Extracorporeal Membrane Oxygenation(ECMO) Past, Present & Future

INJE University SPH

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Ann Thorac Surg 2003;76:S2188-294S

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  - **History of Extracorporeal Membrane Oxygenation(ECMO) I**
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- **Present**
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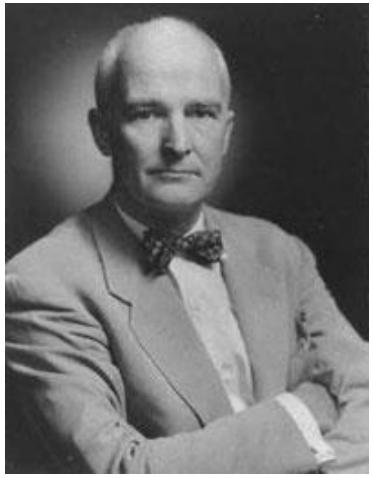
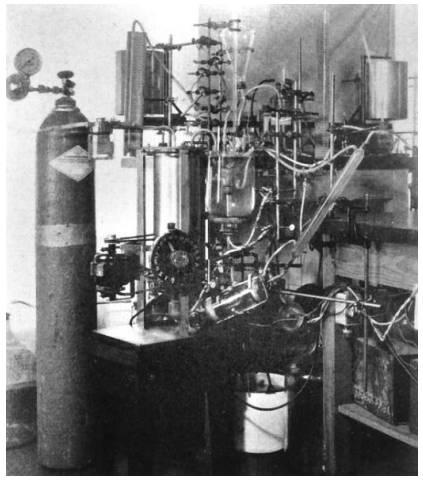
  - **Clinical study**
  - **Equipment**
- **Future**

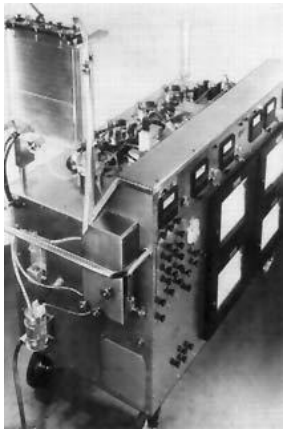
Heart Lung Machine

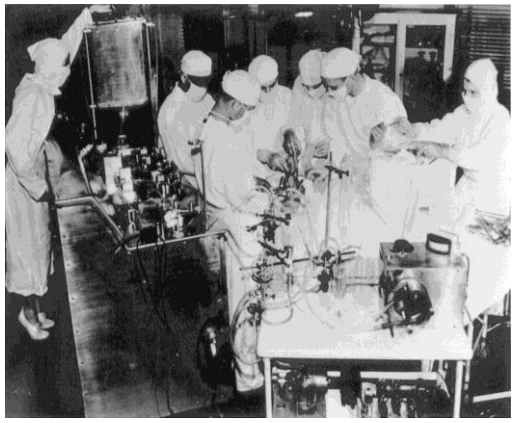
- The first heart - lung machine
  - John Gibbon (1937)
  - first successful heart operation (1953; Cecelia Bavolek)

- Limitation
  - minimize hemolysis, prevent air bubbles & infection
  - direct air- blood interface
  - duration of use limited to a few hours









Heart Lung Machine

- **Dimethylpolysiloxane (1957)**

  - silicone rubber membrane

  - artificial lungs

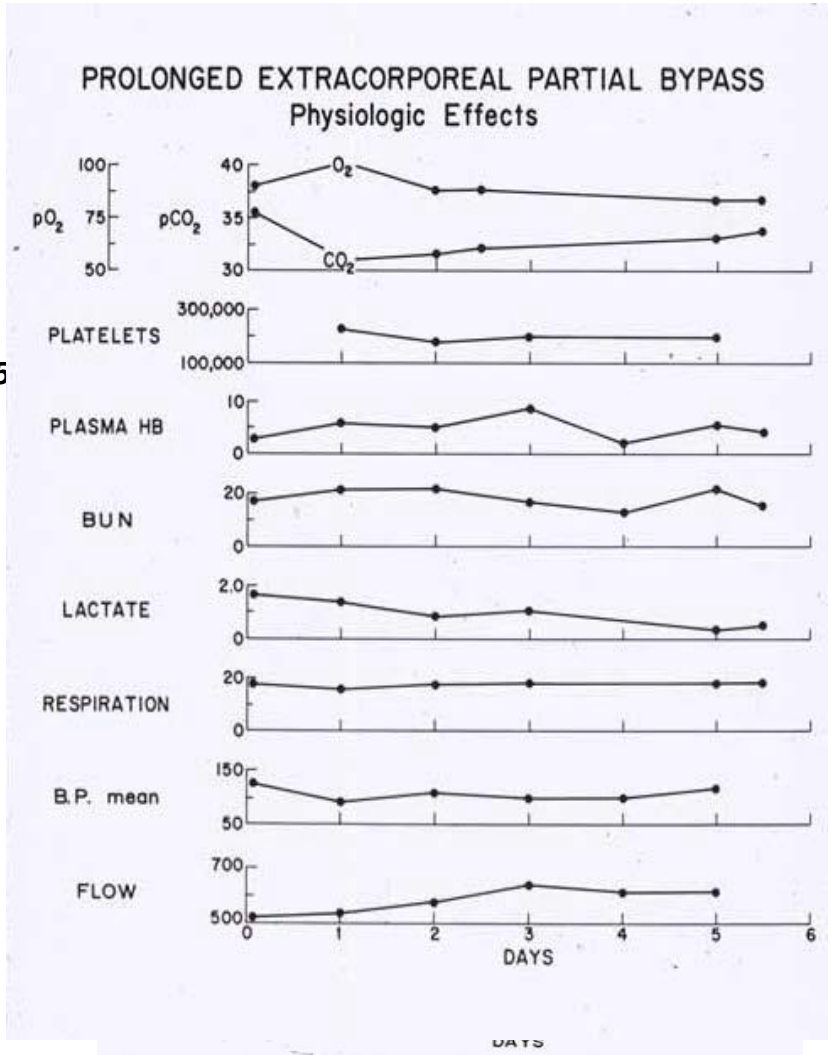
  - Bramson ML J Thorac Cardiovasc Surg 50:391, 1965

- **Heparin titration & ACT measurement**

  - Bartlett RH Surg Forum. 1969;20:152-3.

- **5 day extracorporeal circulation in animals**

  - Bartlett RH, Ann Surg 180:850-856, 1974



1st ECMO Case

N Engl J Med 286:629-634,1972-9.

1st ECMO Case

Cardiac failure post-Mustard atrial baffle

Bartlett RH, ASAIO Trans 22:80-93,1976

ECMO History in Korea (1985~1990)

대한민국의 심장혈관수술 현황(Ⅱ)

김 형 묵*

—Abstract—

Cardiovascular Surgery in Korea(Ⅱ)

young Mook Kim, M.D.*

Table 11. Ventricular Assist Device

site	Weaning from Device /No. of patients						
	85	86	87	88	89	90	Total
LVAD	1/4	7/10	6/8	5/12	6/8	7/8	32/50
RVAD						1/1	1/1
Total	1/4	7/10	6/8	5/12	6/8	8/9	33/51

VAD : Ventricular Assist Device

r World War Ⅱ a great de
elating to the diagnosis and
ical data after the first open
9 up to 1984 revealed the tot
erformed in 22 institutes wit
Korea 1985).
rean Thoracic and Cardiova
surgical cases in Korea agai
stitutes of open heart center

5%(38 out of 42 institutes).
cardiovascular surgery repor
tality of 4.7%(4.5% of the 21,761 operations for con-
genital, and 5.2% of the 8,300 operations for acquired heart diseases).

Out of the total congenital cases, 17,303 cases were acyanotic group with a operative mortality as 2.0%, and 4,458 cases were cyanotic group with a hospital mortality as 14.1%. The incidence of corrective operations for complex congenital cardiac anomalies were increasing recently with decreasing age group.

3. During the year in 1990, 38 institutes performed 5,427 cardiovascular surgery with a hospital mortality of 3.4%.

4. Of the total cummulative 6,458 cases for cardiac valve surgery more than 90% cases were put to prosthetic valve replacement with hospital mortality as 4.8%. And the incidence of re-Do valve surgery was increasing recently as 13.1% in 1990.

5. Coronary artery bypass graft was incresing recently with 7.9% of hospital mortality in total 440 cases. Intracardiac operation for intractable arrhythmia was started since 1987 as 49 cases in total. Experiences on VAD and ECMO were also reported sporadically in recent year.

6. Home made oxygenator(OXYREX) is now in clinical use, and under animal experiment for clinical trial in near future.

그 이외에 기계적인 심실보조장치와 ECMO에 의한 심장소생술의 시도가 근자에 활발히 이루어지고 있다. 특히 수년간에 걸친 연구와 결과로 국산 막형산화기가 국내에서 최초로 개발되어 임상에 사용단계에 있으며, 탄소를 이용한 인공심장기계판막의 국내개발도 상당한 진전을 보여 그완성을 목전에 두고 있고 인공심장의 개발에 대한 연구와 동물실험이 적극적으로 이루어지고 있어 한국흉부외과의 앞날을 밝게하고 있다.

1st Korean Oxygenators

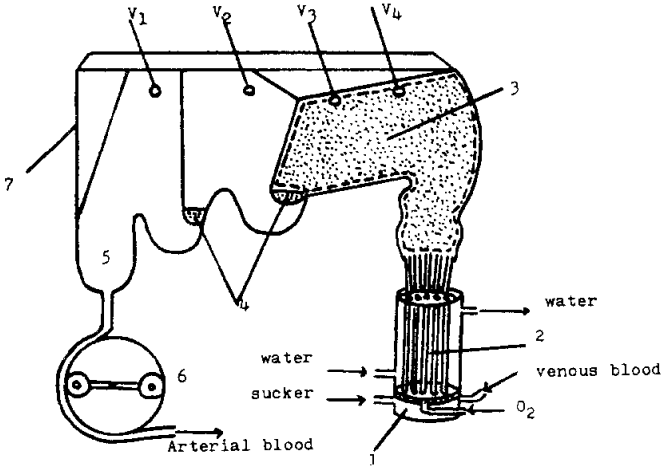
- 1st oxygenator (1982)

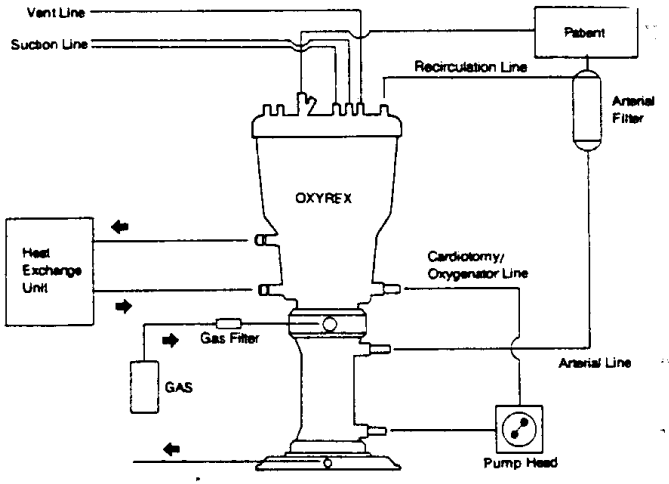
- Korea-Kim venotherm oxygenator

- 1st clinical study (1990 Oxyrex)

- HM KIM KJTCSurg 023(06):1049-56

Operations	No. of Patients
Mitral Valve Replacement	14
Aortic & Mitral Valve Replacement	5
Aortic Valve Replacement	5
Mitral & Tricuspid Vlave Replacement	1
Aortocoronary Bypass	1
VSD Repair	3
ASD Repair	3
Sinus Valsalva Rupture Repair	2
TOF, Total Correction	1
Cortriatriatum, Correction	1
Aortic Aneurysm Resection	1
Cardiac Tumor Resection	1
IVC Thrombosis Removal	1
Total	40





1st ECMO Cases

- 1st case report (4cases 1990.7~1991.12)

Table 1. 한국 ECMO 증례

연번호	연도	성별	연령	심폐부전의 종류	인공폐	체외순환방식	체외순환시간	결과
1	1990	M	8M	Truncus arteriosus 진단하 개심수술후 저심박출량 상태	Kuraray	V-V, V-A	11시간	사망
2	1990	M	13M	폐 좌상, 기흉	Kolobow +Kuraray	V-A	40시간	사망
3	1991	F	23M	TOF 진단하 근치개심수술후 우심 부전	Kuraray	V-A	90시간	생존
4	1991	M	51	급성 심근내막염에 의한 prosthetic valve failure	heparin 결합 Maxima	V-A	12시간	사망

