

Current Status of ECMO In Neonate & Pediatrics

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History

- 1953 Gibbon Heart lung machine
- 1971 Hill & O'Brien First successful report of ECMO
"traumatic respiratory failure (adult)"
- 1975 Bartlett Phase-I trials in neonate
22/40 (55%) survival of neonate
- 1984 Bartlett Phase-II trials in neonate
- 1989 ELSO Registry
- 2004 15th anniversary of ELSO



Extracorporeal Life Support Organization

The Extracorporeal Life Support Organization (ELSO) is an international consortium of health care professionals and scientists who are dedicated to the development and evaluation of novel therapies for support of failing organ systems. Crucial is the promotion of a broad multidisciplinary collaboration. The primary mission of the Organization is to maintain a registry of, at least, use of extracorporeal membrane oxygenation in active ELSO centers. As appropriate, registries of other novel forms of organ system support are within the purview of ELSO. Registry data is to be used to support clinical research, support regulatory agencies, and support individual ELSO centers. ELSO provides educational programs for active centers as well as for the broader medical and lay communities.

ELSO GUIDELINES FOR ECMO CENTERS

PURPOSE

These guidelines developed by the Extracorporeal Life Support Organization, outline the ideal institutional requirements needed for effective use of extracorporeal membrane oxygenation (ECMO). The Extracorporeal Life Support Organization recognizes that differences in regional and institutional regulations especially concerning hospital policies may result in variations from these guidelines. These guidelines will be reviewed and updated every three years in an attempt to keep the document current.

GENERAL




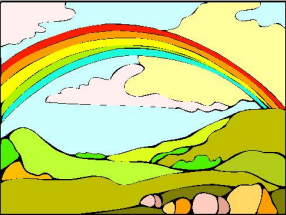

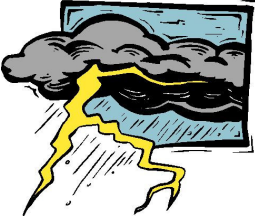
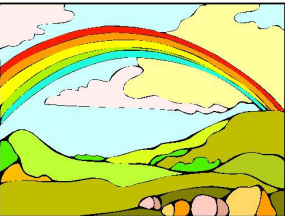

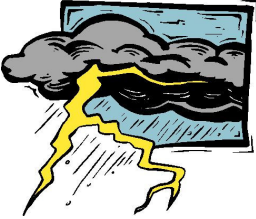
- A. ECMO centers should be located in tertiary centers with a tertiary level Neonatal Intensive Care Unit, Pediatric Intensive Care Unit and/or Adult Intensive Care Unit.
 - B. ECMO Centers should be located in geographic areas that can support a minimum of 6 ECMO patients per center per year. The cost effectiveness of providing fewer than 6 cases per year combined with the loss, or lack of clinical expertise associated with treating fewer than this number of patients per year should be taken into account when developing a new program.
 - C. ECMO Centers should be actively involved in the Extracorporeal Life Support Organization (ELSO) including participation in the Central Registry.
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Current Status of ECMO

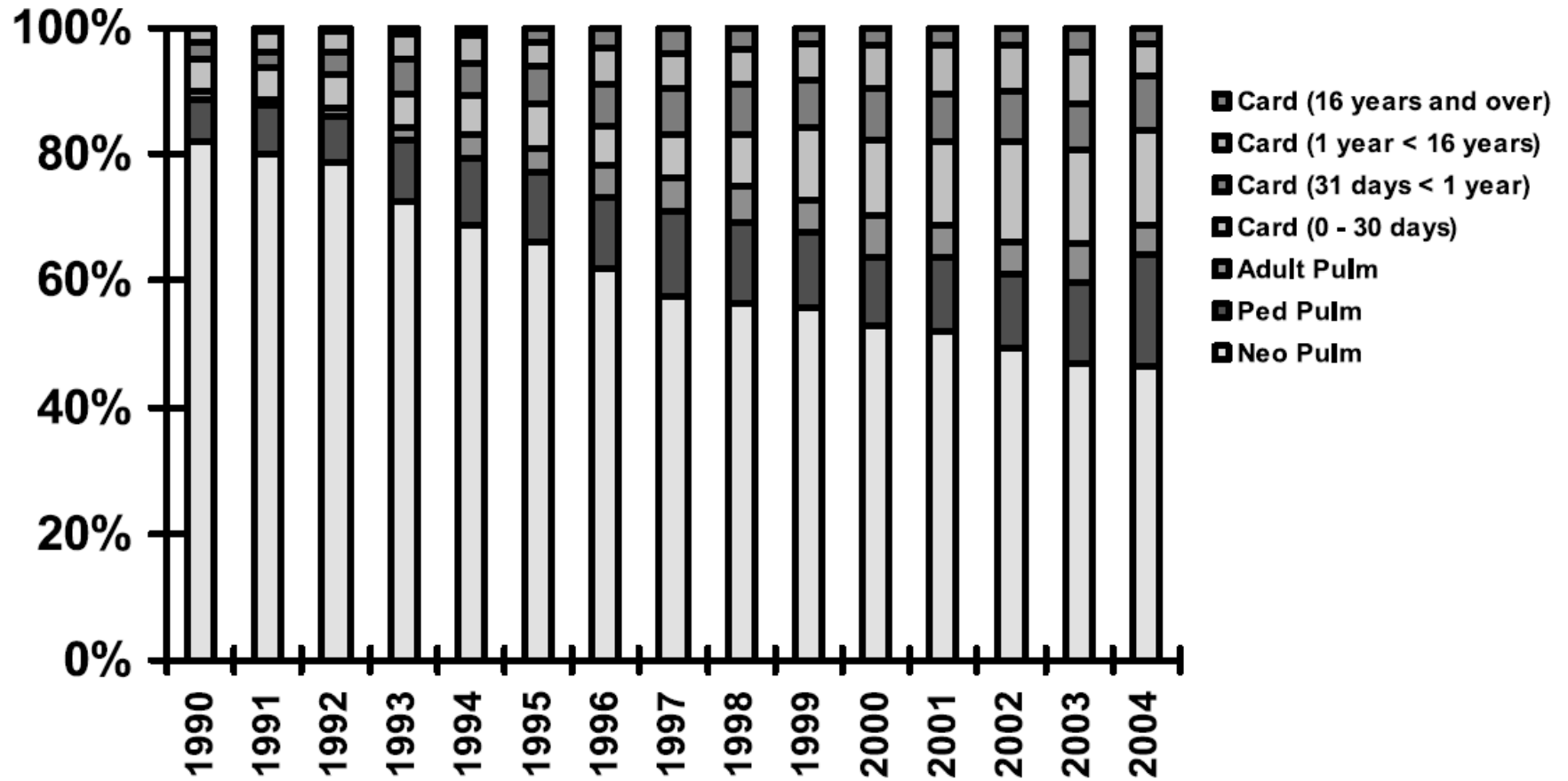
Group	Total Cases	Survive to DC (no.)	Transfer (%)
Neonatal			
Respiratory	19,061	14,681	77
Cardiac	2,215	841	38
ECPR	151	65	43
Pediatric			
Respiratory	2,762	1,536	56
Cardiac	2,936	1,256	43
ECPR	282	111	39
Adult			
Respiratory	972	515	53
Cardiac	474	156	33
ECPR	132	50	38
Total	28,985	19,211	66

