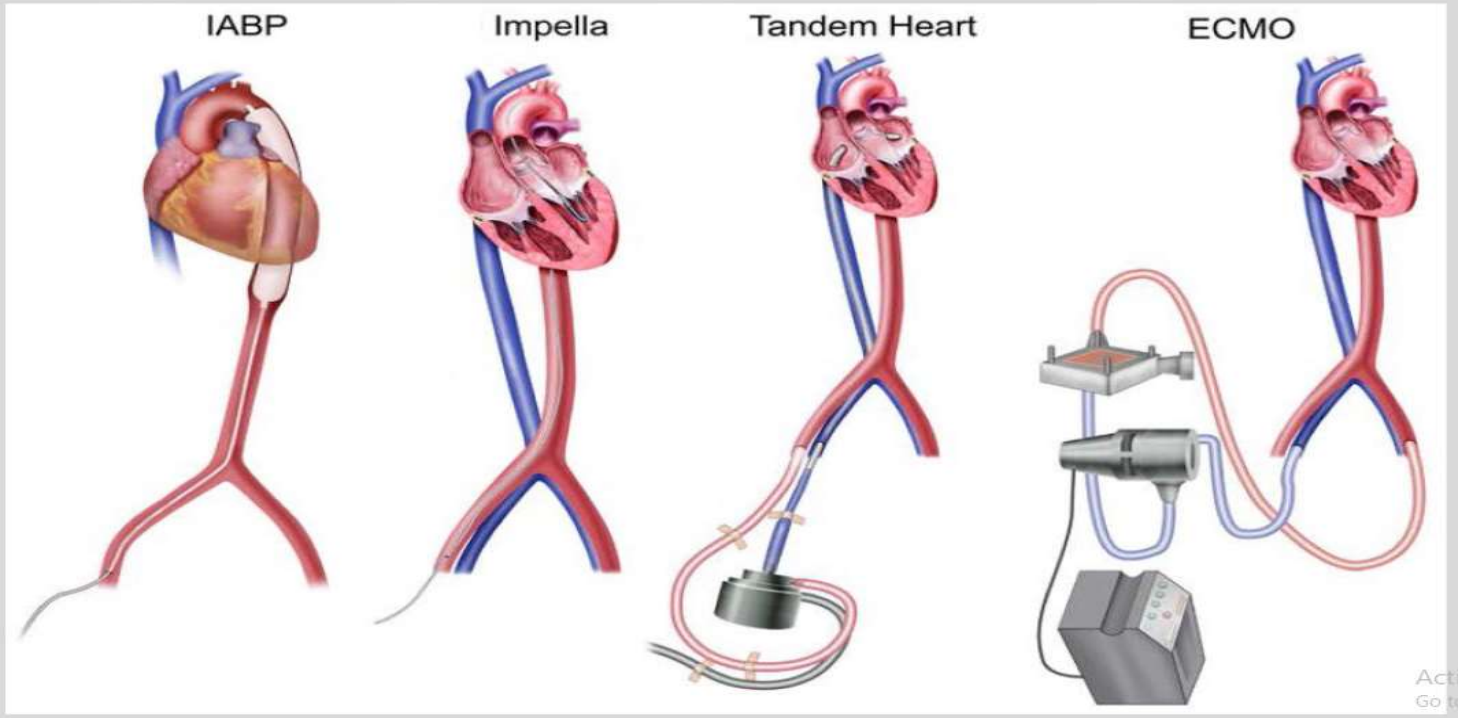
ECMO for Circulatory Failure (VA ECMO)

- VA ECMO can be used to support the heart and lungs temporarily in a patient with poor cardiac function.
- VA ECMO use postoperative cardiopulmonary support in a cardiac surgery patient who fails to separate from CPB.
- It use in patient with refractory cardiac failure with or without associated respiratory failure. (e.g., myocarditis).
- VA ECMO use To evaluate for long-term advanced therapies such as a durable ventricular assist device or cardiac transplant.
- Urgent use of ECMO in the acute setting of in-hospital cardiac arrest (ECPR) is also practiced in some centers.
- VA ECMO can be instituted at the bedside.
- It may be the preferred technique for emergent cannulation in any form of respiratory or cardiac failure.

