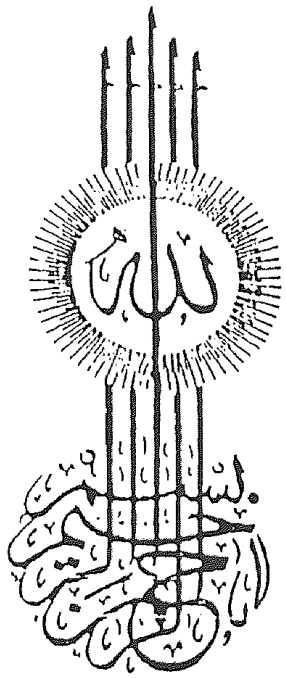


سبحانك

لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

(آيـــه ٣٢ سورة البقـــرة)

Extracorporeal Membrane Oxygenation (ECMO) Therapy In Neonates

An Essay Submitted For Partial Fulfilment Of Master Degree Of Paediatrics

By

Dr. : Waleed Mohamed Maamoon

M.B. , B.ch.

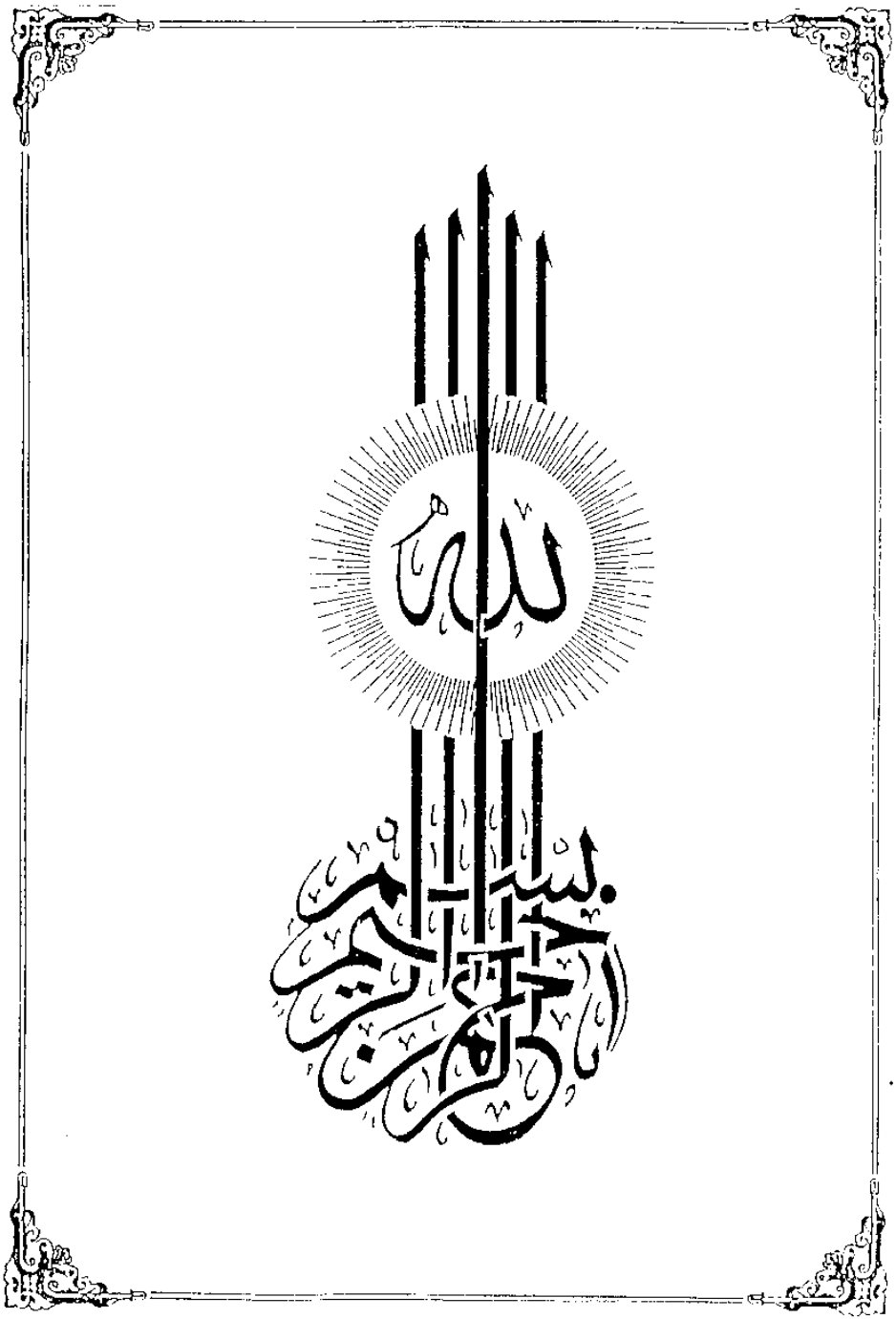
Supervised By

Dr. : Salah Awwaad

Professor Of Paediatrics
Ain Shams University

Ain Shams University
1993

....