Total numbers of ECLS cases reported by the ELSO registry international summary, July 2004. *Seminars in Perinatol 29:24-33*

Weather Report

	Respiratory	Cardiac	E-CPR
Neonatal			
Pediatric			
Adult			

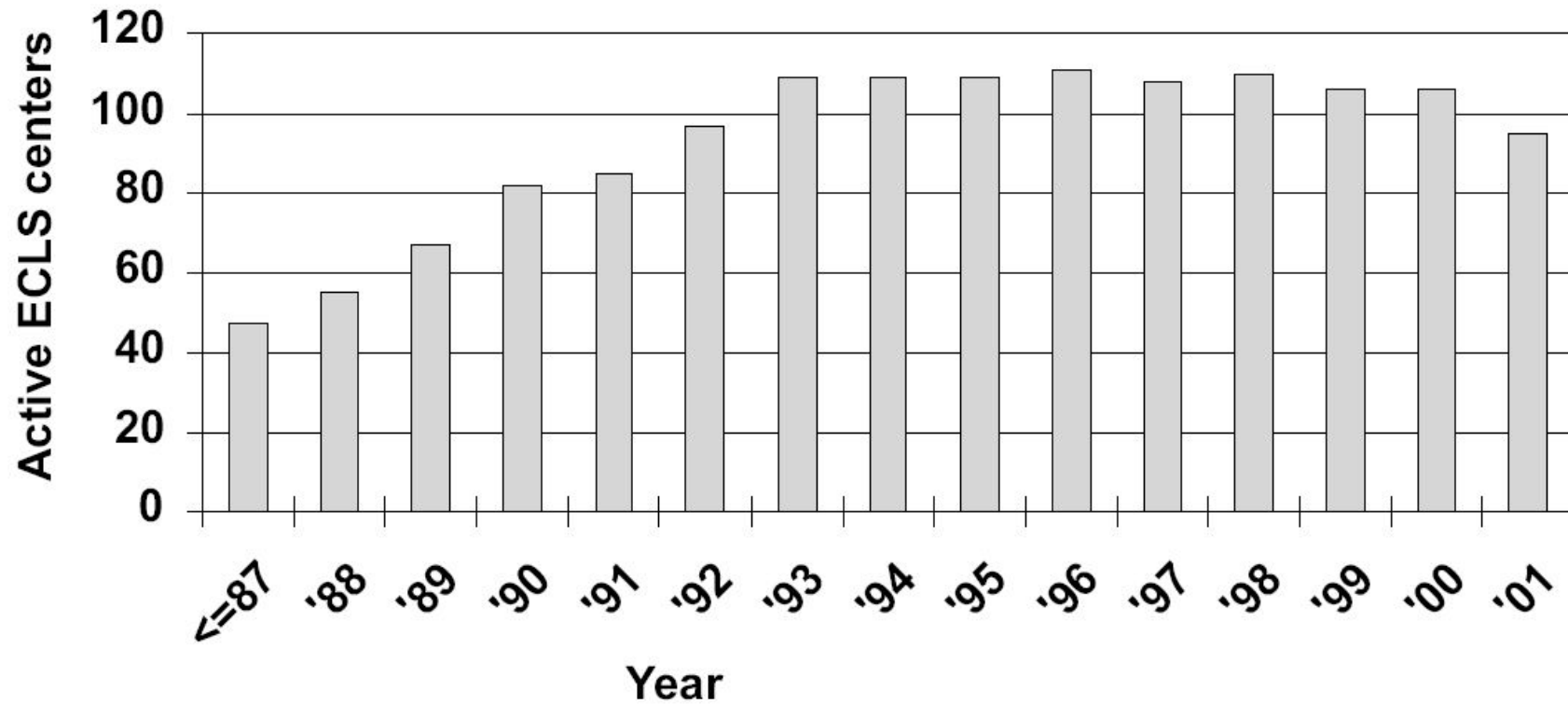
Current Status of ECMO



ECLS cases reported to the ELSO Registry as of July 2004.