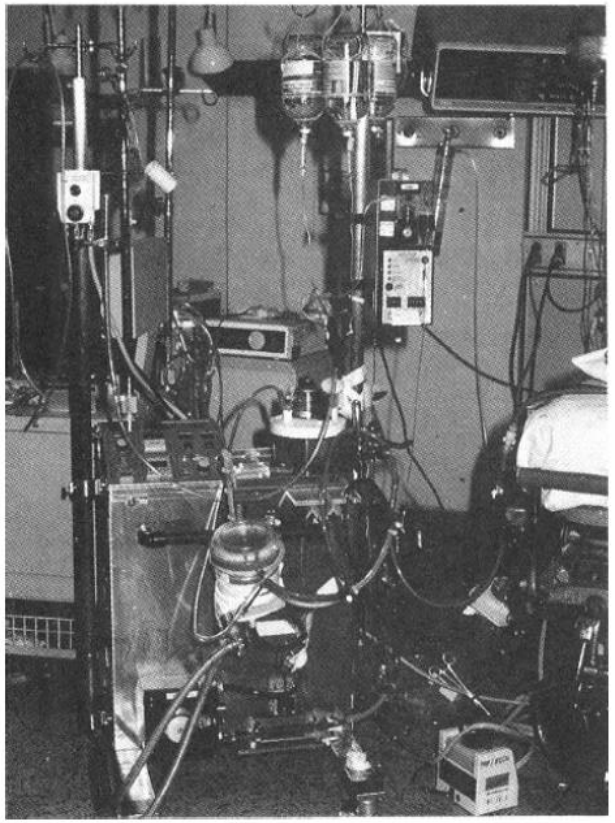
- korean J Anestheisol 1992;025(02):424-32

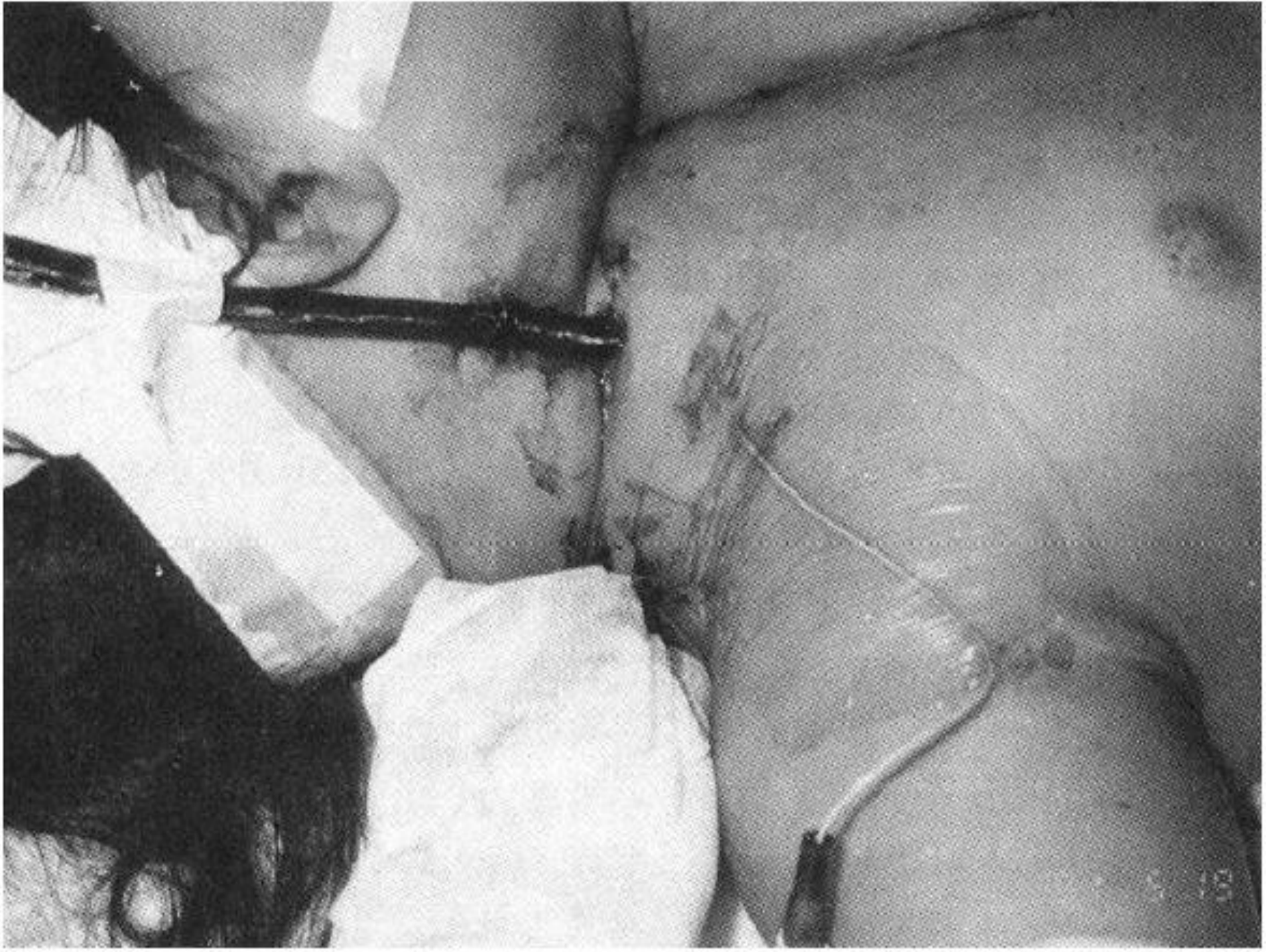
- 1st Respiratory support

- KP Hong KJTC Surg 1994;27:60-2

- 1st Extracorporeal Cardiopulmonary Resuscitation (E-CPR)

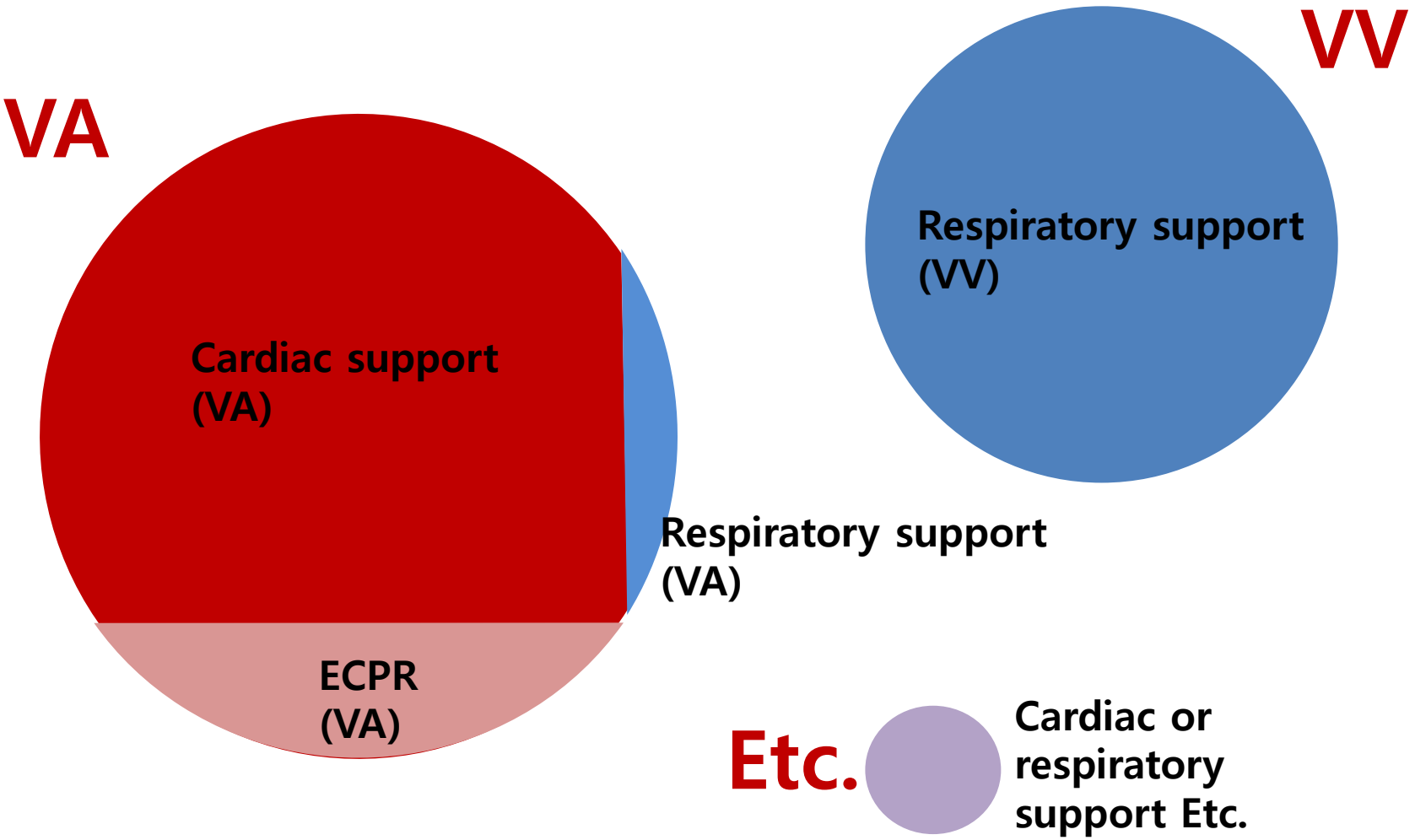
- JH JUN KJTC Surg 1999;32:53-7





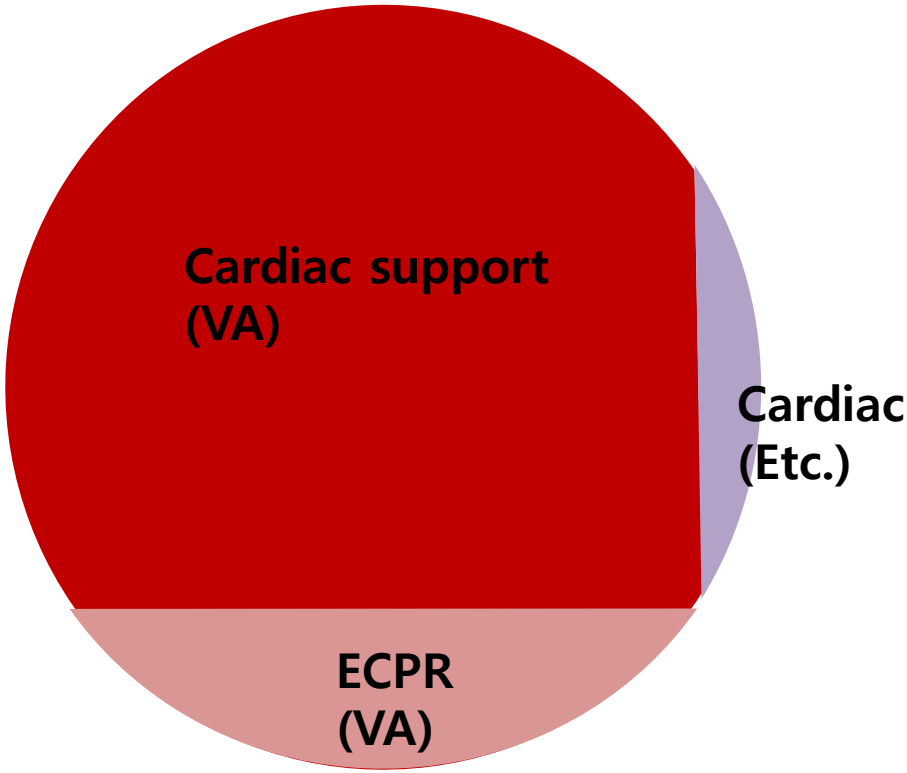
VA ≒ Cardiac support
VV ≒ Venous support