ECMO for Circulatory Failure (VA ECMO)

- The historical perspective for use of VA ECMO for cardiac or combined cardiorespiratory support in adults is illustrated in the 2016 report from the ELSO registry.
- Adult cardiac ECMO was in its infancy in 1990 with little increase in use until 2006.
- There were more than 2000 adult cardiac ECMO runs reported to ELSO in 2015.
- Success in the neonatal and pediatric populations.
- Success and experience with VV ECMO for adult respiratory failure.
- Overall survival in adults who receive ECMO for cardiac indications is approximately 40% with a slight increasing trend over the last 10 years.

Left-Sided Mechanical Circulatory Support



A Mandawat, SV Rao. Circ Cardiovasc Interv. 2017

Indications For VA ECMO

- Such patients always need left ventricular support but if right heart function and pulmonary function are adequate a short-term percutaneous LVAD might be appropriate.
- Short-term devices such as a percutaneous left ventricular assist device (LVAD, e.g., Impella)are one type of support.
- If, however the right heart, or lungs, or both, needs support, then VA ECMO is most appropriate.
- Another issue is urgency or acuity:peripheral VA ECMO can be initiated at the bedside without imaging more rapidly than a temporary assist device.
- For acute recoverable myocardial illness such as myocarditis, survival is approximately 67% with VA ECMO.

Indications For VA ECMO

- According to the 2013 ELSO guidelines the most common indication for VA ECMO in adult cardiac failure is the presence of cardiogenic shock (end organ hypoperfusion) despite the use inotropes. This includes :
- 1-Cardiogenic shock with or without myocardial infarction.
- 2-Fulminant myocarditis.
- 3-Peripartum cardiomyopathy.
- 4-Decompensated chronic heart failure.
- 5-Right heart failure.
- 6-Medication or toxic drug overdose.
- 7-Postcardiotomy shock.

Contraindications to VA ECMO

- Absolute contraindications to VA ECMO include
- 1-Acute intracranial hemorrhage.
- 2-Massive stroke.
- 3-Active bleeding.
- 4-Severe aortic insufficiency.
- Relative contraindications may include
- 1-Contraindication anticoagulation.
- 2-Advanced age.
- 3-Obesity.
- 4-Active cancer.
- 5-Suicide attempt.
- 6-Chronic hemodialysis.
- 7-End-stage liver disease.
- 8-Aortic dissection.
- 9-Lack of social support.

The Ethics of ECMO

- The initiation of any form of ECMO is lifesaving when the heart, or lungs,or both are failing despite maximum medical therapies.
- When the young and healthy patient advanced
- 1-Acute cardiac failure(viral cardiomyopathy)
- 2-Acute refractory lung failure(viral pneumonia)
- 3-Acute intoxication(Alp intoxication)
- The decision to initiate lifesaving extracorporeal support as a “bridge to recovery” seems relatively straightforward.