Seminars in Perinatol 29:24-33

Number of ECLS Center

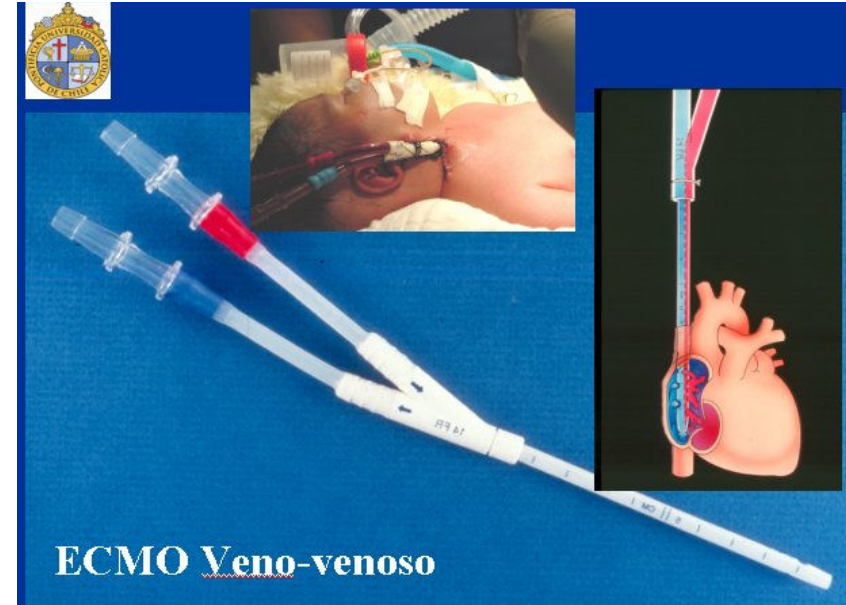
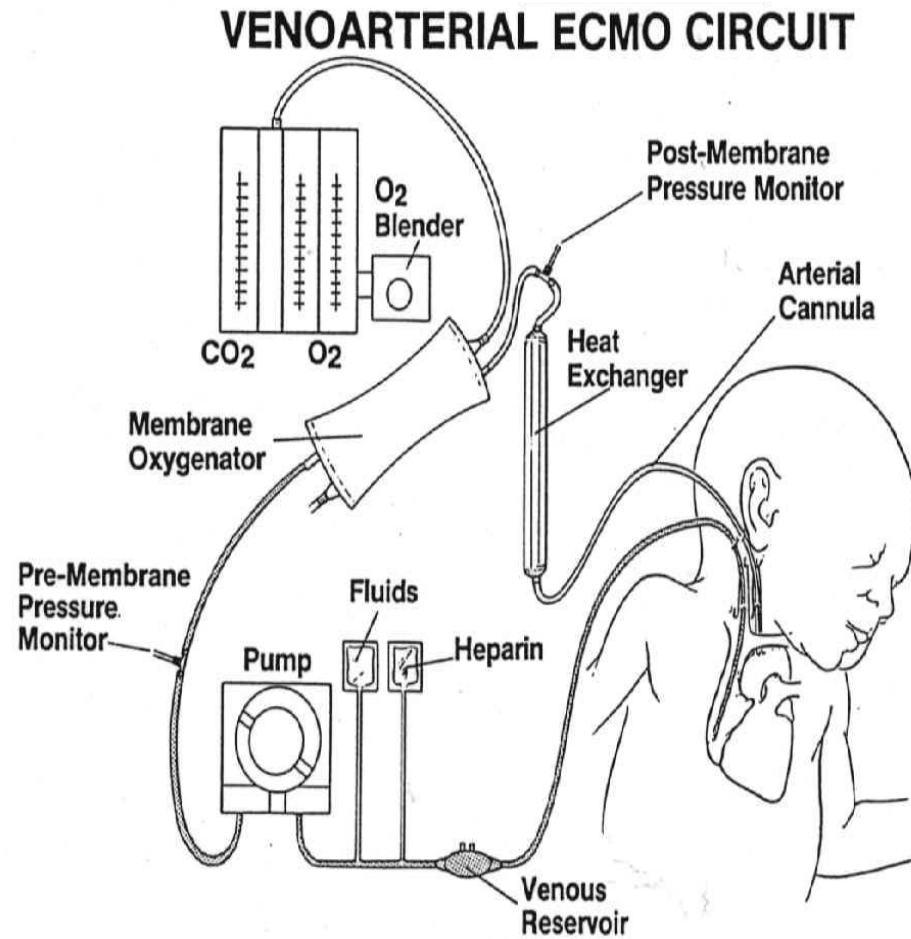