ECMO Support Type

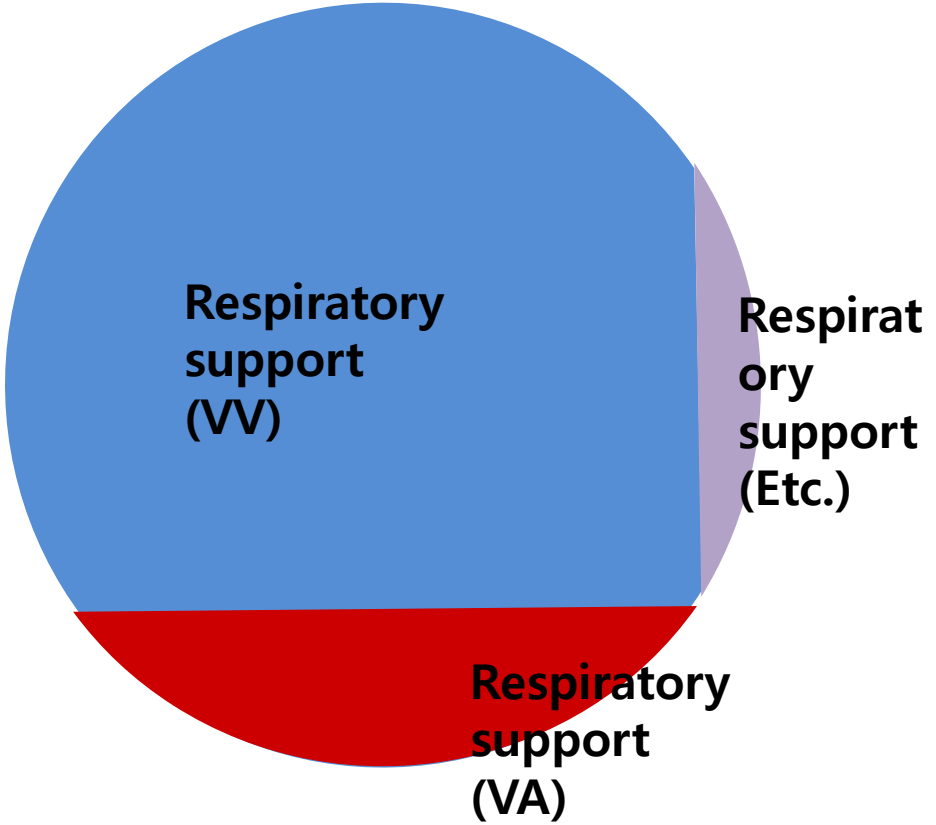


ECMO Support Target

Cardiac

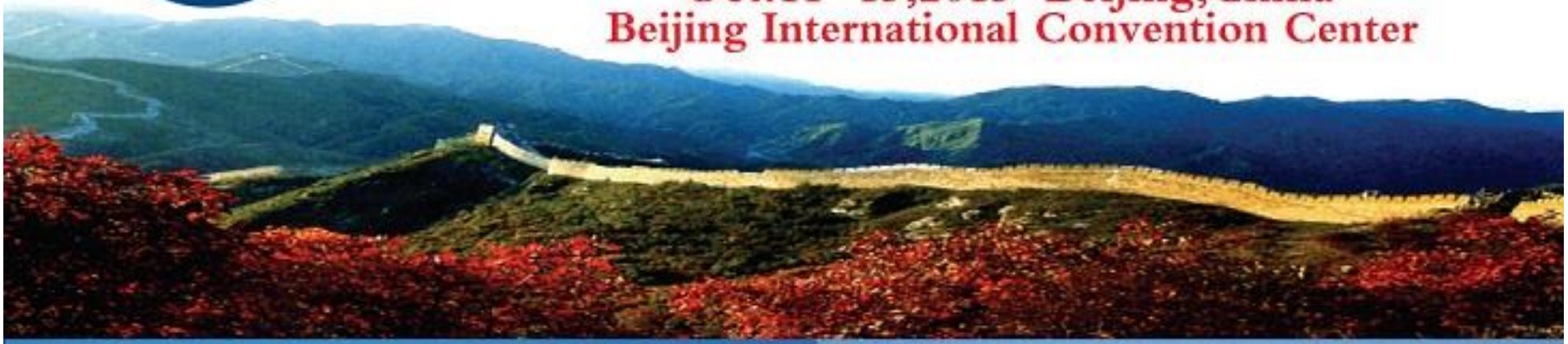


Respiratory



1st Asia Pacific ELSO Conference

Oct.11–13,2013 Beijing,China
Beijing International Convention Center



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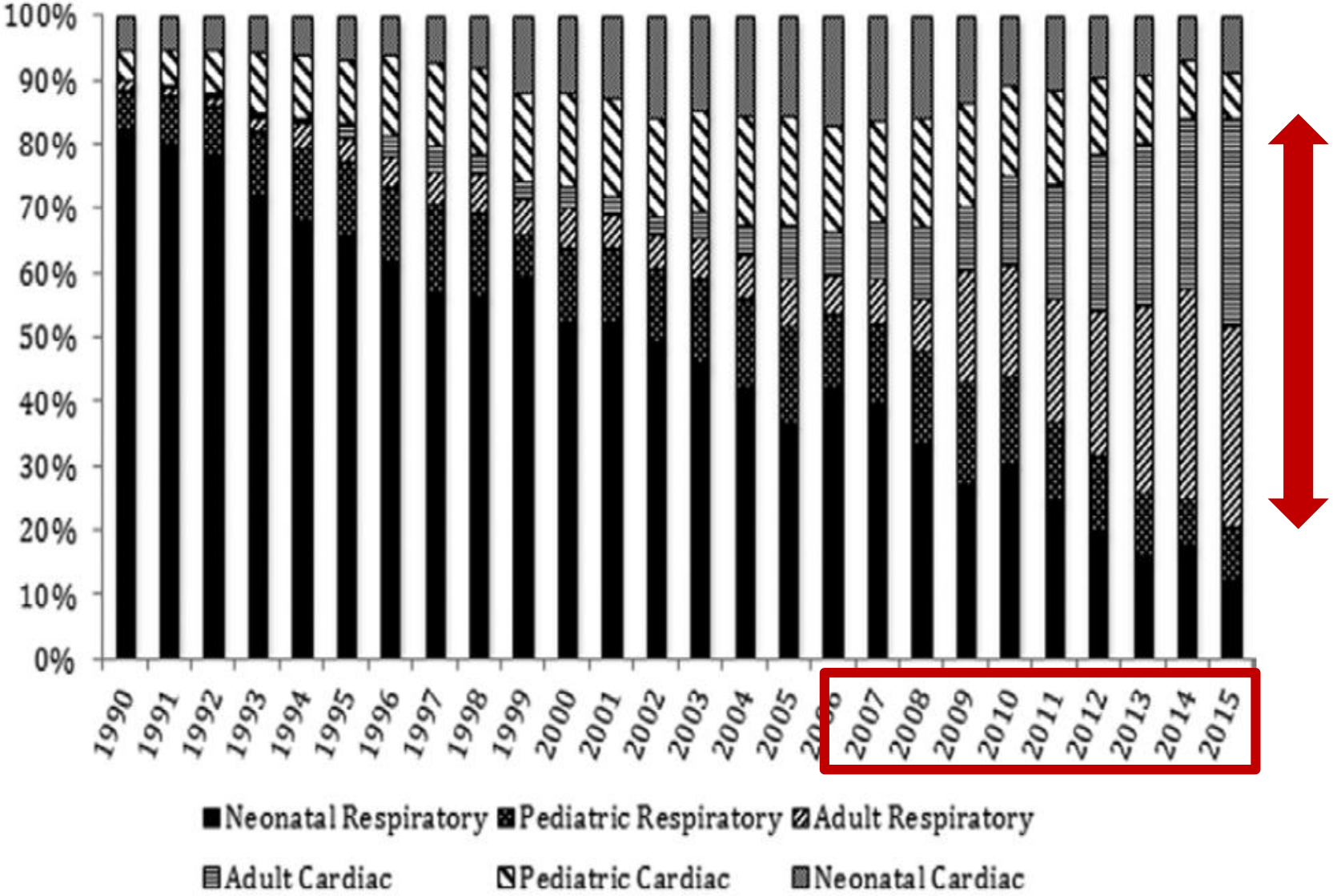
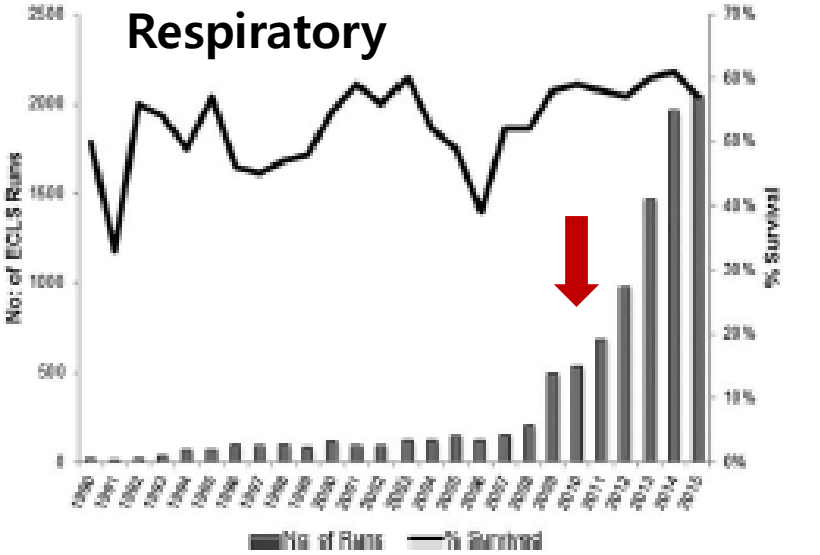
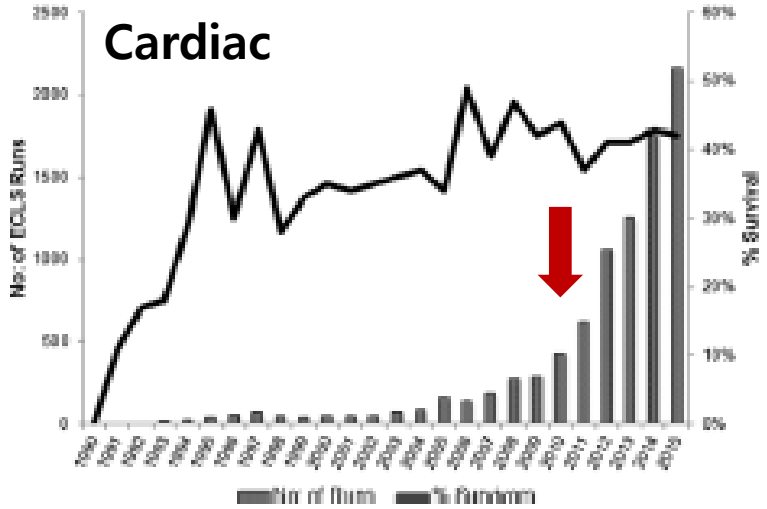
www.elsonet.org or apelso2013.chinacpb.com
ELSO Asia–Pacific ELSO ChSECC CSCCM

ELSO Results(2017)



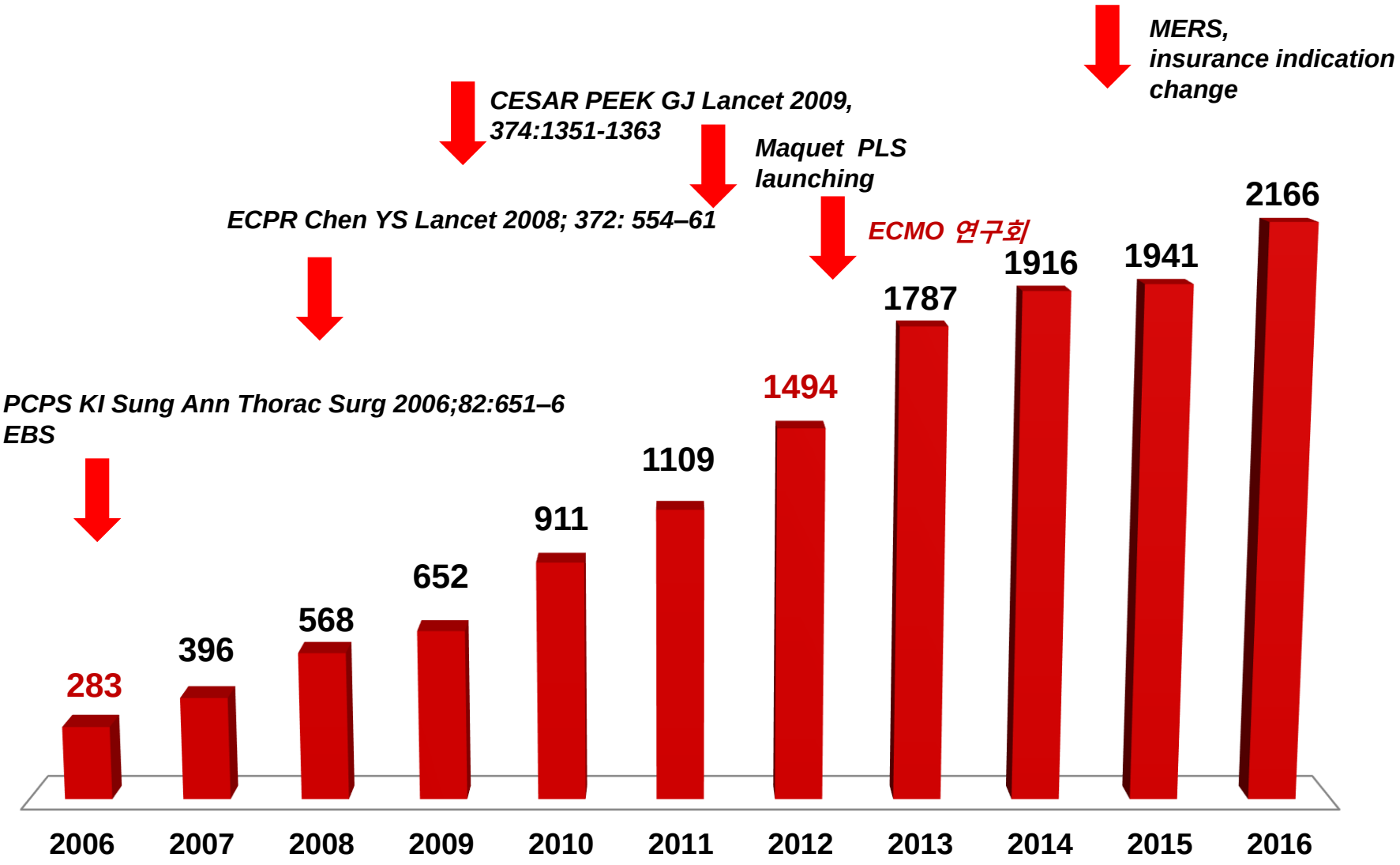
ELSO Results(2017)