The Ethics of ECMO

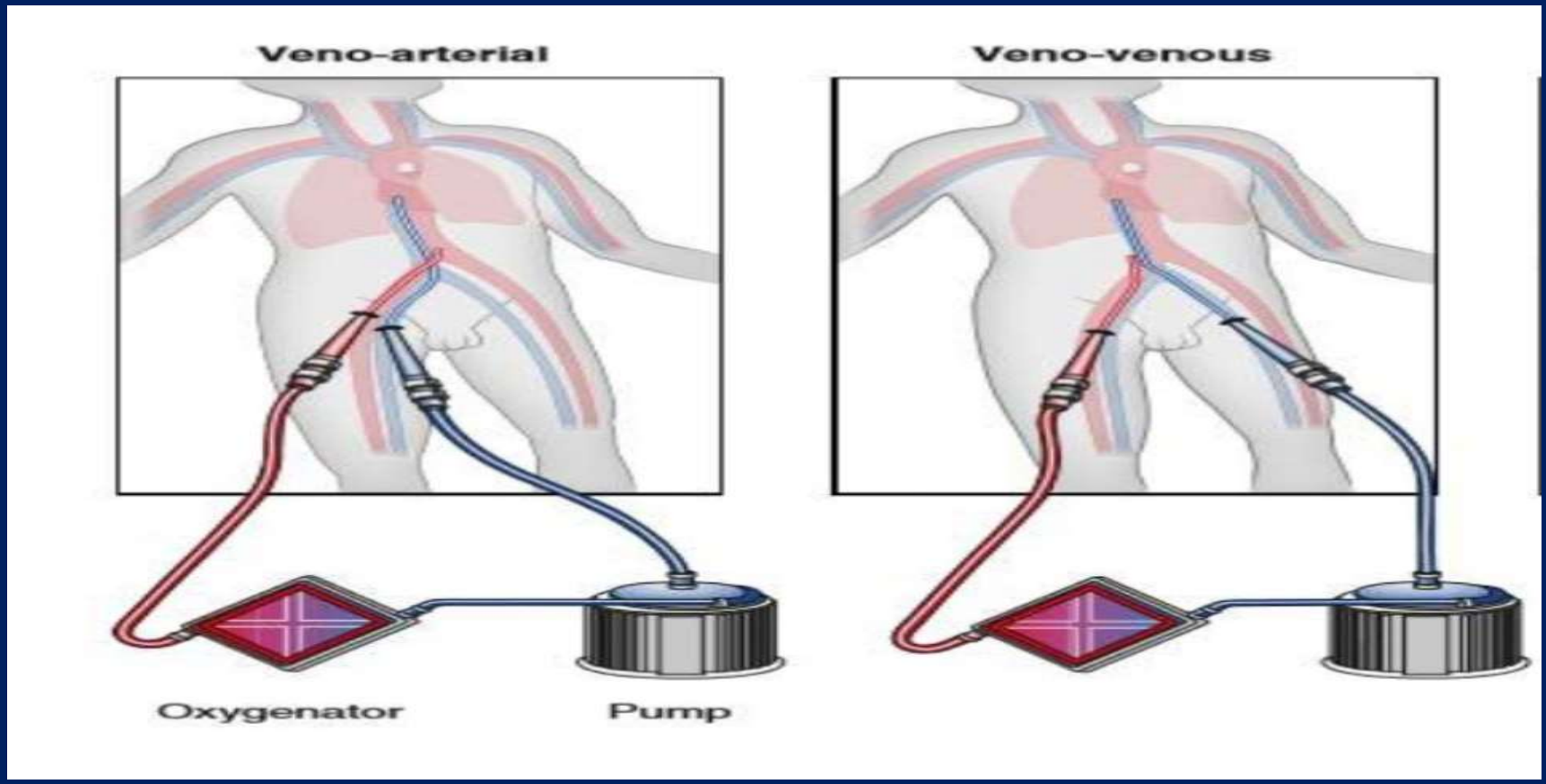
- When a request comes from an outside hospital, many institutions make this a shared decision by a small committee (i.e., 3 individuals) who are all familiar with and participate in ECMO management.
- Overall survival for adult respiratory and cardiac ECMO is approximately 60% and 40%, respectively.
- The other side of this coin is that mortality remains at 40% and 60%.

Box 85.3 Extracorporeal Membrane Oxygenation as "Bridge" Therapy

Bridge to Decision	Urgent initiation before the ability to assess likelihood of recovery or candidacy for advanced therapy
Bridge to Recovery	Initiation for organ failure that is believed to be potentially recoverable
Bridge to Advanced Durable Therapy	Initiation after acceptance for eligibility for device (e.g., VAD) or transplant
"Bridge to Nowhere"	Bridge to decision which is likely to be non-recovery and non-eligibility for advanced therapy

VAD, Ventricular assist device.

VV ECMO	VA ECMO
Provides respirarory support	Provides respiratory and Hemodynamic support
Blood from and return to venous circulation	Blood from venous and Return to Arterial circulation
There are no absolute contraindications	Absolute contraindications
Less Arterial injery	Bridge to recovery or for Transplant
Changing flow rate affects on po2	Changing flow rate affects on cardiac out put


Veno-arterial
Veno-venous
Oxygenator
Pump