Pediatric Resp Review 2004:5(suppl A) S329-S337

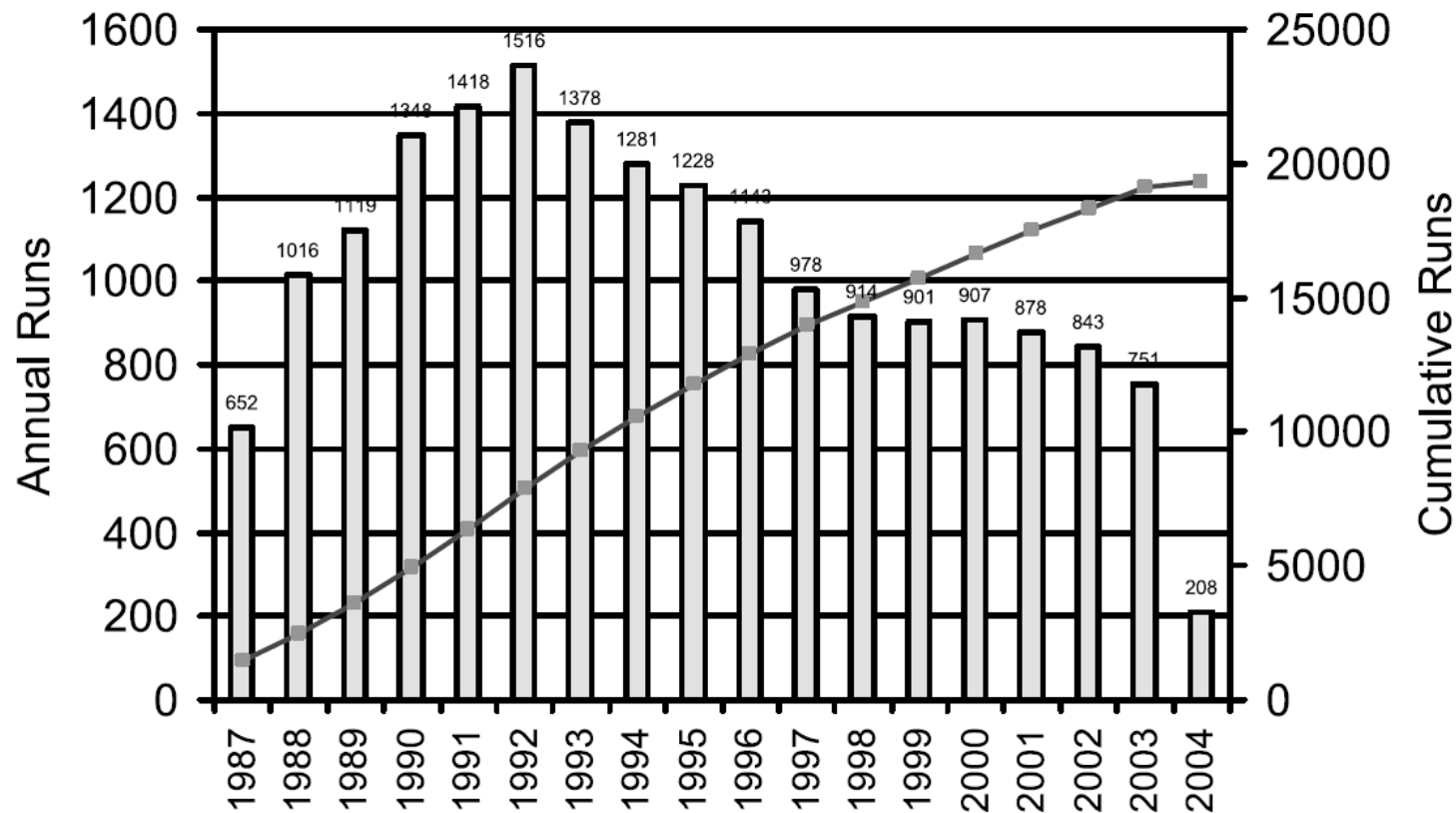
Distinctive Feature of Neonate & Pediatrics

- Superior survival rate
overall 78% (neonate) vs 53% (adult)
- Assess Vessel
neck vessel >> femoral vessel
→ carotid artery & internal jugular vein were used
difficult to insert percutaneously, usually cut-down and
carotid artery ligation
- Double lumen venous catheter

Type of Neonatal ECMO



Neonatal Respiratory Cases



Neonatal respiratory ECLS cases reported to the ELSO Registry as of July 2004
Seminars in Perinatol 29:24-33

Recent Trend of Neonatal ECMO

- About 66% of overall ECMO case, but gradually decrease of number of ECMO

early 1990s – 1500 case/year middle 2000s – 800 case/year

- Cause of decreased number of ECMO
improved prenatal care and perinatal preventive medicine
alternative therapies for support of neonatal respirator failure
- high frequency ventilation, inhaled nitric oxide, surfactant
- Increased proportion of more sicker patients
→ increased duration of ECMO support and increased mortality

Extracorporeal Life Support for Neonatal Respiratory Failure (July 2004)

Primary Diagnosis or Mode	Total Cases	Number Surviving	% Surviving
Neonatal cases by diagnosis			
CDH	4,491	2,367	53
MAS	6,560	6,160	94
PPHN/PFC	2,914	2,287	78
Infant RDS	1,380	1,161	84
Sepsis	2,384	1,794	75
Other	1,567	1,003	64
Neonatal mode of ECLS			
VA	13,301	9,882	74
VV	276	220	80
VVDL	3,537	3,053	86
VA(+V)	1,159	868	75
VV → VA	544	360	66
VVDL + V	410	346	84