	Neonate (%)	Pediatric (%)	Adult (%)
Respiratory			
Mechanical: pump malfunction	1.6	2.2	1.5
Mechanical: oxygenator failure	5.7	10.6	9.1
Cannula hemorrhage	7.9	18.3	13.2
Surgical hemorrhage	6.3	12.6	10.5
Pulmonary hemorrhage	4.5	8.1	6.1
CNS hemorrhage	7.6	6.4	3.9
CNS infarction	6.8	4.2	2.0
Renal failure	7.8*	12.9*	9.3†
Hyperbilirubinemia	7.3	5.2	8.7
Infection	5.8	16.8	17.5
Cardiac			
Mechanical: pump malfunction	1.5	1.8	0.8
Mechanical: oxygenator failure	6.1	7.2	6.6
Cannula site hemorrhage	10.7	15.6	18.5
Surgical site hemorrhage	29.3	29.9	20.2
Pulmonary hemorrhage	5.2	5.3	3.1
CNS hemorrhage	11.3	5.3	2.2
CNS infarction	3.4	5.0	3.8
Renal failure	12.3*	7.2*	12.3†
Hyperbilirubinemia	4.9	7.2	12.2
Infection	7.1	11.0	13.0

ECMO in Korea



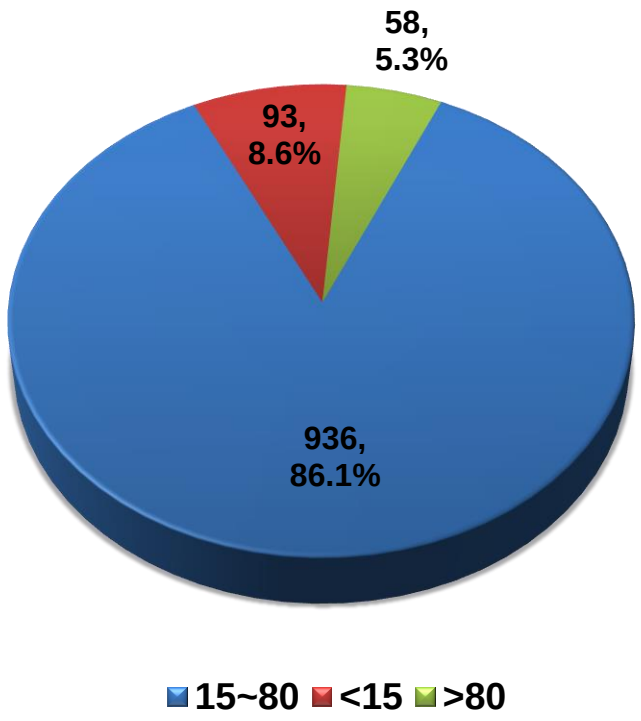
Korean Health Insurance Review

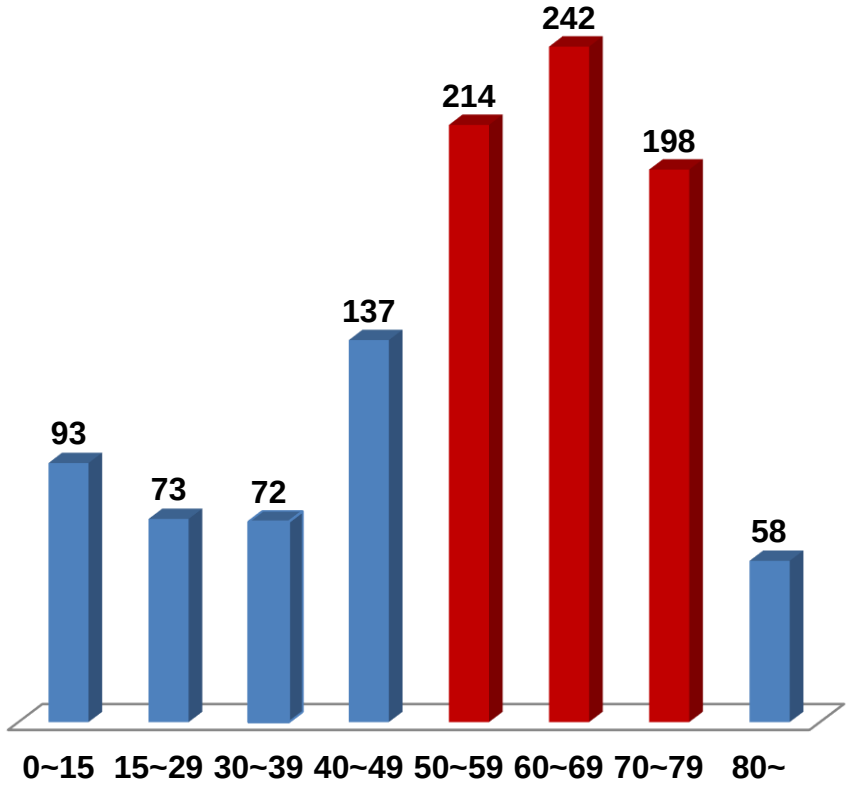
Methods

no	Year	Month	Days	Sex	Age
ECMO insertion department	Insertion place	Arrest or not	Out of hospital arrest vs. in hos pital arrest	Indication	Support type
Support target	Equipment	Distal perfusion	Type of Cannula & size	Oxygenator change	Weaning date
Support time	Anticoagulation method	Alive discharge	Cause of death	Complications	CPC score

Demography

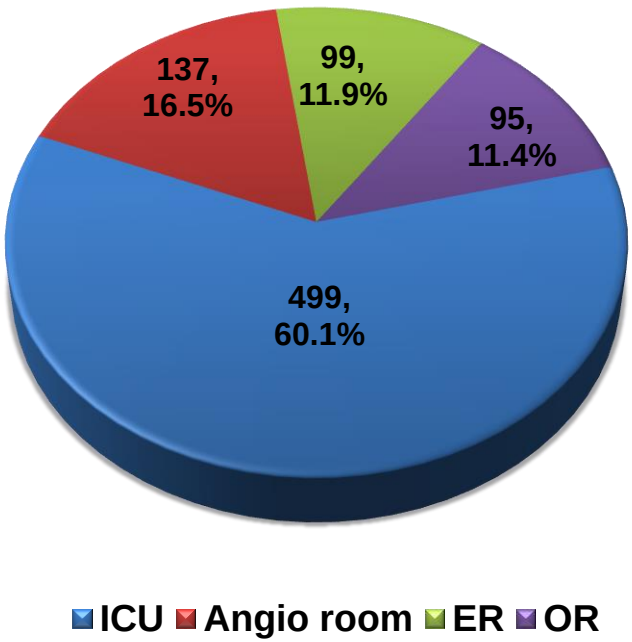
- N=1087(1087/2668, 40.7%)
  - M:F = 685:401, 52.8±21.9yrs
  - 2011=537/1174(45.7%), 2012=550/1494(36.8%)



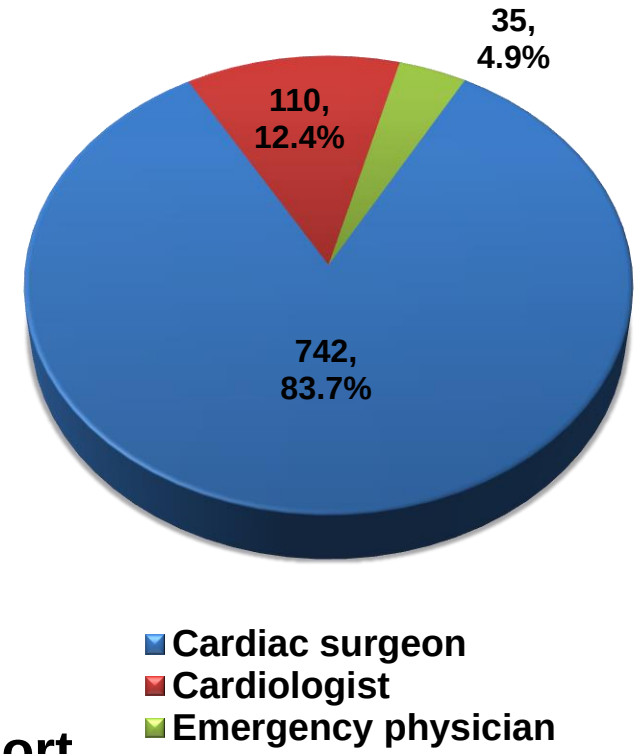


ECMO Insertion I

- **Where?**
  (RR 830/1087, 76.3%)



- **Who?**
  (RR 887/1087, 81.6%)

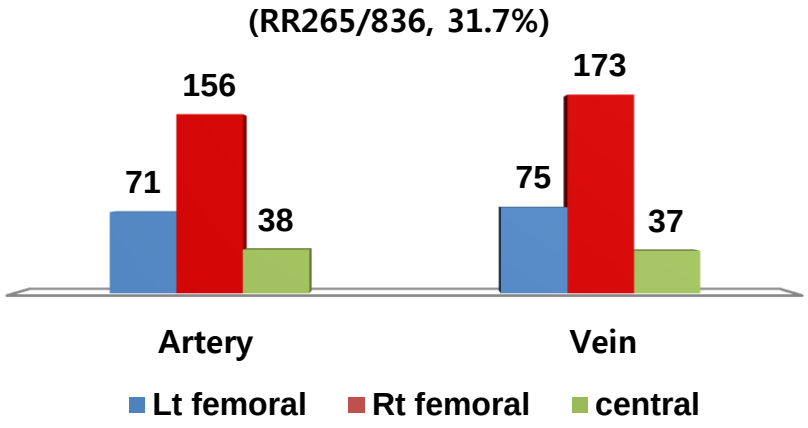


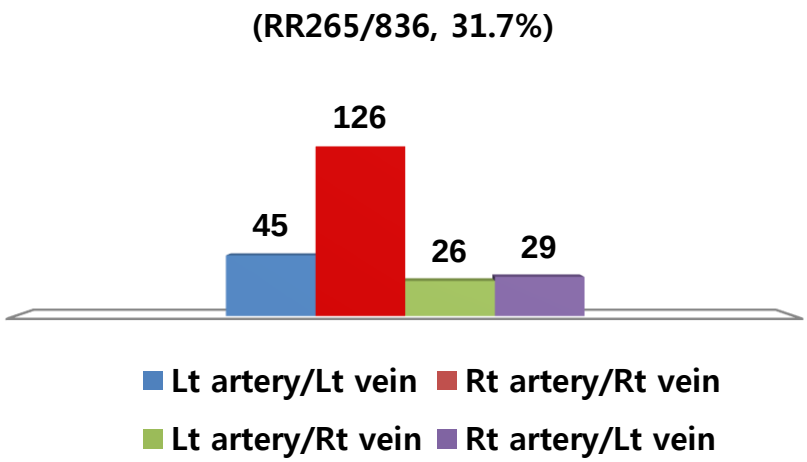
- **Patients status before ECMO support**
  - Arrest = 304/833(36.5%) (RR 833/108, 76.6%)