ACKNOWLEDGEMENT

First, Thanks are all due to God for blessing this work until it has reached its end as a little part of his generous help throughout our life .

I would like to express my grateful appreciation to *Prof. Dr. SALAH AWWAAD*, Professor of Paediatrics, Faculty of Medicine, Ain-Shams University, for his continuous encouragement and support that he gave me throughout the whole work . It is a great honour to work under his guidance and supervision .

Waleed M. Maamoon

- 1993 -

CONTENTS

Abbreviations

A-a DO_2	*Alveolar-Arterial Oxygen Difference*
ACT	*Activated Clotting Time*
AIDS	*Acquired Immunodeficiency Syndrome*
BPD	*Bronchopulmonary Dysplasia*
CDH	*Congenital Diaphragmatic Hernia*
CMT	*Conventional Medical Therapy*
CNS	*Central Nervous System*
CT	*Computerized Tomography*
ECMO	*Extracorporeal Membrane Oxygenation*
EEG	*Electroencephalogram*
ELSO	*Extracorporeal Life Support Organization*
FiO_2	*Fraction of Inspired Oxygen*
ICH	*Intracranial Haemorrhage*
IQ	*Intelligence Quotient*
IVH	*Intraventricular Haemorrhage*
LFPPV-$ECCO_2$R	*Low Frequency Positive Pressure Ventilation With Extracorporeal CO_2 Removal*
MAP	*Mean Airway Pressure*
MAS	*Meconium Aspiration Syndrome*
NIH	*National Institutes of Health*
NPII	*Newborn Pulmonary Insufficiency Index*
OI	*Oxygenation Index*
$PACO_2$	*Partial Pressure of Alveolar Carbon Dioxide*
$PaCO_2$	*Partial Pressure of Arterial Carbon Dioxide*
PaO_2	*Partial Pressure of Arterial Oxygen*

PaO_2 / PAO_2	*Ratio Between Arterial and Alveolar Partial Pressure of Oxygen*
PEEP	*Positive End Expiratory Pressure*
PIP	*Peak Inspiratory Pressure*
PPHN	*Persistent Pulmonary Hypertension of the Newborn*
PRA	*Plasma Renin Activity*
RCCA	*Right Common Carotid Artery*
RDS	*Respiratory Distress Syndrome*
SDs	*Standard Deviations*
SGA	*Small for Gestational Age*
SNHL	*Sensorineural Hearing Loss*
V-A	*Veno-Arterial*
V-V	*Veno-Venous*

I- Introduction And Aim

Of

The Present study

Extracorporeal membrane oxygenation (ECMO) is a modification of cardiopulmonary bypass intraoperative technique . It makes use of prolonged extracorporeal bypass via extrathoracic cannulation, and provides partial or complete heart-lung functions, while the underlying disease resolves . *[Brutocao and O'Rourke , 1992]* .

It cannot be overemphasized that ECMO is not a cure for lung or heart disease, but rather it supports the patient's cardiopulmonary functions, while the disease process abates . Therefore, before the institution of ECMO, it is imperative to identify irreversible lethal damage from the primary disease . *[Brutocao and O'Rourke ,1992].*

At present, ECMO is the standard care for the support of term neonates with acute respiratory failure . It is being evaluated for paediatric pulmonary and cardiovascular support. *[Brutocao and O'Rourke , 1992].*

The present study will include a historical review on the subject of neonatal ECMO, followed by a discussion of the technical considerations, indications , inclusion and exclusion criteria and, complications that may arise during its use . A short account on the use of ECMO for paediatric pulmonary and cardiac support is followed by the outcome of ECMO patients. Finally, our study will close by the summary and conclusions.

II- HISTORICAL REVIEW

OF

NEONATAL ECMO

The first use of ECMO was in adult patients in the early 1970s, where it was used in adult patients with acute respiratory failure refractory to conventional therapy *[Zapol et al, 1979]* and the first adult survivor was reported by *Hill et al (1972)* . Over the next 5 years there were sporadic clinical series,with cumulative survival of 10-15 % *[Short and Pearson, 1986]* .