Type of ECMO for Neonatal Respiratory Failure

- Veno-arterial ECMO
- Veno-venous ECMO

Veno-Arterial ECMO

- most commonly used
- advantage
 - : heart & lung support
- cause
 - most experienced & familiar to cardiovascular surgeon
 - frequently neonate requires inotropic support
- disadvantage
 - requires carotid artery ligation → possibility of brain ischemia(?)
 - deoxygenated coronary perfusion → ischemic cardiomyopathy

Veno-Venous ECMO

- Advantage

oxygenated blood → pulmonary vasodilation

does not require to ligate carotid artery

oxygenated coronary perfusion

→ improved survival in respiratory support

Veno-arterial 74% Veno-venous 80%

- double lumen venous catheter

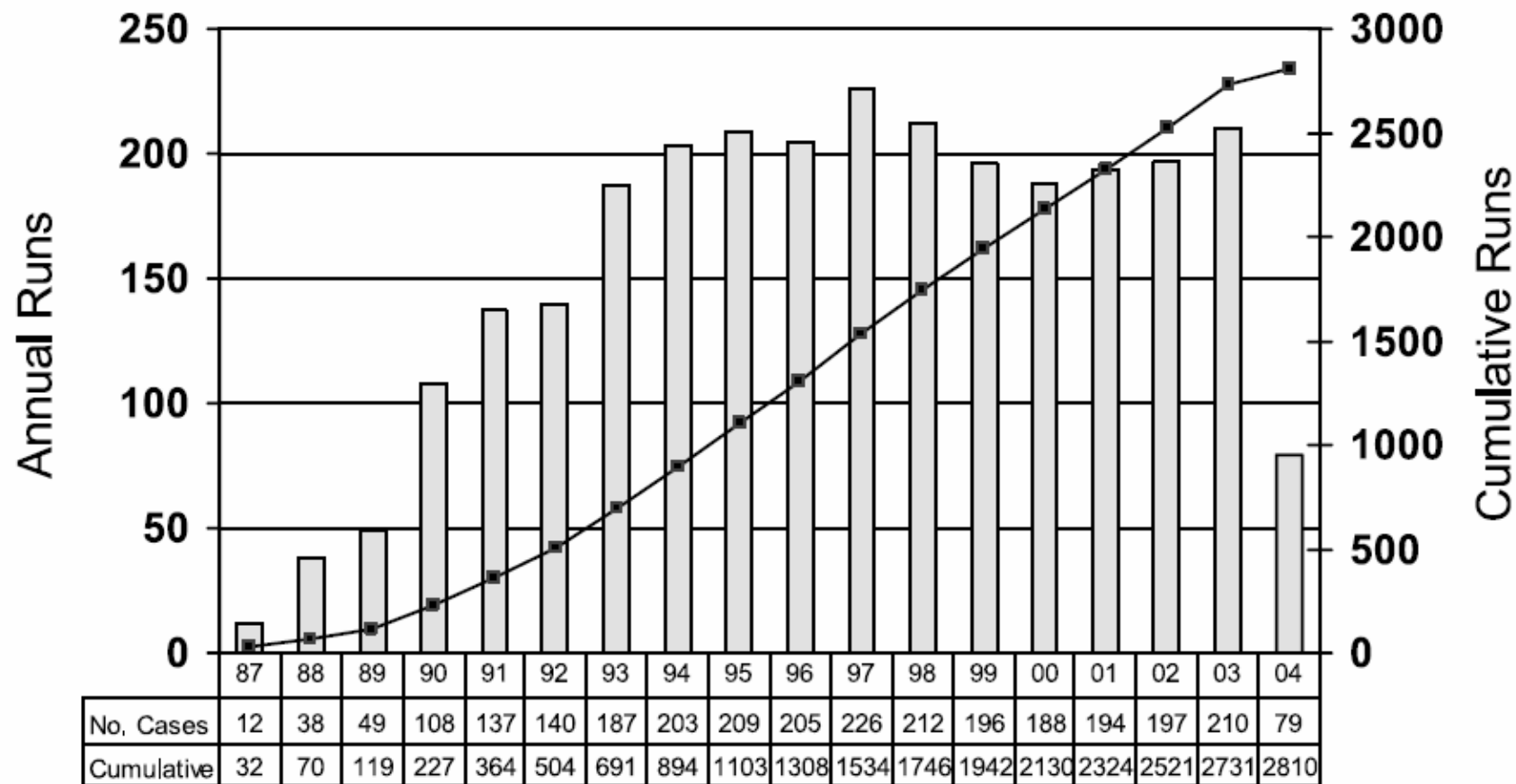
single cannulation, possible to insert percutaneously

- Disadvantage

impossible to cardiac support

So, high dose of inotropics → veno-arterial support

Pediatric Respiratory Cases



Pediatric respiratory ECLS cases reported to the ELSO Registry as of July 2004
Seminars in Perinatol 29:24-33

Extracorporeal Life Support for Neonatal Respiratory Failure (July 2004)