ECMO Insertion II

- Cannulation
  - VA/VAV

- Arterial cannula 16.55 ±1.7Fr - Venous cannula 21.0 ± 2.4Fr





- Distal perfusion (RR 700/836, 81.1%) 98/700,14%

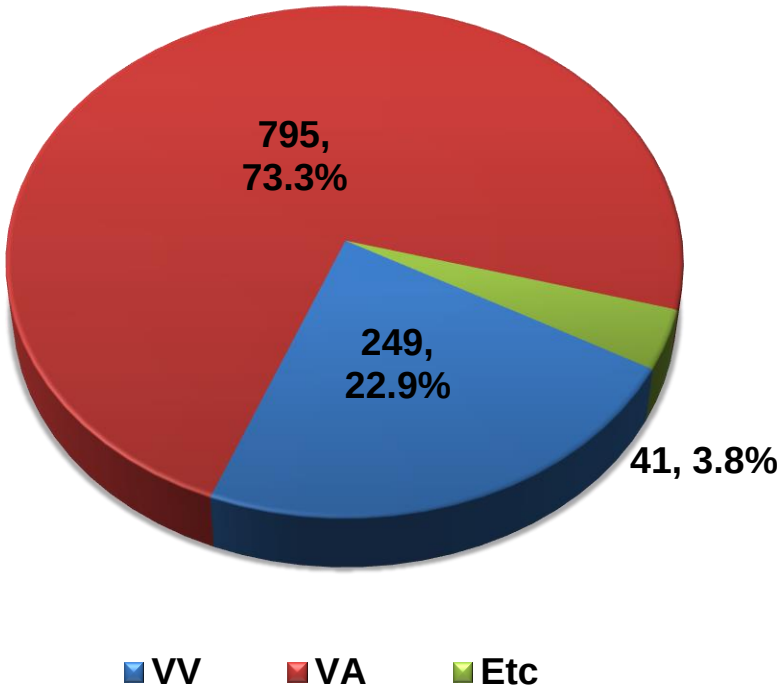
  - VV cannulation

- In-flow cannula 18.6 ±4.0Fr

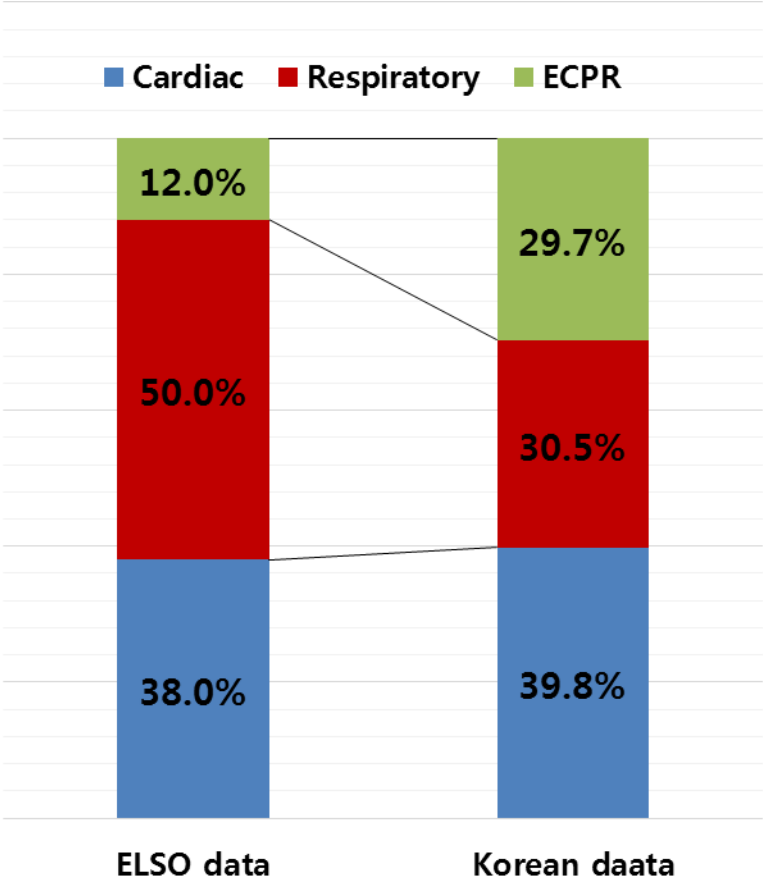
- Out-flow cannula 21.1 ±4.0Fr

ECMO Management I

- **Support Type of ECMO (RR1087/1085,99.8%)**

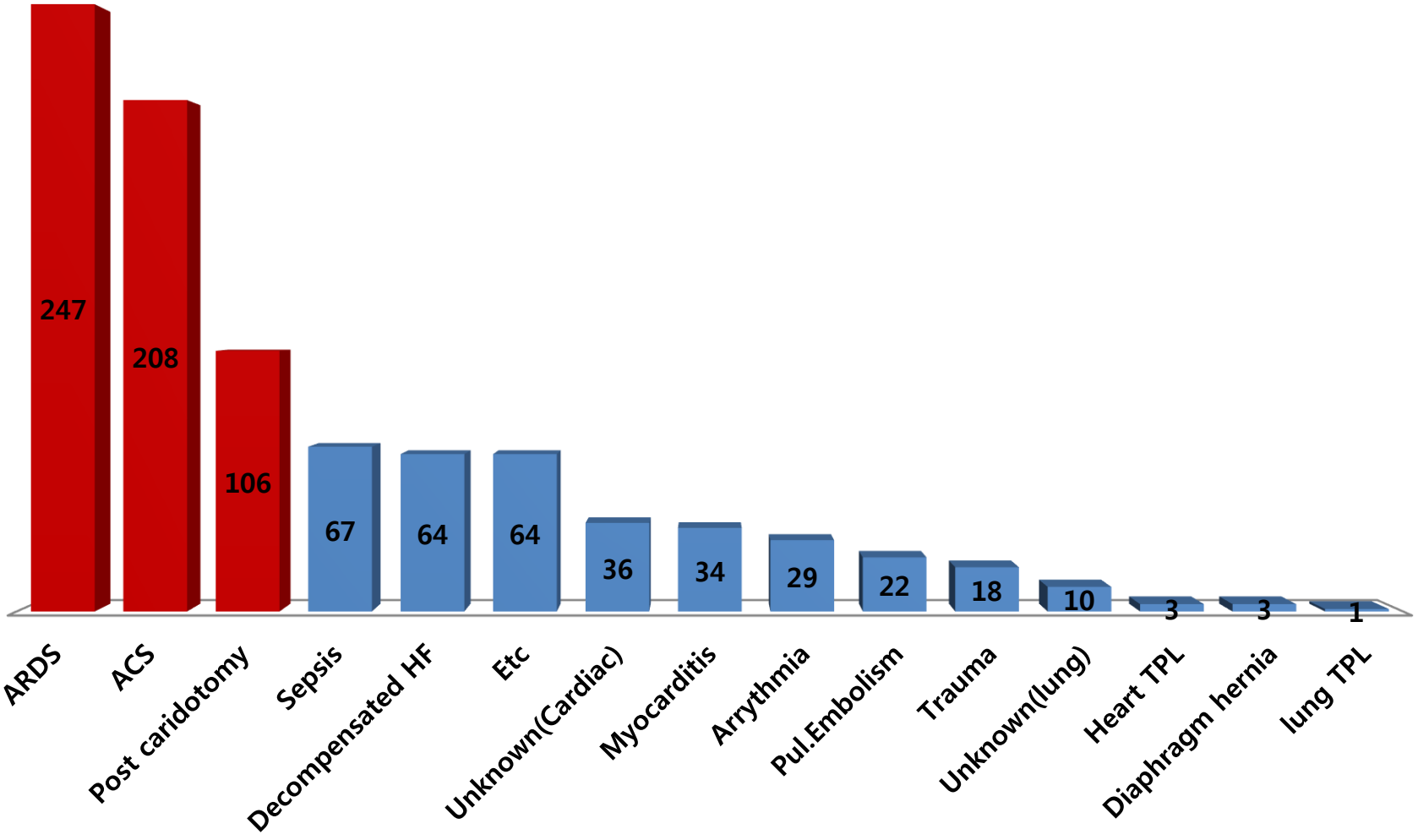


- **Target of ECMO (RR 1087/1087, 100.0%)**



ECMO Management II

- **Indication (Response Rate(RR), 912/1087, 84.2%)**

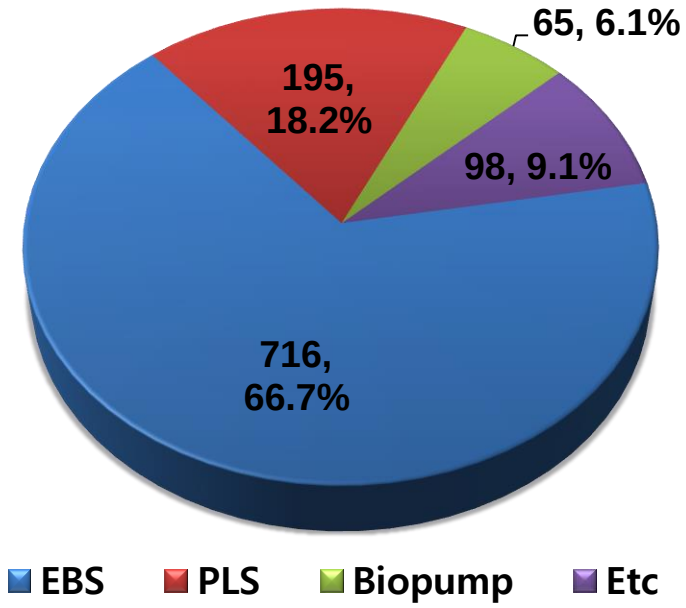


ECMO Management III

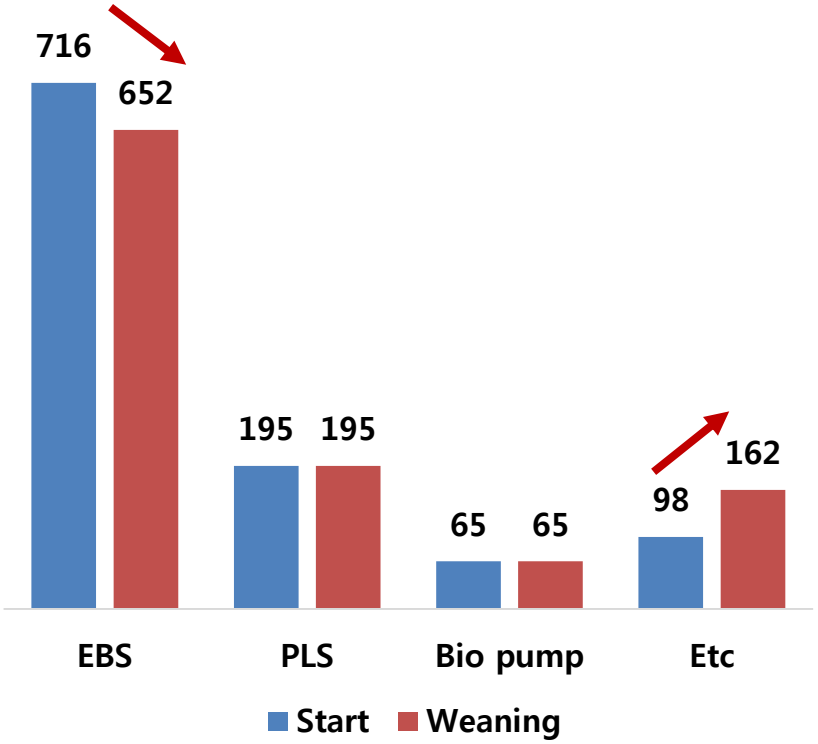
- **ECMO support time**
  - **Total ECMO support time** — **149.4±396.5hrs**
    - **Weaning vs. failure group** — **140.2±410.7 vs.157.3±385.2hrs**
    - **Alive vs. Mortality group*(p<0.05)*** — **114.2±121.9 vs.164.5±466.1hr**
  - **ECMO support time(Type of ECMO, *p<0.05*)**
    - **VA support group** — **114.2±415.0hrs**
    - **VV support group** — **234.7±318.8hrs**
  - **ECMO support time (Target of ECMO, *p<0.05*)**
    - **Cardiac support** — **148.7±544.4hrs**
    - **Respiratory support** — **224.3±303.9hrs**
    - **ECPR** — **73.7±107.6.5hrs**

ECMO Management IV

- ECMO Equipment
  (RR 1074/1087, 98.8%)



- Equipment change 'from start to wean' (RR 1074/1087, 98.8%)