Inspite of the low survival rate , the successes were individually dramatic . Continued interest in the subject culminated in a National Institutes of Health (NIH), sponsored multicentre clinical trials , comparing ECMO and conventional mechanical ventilation for the treatment of severe acute respiratory failure in adults *[Zapol et al, 1979].* Ninety-Six patients with 80 % predicted mortality were randomized to conventional mechanical ventilation or ECMO . The results were disappointing as there were no difference in survival of both groups, being 8.7 % for conventional ventilation, versus 9.3 % for ECMO therapy . However, the study design was criticised *[Short and Pearson, 1986]* and the criticism claimed that prolonged mechanical ventilation (average 9.6 days) and predominance of viral and bacterial pneumonia as admission diagnoses, gave most patients a high probability of irreversible lung disease on entery . It is implied that earlier institution of ECMO may have prevented pulmonary fibrosis and improved survival .Despite these criticisms this

NIH study effectively terminated the use of ECMO for adults with acute respiratory failure *[Hirschl and Bartlett, 1987]* .

A better population for ECMO therapy appeared with the first neonatal ECMO survivor reported by *Bartlett et al (1975).* Since that time, there has been remarkable success in managing newborns with persistent pulmonary hypertension refractory to conventional therapy *[Bartlett et al, 1986]* .

In 1982, a registry was formed to collect and organize clinical ECMO data by the Extracorporeal Life Support Organization . By 1991, 4431 full term neonates with acute respiratory failure and persistent pulmonary hypertension having 80 % or greater predicted mortality with continued conventional management, have been supported with ECMO in 76 centres in the USA . Eighty - three per cent (83%) of these infants survived *[Extracorporeal Life Support Registry, 1991]* .

This experience had advanced ECMO from rescue therapy to a state of art *[Brutocao and O'Rourke, 1992]* .

Presently ECMO support is routinely offered to term neonates with severe hypoxaemia from persistent pulmonary hypertension *[Brutocao and O'Rourke, 1992]* .

III- TECHNICAL CONSIDERATIONS OF NEONATAL ECMO

Presently , as we mentioned , ECMO is routinely offered to term neonates with severe hypoxaemia from persistent pulmonary hypertension .

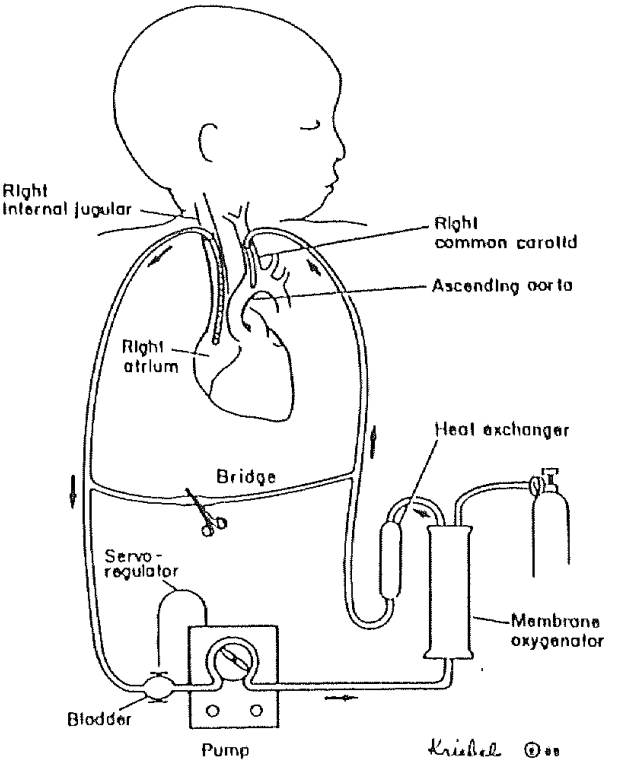
The type of ECMO used in these cases , described by *Bartlett et al (1977)* is veno-arterial , which describes the circuit in which blood exits from the venous system and is returned to the arterial circulation *(Fig 1)*.

The blood of the term neonate is drained from his right atrium through a large catheter **(12-14 French gauge)** . This is accomplished by making an incision in the right side of the neck of the neonate , through which two perfusion cannulae are inserted . One of these is inserted through the internal jugular vein into the right atrium and the second is inserted into the common carotid artery , so that its tip is at the origin of the brachiocephalic artery .

The blood drained from the right atrium flows by gravity to a bladder in the machine *(Fig 1)* ,which adds capacitance to the system and acts as a safeguard against inconsistent venous return . The bladder also functions as a trap for any air contained in the venous limb of the circuit .Thenafter, the blood is propelled forward by an occlusive blood pump which is servoregulated to the pressure of the venous return

In the neonate an ECMO flow of 80 - 120 ml / kg / min is usually adequate to support gas exchange : this approximates to one - half to two - thirds of the cardiac output in the normal neonate .

Figure (1)



Veno-arterial extracorporeal membrane oxygenation.

[Brutocao and O'Rourke, 1992]