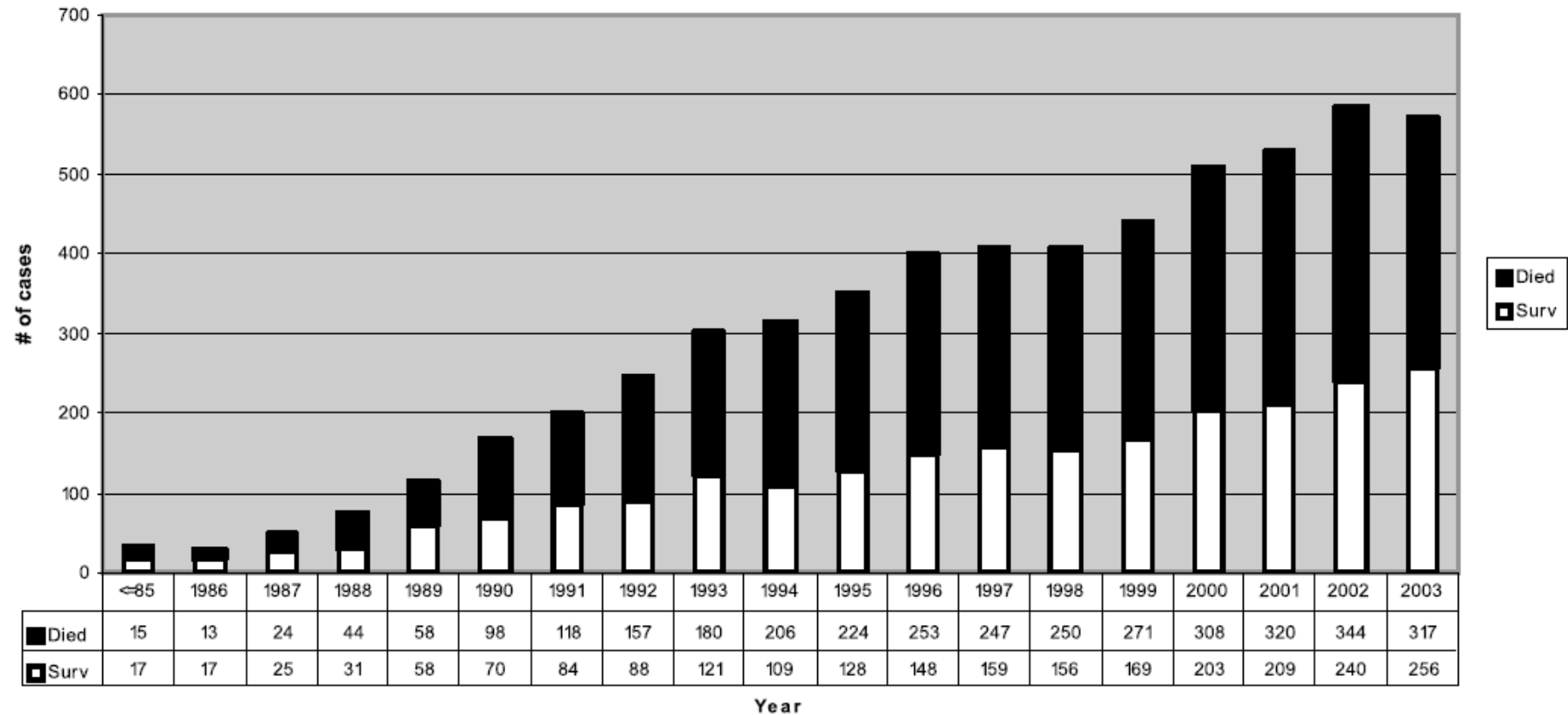
Primary Diagnosis or Mode	Total Cases	Number Surviving	% Surviving
Pediatric cases by diagnosis			
Bacterial pneumonia	290	157	54
Viral pneumonia	728	457	63
Aspiration pneumonia	168	110	65
ARDS	348	188	54
ARF, non-ARDS	605	286	47
Other	671	359	54
Pediatric mode of ECLS			
VA	1,663	851	51
VV	510	328	64
VVDL	283	200	71
VA(+V)	89	42	47
VV → VA	163	74	45
VVDL + V	44	32	73

ARF, acute respiratory failure; ARDS, acute respiratory distress syndrome

Specific Problems of Pediatric ECMO (Technical Aspects)

- Variant size of femoral vessel with age
 - Lack of suitable double lumen catheter
difficult to initiate venovenous ECMO
- veno-arterial ECMO > veno-venous ECMO
for respiratory support

ECLS Cardiac Cases by Year



Cardiac ECLS cases per year. Adapted from ECLS Orgniation International Registry as of July 2004

Neonatal & Pediatric ECMO for Cardiac Support

- Rapidly increased in recent year
- Cause
 - post-cardiotomy heart failure (most common)
 - fulminant myocarditis
 - cardiomyopathy
 - E-CPR
- Type of ECMO (veno-arterial)
 - through sternotomy (ascending aorta & RA)
 - through neck vessels

Neonatal and Pediatric ECMO의 국내보고 현황

- 국내 문헌상 보고 : total 17례

소아 개심술 후 시행한 순환보조장치의 임상적 고찰

권오춘, 이영탁 대한흉부외과학회지 2000 May;033:385-390

개심술 후 심폐소생술 실패환아에서의 체외막 산소화 치험 1례

전희재, 성시찬, 우종수, 이해경 대한흉부외과학회지 1999 Jan;032:53-57

- 전례에서 post-cardiotomy heart support sternotomy wound를 통한 ECMO
- Respiratory support에 대한 case는 일부 있었으나 문헌상 보고는 없음.