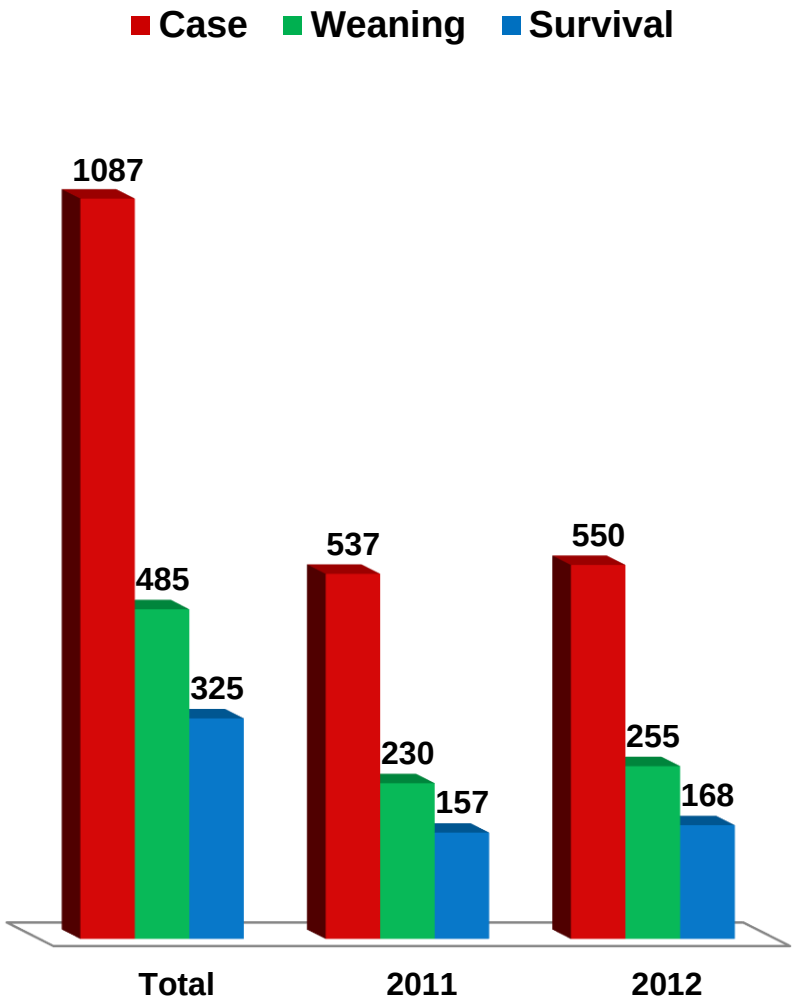
- Anticoagulation(RR 427/1087, 38.8%)
  - Heparin 233/425(54.6%), Futhan102/422(23.9%), None 82/422(19.4%)

Results of ECMO I

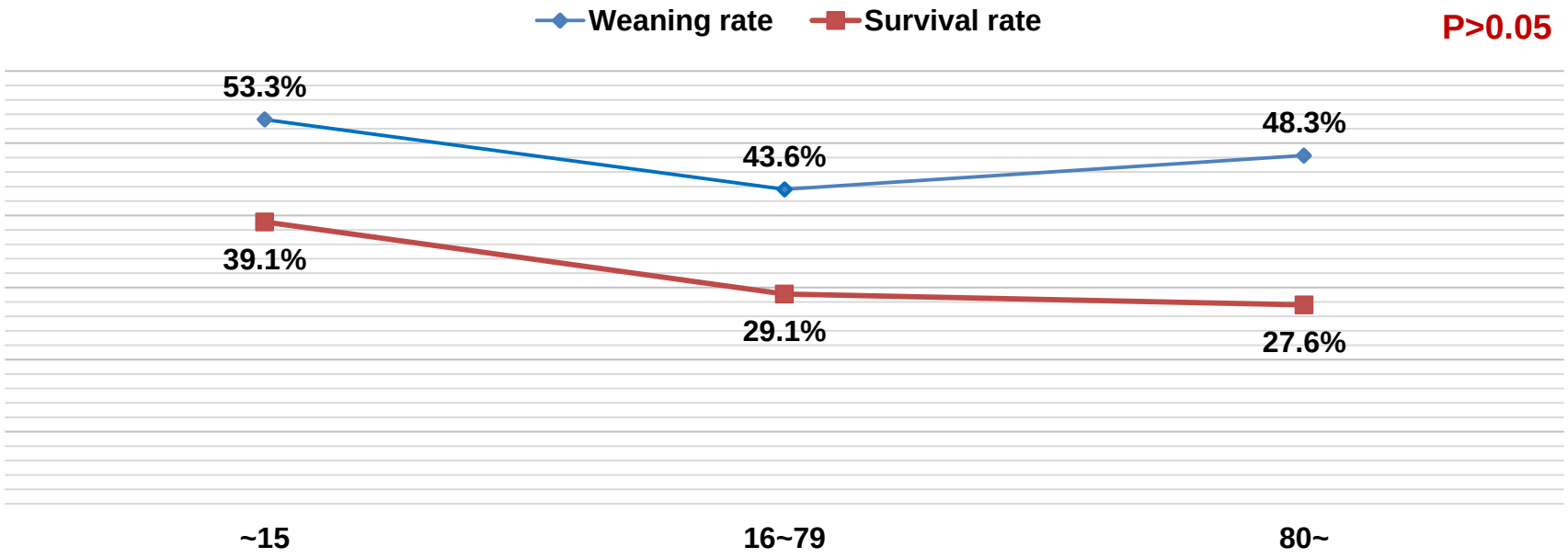
- **Weaning**
  - **Total** **485/1087(44.6%)**
  - **2011** **230/537(42.8%)**
  - **2012** **255/550(46.3%)**

- **Survival discharge**
  - **Total** **325/1087(29.9%)**
  - **2011** **157/537(29.2%)**
  - **2012** **168/550(30.8%)**

- **CPC 1-2 rate (225/325 RR 69.2%)**
  - **212/231(92.0%)**

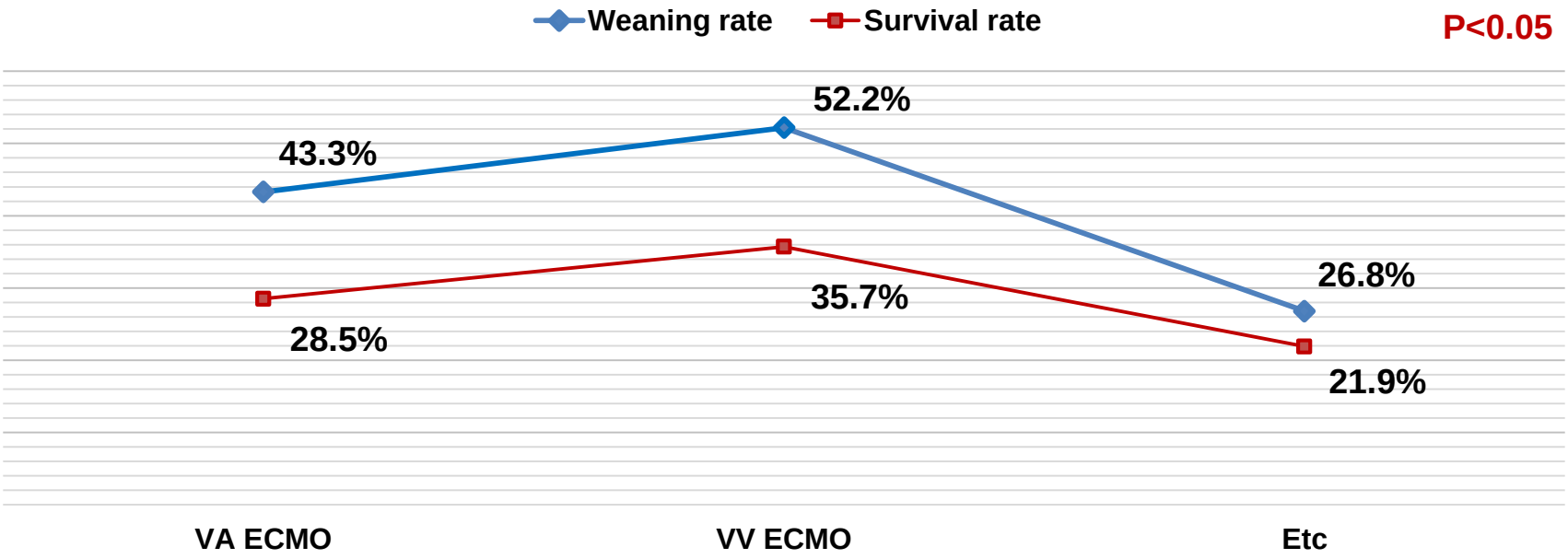


Results of ECMO II



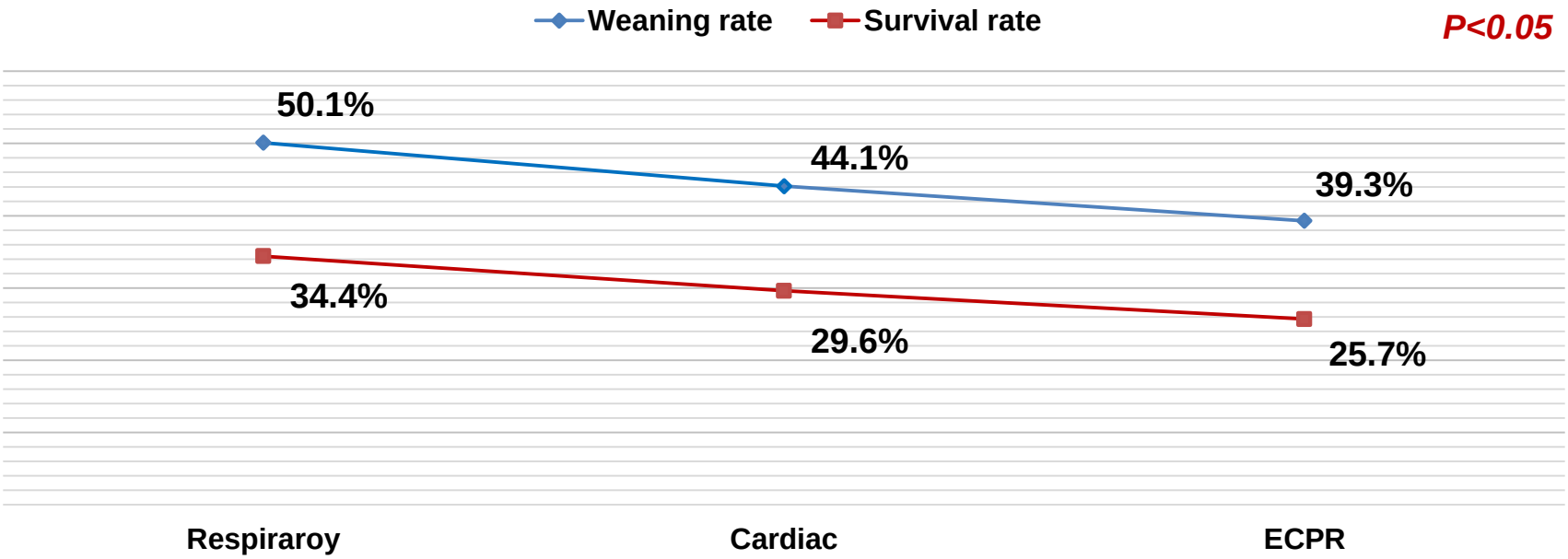
	Cases	Weaning	Survival discharge
~15	92	49(53.3%)	36(39.1%)
15~79	937	408(43.6%)	273(29.1%)
80~	58	28(48.3%)	16 (27.6%)

Results of ECMO III



	Cases	Weaning	Survival discharge
VA ECMO	794	344(43.3%)	227(28.5%)
VV ECMO	249	130(52.2%)	89(35.7%)
Etc	41	11(26.8%)	9 (21.9%)

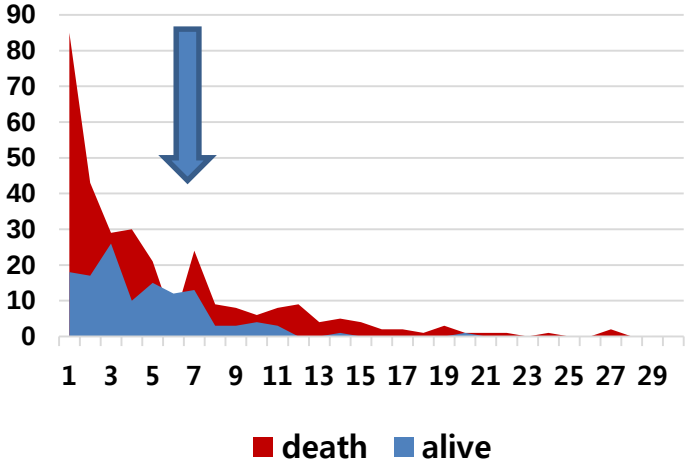
Results of ECMO IV

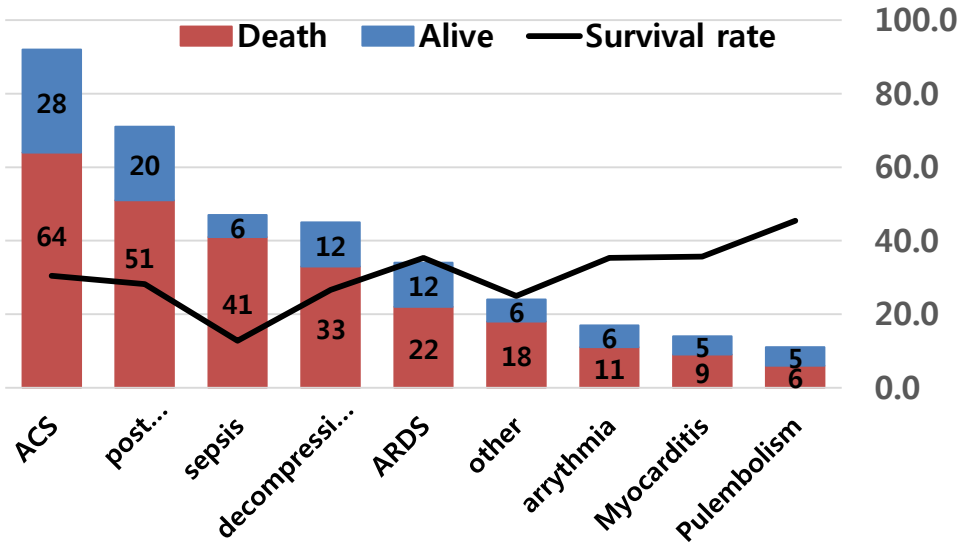


	Cases	Weaning	Survival discharge
Respiratory	331	166(50.1%)	114(34.4%)
Cardiac	433	191(44.1%)	128(29.6%)
ECPR	323	128(39.6%)	83 (25.7%)
Total	1087	483(44.4%)	325(29.9%)