국내에서의 Neonatal and Pediatric ECMO가 적은 이유

- **Absence of Available Catheter**

- Double lumen venous catheter – 수입안됨
- 효과적인 venous catheter가 없어 여러 catheter가 대용으로 시도됨 (small sized arterial catheter, vent catheter)
 - insufficient ECMO flow
 - ineffective cardiac or respiratory support
- Central cannulation
 - excessive bleeding

Therefore, worsened the Results of ECMO

SNUCH Experience for Neonatal & Pediatric ECMO

- 2000. 2. ~2006. 3, total 26 patients
- Cause of ECMO support

for respiratory support (viral pn.)	1 case
for cardiac support	25 cases
post-cardiotomy	(17)
E-CPR	(5)
myocarditis or dCMP	(3)

SNUCH Experience for Neonatal & Pediatric ECMO

- Type of ECMO

veno-venous	0 case
veno-arterial	26 cases
through sternotomy	(22)
Rt carotid & common femoral vein	(1)
femoral artery & vein	(3)

- Survival (4/26 = 15.4%)

post-cardiotomy	(3)
E-CPR	(1)

SMC Experience for Neonatal & Pediatric ECMO

- 2005. 10. ~ 2007. 7., total 13 patients
- Cause of ECMO support
 - for respiratory support 3 cases
 - for cardiac support 10 cases
 - post-cardiotomy (4)
 - preop. support (2)
 - acute drug-induced cardiomyopathy (2)
 - PPHN (1)
 - myocarditis (1)

SMC Experience for Neonatal & Pediatric ECMO

- Type of ECMO
 - veno-venous 2 cases
 - femoral vein & internal jugular vein
 - veno-arterial 11 cases
 - Rt carotid & internal jugular vein (7)
 - through sternotomy (3)
 - femoral artery & vein (1)
- Survival (4/13 = 30.8%)
 - post-cardiotomy (2)
 - drug-induced cardiomyopathy (1)
 - myocarditis (1)

ECMO Results in SNUBH

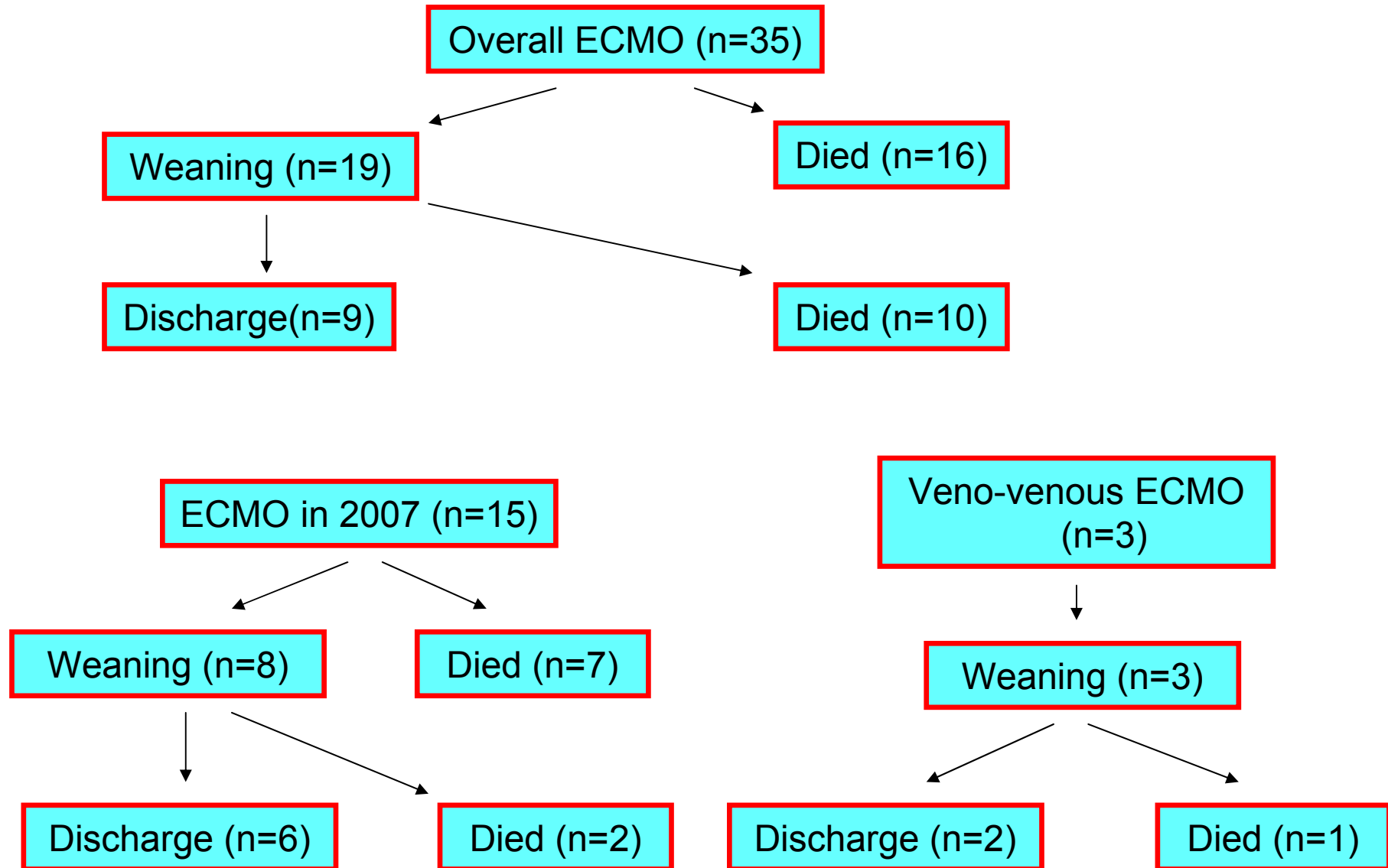
- Period 2003. 10. ~ 2007. 10. 11.
- No of patients 35 명 (41 cases)
 - for cardiac support 31 명
 - for respiratory support 4 명
 - V-A 1, V-V 3
- Type of ECMO
 - veno-arterial 32 명 (37 cases)
 - veno-venous 3 명 (4 cases)
- Age : mean 61.6 (2day ~ 76 yr)
- M : F = 26 : 9