Summary of Cardiac Support

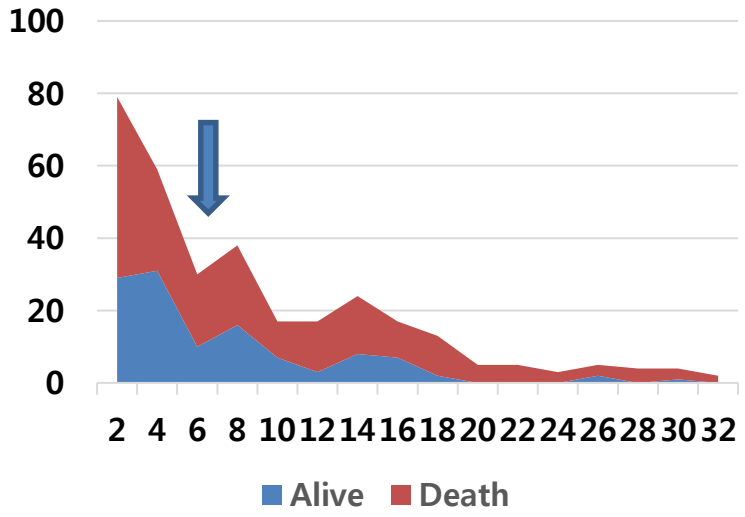
- N=433(M:F=264:169, mean age= 54.4±20.7)
- Mean support time 148.7±544.4hrs
- Weaning rate 191/433(44.1%), Survival rate 128/433(29.6%)
- CPC 1~2 rate(94/128, 74.2%) 92/95(97.8%)
- Risk Factors*(p<0.05)*
  - Cannula insertion department, ECMO equipment, ECMO support over 7days
- Survival rate

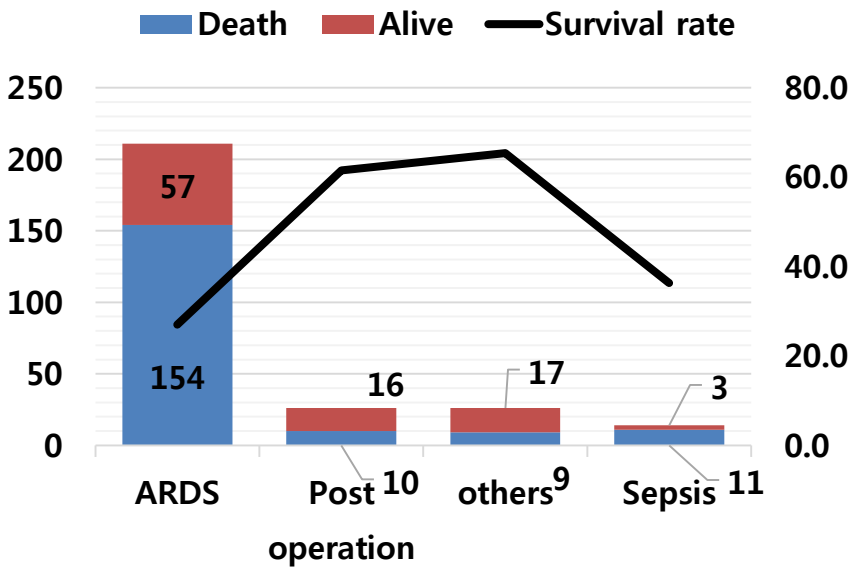




Summary of Respiratory Support

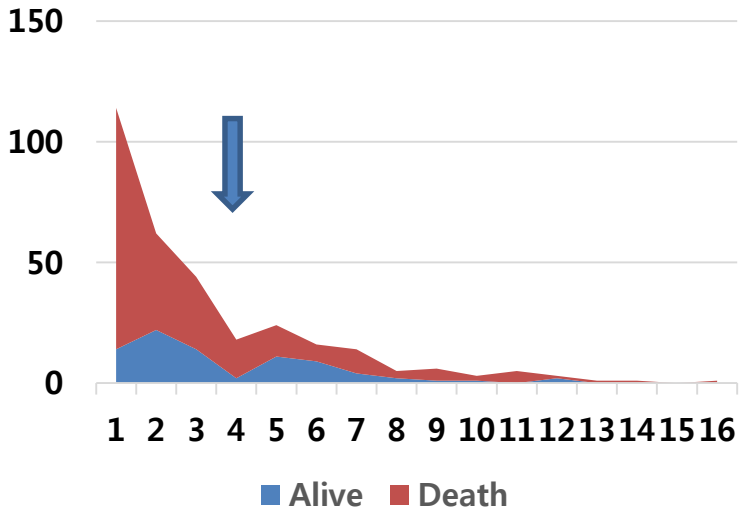
- N=331(M:F=130:201, mean age= 46.9±25.1)
- Mean support time 224.3±303.9hrs
- Weaning rate 166/331(50.1%) survival rate 114/331(34.4%)
- CPC 1~2 rate(89/114, 78.0%) 80/89(89.9%)
- Risk Factors*(p<0.05)*
  - Oxygenator change, ECMO support over 3days.
- Survival rate

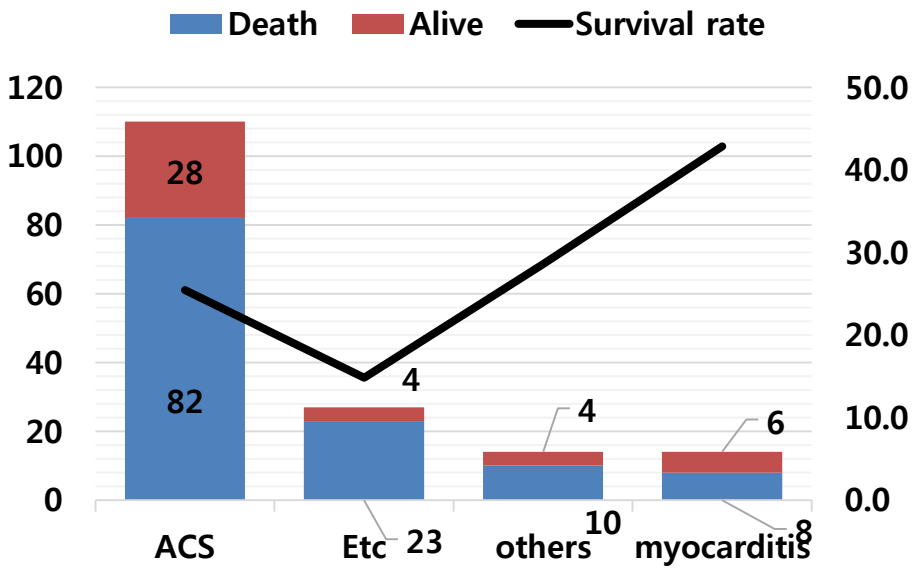




Summary of ECPR

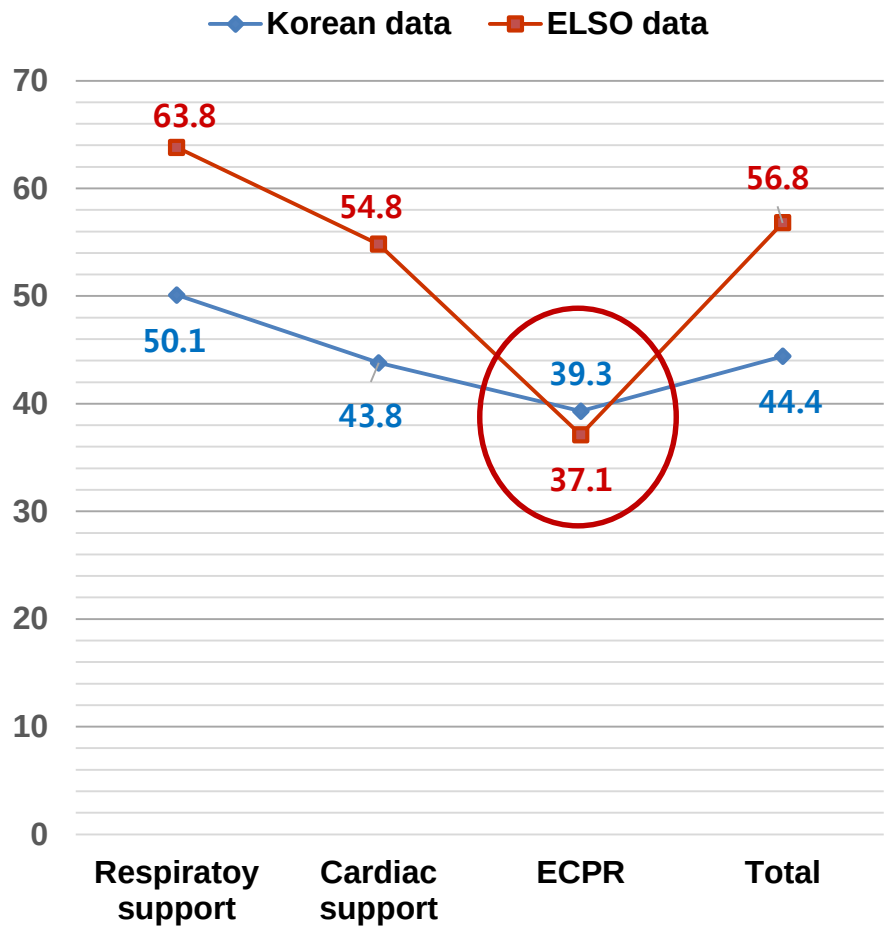
- N=323(M:F=103:220, mean age= 56.7±18.4)
- Mean support time 73.7±107.6.5hrs
- Weaning rate128/323(39.6%), Survival rate 83/323 (25.7%)
- CPC 1~2 rate(41/83, 49.4%) 35/41(85.3%)
- Risk Factors*(p<0.05)*
  - **ECMO support over 4days**
- Survival rate



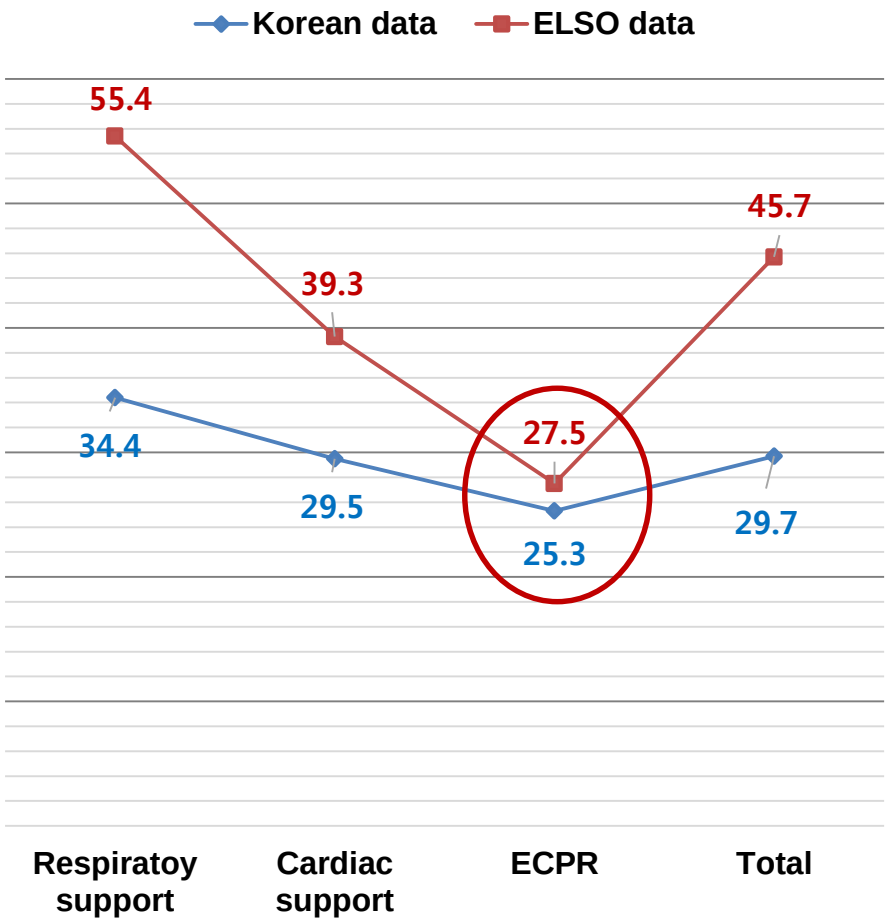


Summary of ECMO Results

ECMO Weaning Rate



Survival Rate



Clinical Trial

- **Neonatal respiratory**
  - **1985 Bartlett randomized trial**
  - **1996 UK Collaborative trial**
- **Adult respiratory**
  - **1979 NIH-ARDS randomized trial**
  - **1986 Gattinoni ECCO2R cohort trial**
  - **1994 Morris ECCO2R randomized trial**
  - **2009 PEEK CESAR randomized trial**
- **Adult Cardiac support**
  - **2008 cardiopulmonary resuscitation with ECMO and observational study**