ECMO Results in SNUBH

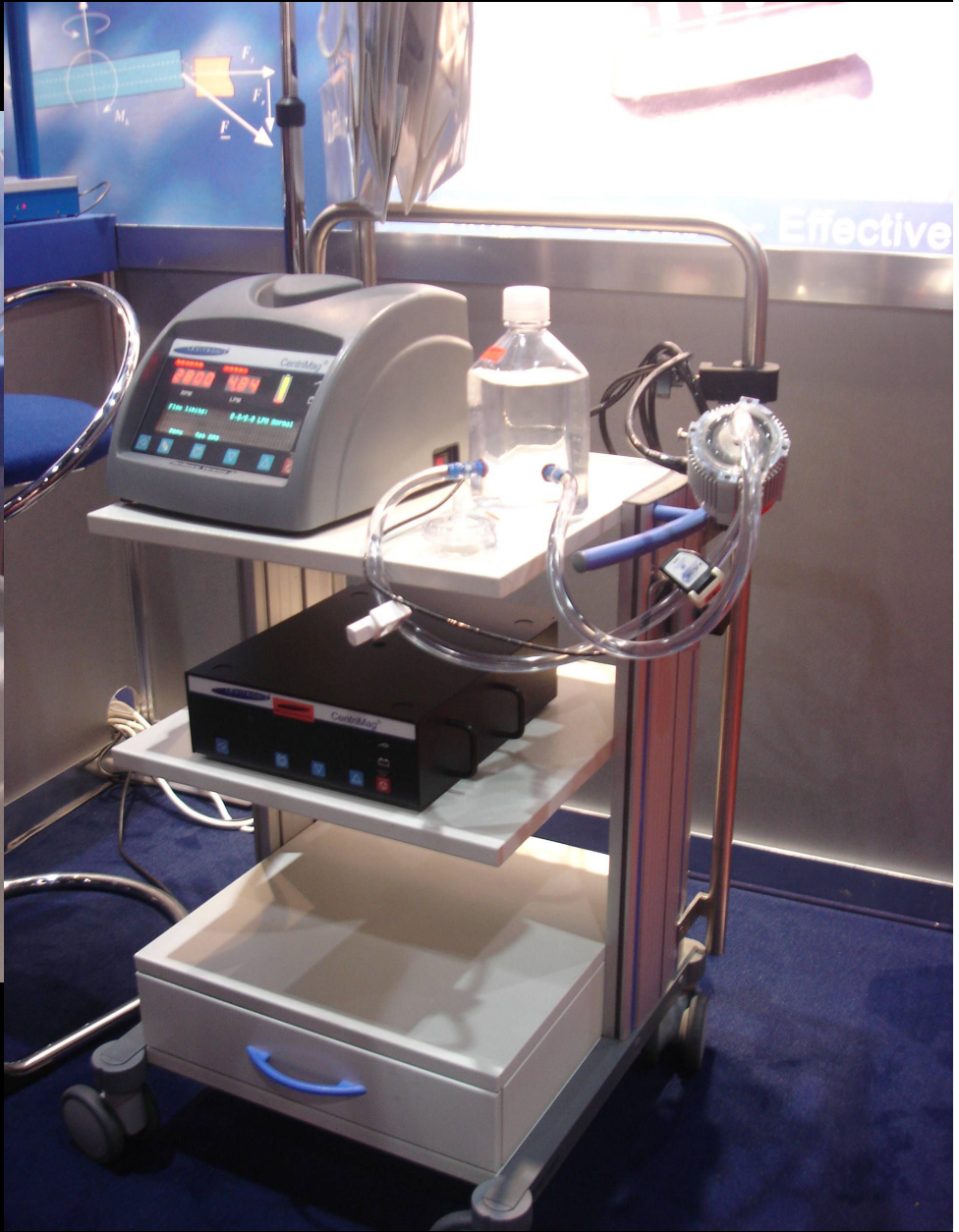
- Overall results
 - total 35 patients (41 cases)
 - weaning 45.7 % 16 patients (19 cases)
 - survival 25.7 % 9 patients (F/U중 1명 사망)
- Pre-EBS Era : 2003.10. ~ 2006. 12.
 - total 20 patients (22 case)
 - weaning 40 % 8 patients
 - survival 15 % 3 patients
- EBS Era : 2007. 1. ~ 2007. 10.
 - total 15 patients (19 cases)
 - weaning 53.3 % 8 patients (11 cases)
 - survival 40 % 6 patients

ECMO Results in SNUBH



Considerations

- To increase successful ECMO case
 - earlier detection of proper candidate
 - prepare hardware
 - appropriate catheter
 - double lumen venovenous catheter
 - smaller EBS system
 - prepare software
 - physician & surgeon's collaboration
 - effective organization (like ELSO)
 - accumulation of experience



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