Venoarterial extracorporeal membrane oxygenation for treatment of cardiogenic shock: Clinical experiences in 45 adult patients

Farhad Bakhtiary, MD,[a] Harald Keller,[b] Selami Dogan, MD,[a] Omer Dzemali, MD,[a] Feyzan Oezaslan, MD,[a] Dirk Meininger, MD, PhD,[c] Hanns Ackermann, MD, PhD,[d] Bernhard Zwissler, MD, PhD,[c] Peter Kleine, MD, PhD,[a] and Anton Moritz, MD, PhD[a]

TABLE 3. ECMO results

	Total	CABG	AVR	CABG + MVR	CABG + AVR	LVAD	CABG + VSD	HTX	Others*
No.	45	20	2	5	3	5	3	2	5
Duration of ECMO (d)	6.4 ± 4.5	6.8 ± 4.2	6.0 ± 2.8	4.3 ± 2.5	5.2 ± 7.8	8.0 ± 4.2	4.3 ± 2.9	6.2 ± 5.3	7.2 ± 5.2
Successful weaning	25 (56%)	12 (60%)	2 (100%)	1 (20%)	2 (67%)	5 (100%)	2 (67%)	1 (50%)	0 (0%)
Bridge to long-term assist device	5 (11%)	3 (15%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	1 (33%)	0 (0%)	0 (50%)
Heart transplantation	2 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (100%)	0 (50%)
Mechanical ventilation (d)	12.6 ± 10.3	11.6 ± 8.8	11.0 ± 1.4	16.7 ± 22.7	7.2 ± 8.6	24.0 ± 14.2	12.0 ± 6.9	11.5 ± 4.2	9.8 ± 6.2
ICU stay (d)	21.55 ± 20.8	21.1 ± 18.4	47.5 ± 3.5	17.0 ± 23.4	21.0 ± 28.5	24.0 ± 14.2	45.3 ± 1.4	54.5 ± 4.5	8.8 ± 6.3
Post-ECMO hospital stay (d)	25.6 ± 19.2	18.2 ± 15.8	30.5 ± 14.8	33.2 ± 2.9	34.5 ± 13.4	34.0 ± 1.7	59.5 ± 2.1	59.3 ± 30.3	0.3 ± 0.8
30-d Mortality	24 (53%)	10 (50%)	1 (50%)	4 (80%)	3 (100%)	2 (40%)	1 (33%)	1 (50%)	2 (40%)
Discharged from hospital	13 (67%)	6 (30%)	1 (50%)	0 (0%)	0 (0%)	3 (60%)	2 (67%)	1 (50%)	0 (0%)
In-hospital mortality	32 (71%)	14 (70%)	1 (50%)	5 (100%)	3 (100%)	2 (40%)	1 (33%)	1 (50%)	5 (100%)

CABG, Coronary artery bypass grafting; *AVR*, aortic valve replacement; *MVR*, mitral valve repair; *LVAD*, left ventricular assist device; *VSD*, ventricular septal defect; *HTX*, heart transplantation; *ECMO*, extracorporeal membrane oxygenation; *ICU*, intensive care unit. *Including double-valve replacement (n = 2), liver transplantation (n = 2), and type A aortic dissection (n = 1).

Cardiac Support !!

J Thorac Cardiovasc Surg 2008;135:382-8

CPR Time before ECMO

Author	CPR < 30 min	CPR > 30 min
Hill et al.	14/54 (25.9%)	8/56 (14.3%)
Wittenmyer et al.	16/63 (25.4%)	1/13 (7.7%)
Willms et al.	15/29 (51.7%)	1/20 (5.0%)
Hartz et al.	1/19 (5.3%)	0/10 (0%)
Cochran et al.	N/A	2/3 (67%)

- Perfusion 2002;17:269-77

CPR with ECMO

Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis

Yih-Sharng Chen, Jou-Wei Lin*, Hsi-Yu Yu, Wen-Je Ko, Jih-Shuin Jerng, Wei-Tien Chang, Wen-Jone Chen, Shu-Chien Huang, Nai-Hsin Chi, Chih-Hsien Wang, Li-Chin Chen, Pi-Ru Tsai, Sheoi-Shen Wang, Juey-Jen Hwang, Fang-Yue Lin*

Summary

Background Extracorporeal life-support as an adjunct to cardiac resuscitation has shown encouraging outcomes in patients with cardiac arrest. However, there is little evidence about the benefit of the procedure compared with conventional cardiopulmonary resuscitation (CPR), especially when continued for more than 10 min. We aimed to assess whether extracorporeal CPR was better than conventional CPR for patients with in-hospital cardiac arrest of cardiac origin.

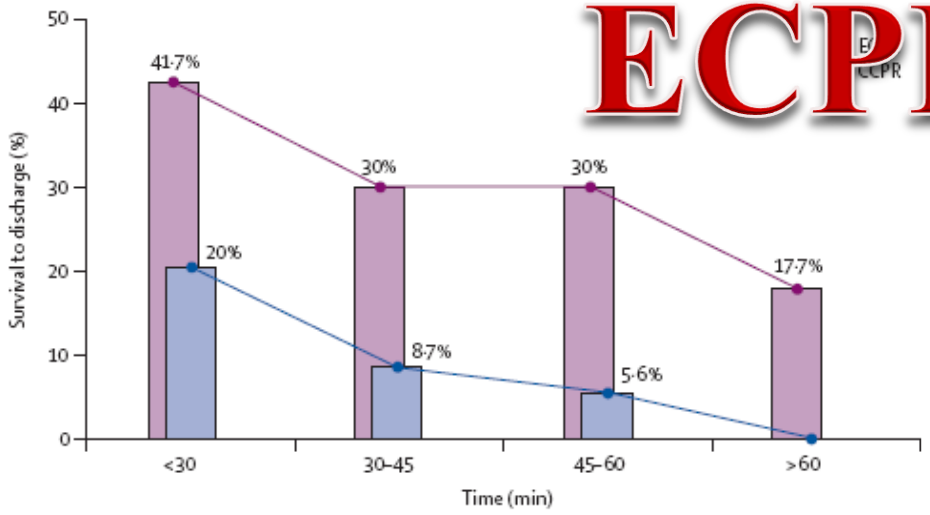
Methods We did a 3-year prospective observational study on the use of extracorporeal life-support for patients aged 18–75 years with witnessed in-hospital cardiac arrest of cardiac origin undergoing CPR of more than 10 min compared with patients receiving conventional CPR. A matching process based on propensity-score was done to equalise potential prognostic factors in both groups, and to formulate a balanced 1:1 matched cohort study. The primary endpoint was survival to hospital discharge, and analysis was by intention to treat. This study is registered with ClinicalTrials.gov, number NCT00173615.

Findings Of the 975 patients with in-hospital cardiac arrest events who underwent CPR for longer than 10 min, 113 were enrolled in the conventional CPR group and 59 were enrolled in the extracorporeal CPR group. Unmatched patients who underwent extracorporeal CPR had a higher survival rate to discharge (log-rank p<0·0001) and a better 1-year survival than those who received conventional CPR (log rank p=0·007). Between the propensity-score matched groups, there was still a significant difference in survival to discharge (hazard ratio [HR] 0·51, 95% CI 0·35–0·74, p<0·0001), 30-day survival (HR 0·47, 95% CI 0·28–0·77, p=0·003), and 1-year survival (HR 0·53, 95% CI 0·33–0·83, p=0·006) favouring extracorporeal CPR over conventional CPR.

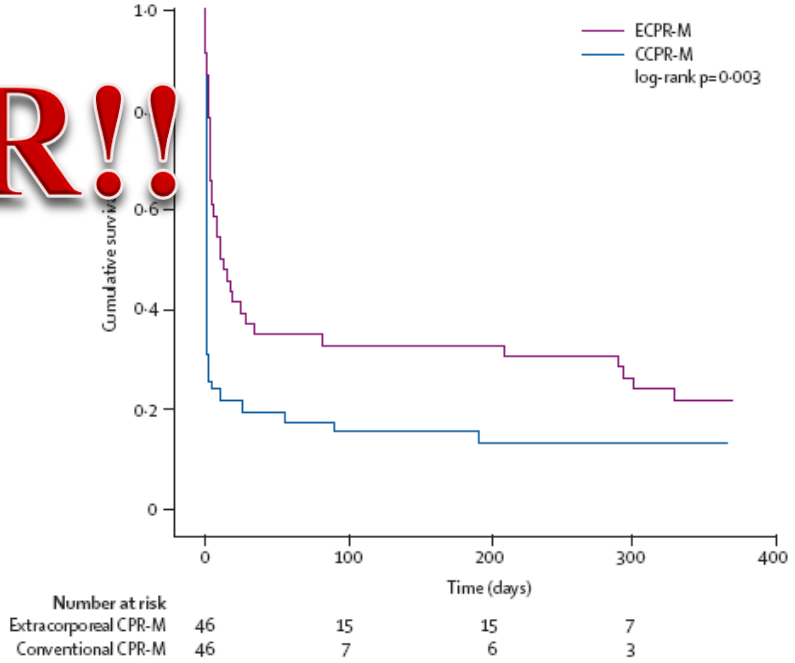
Interpretation Extracorporeal CPR had a short-term and long-term survival benefit over conventional CPR in patients with in-hospital cardiac arrest of cardiac origin.

- Lancet 2008; 372: 554–61

- **N= 113 vs 59 (conventional CPR group vs ECPR group)**
- **ECPR groups ; higher survival rate to discharge (p<0·0001) and better 1-year survival**



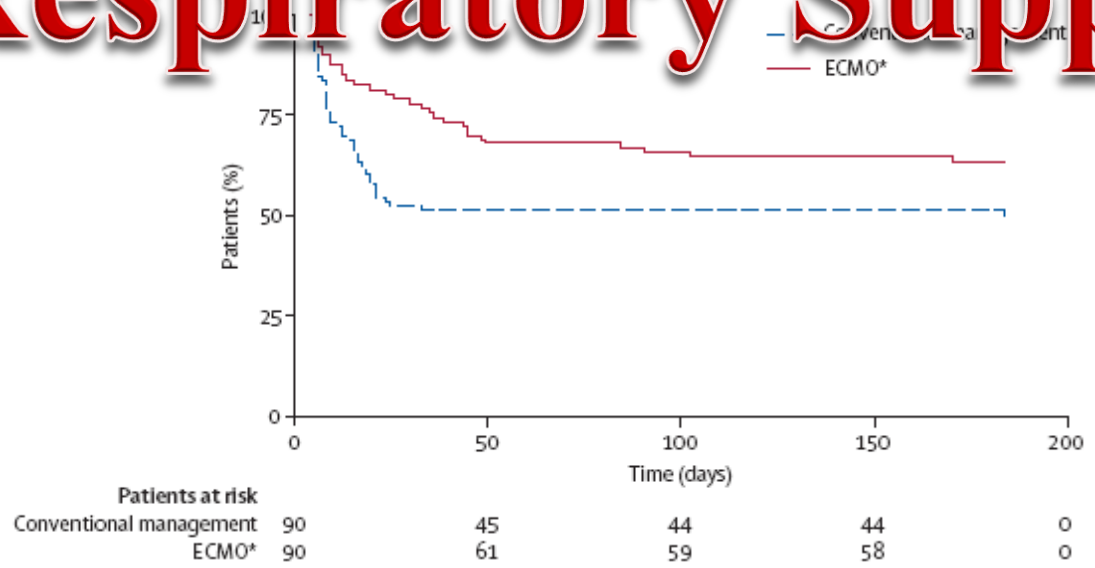
ECPR!!



CESAR Randomized Trial

- Multicenter, randomize trial
- N= 180 (18~65yrs ECMO support vs conventional support)
- 6 months survivors
  - 63% (57/90) vs 47% (41/87) p =0.03
  - 0·03 quality-adjusted life-years

Respiratory Support!!



Clinical Trial in Korea

- 1st Cardiac support clinical study
  - N= 16 (1993~95 mean age 2.5 ±3.5yrs)
  - Weaning 9 (56.3%) - Alive 5 (31.3%)

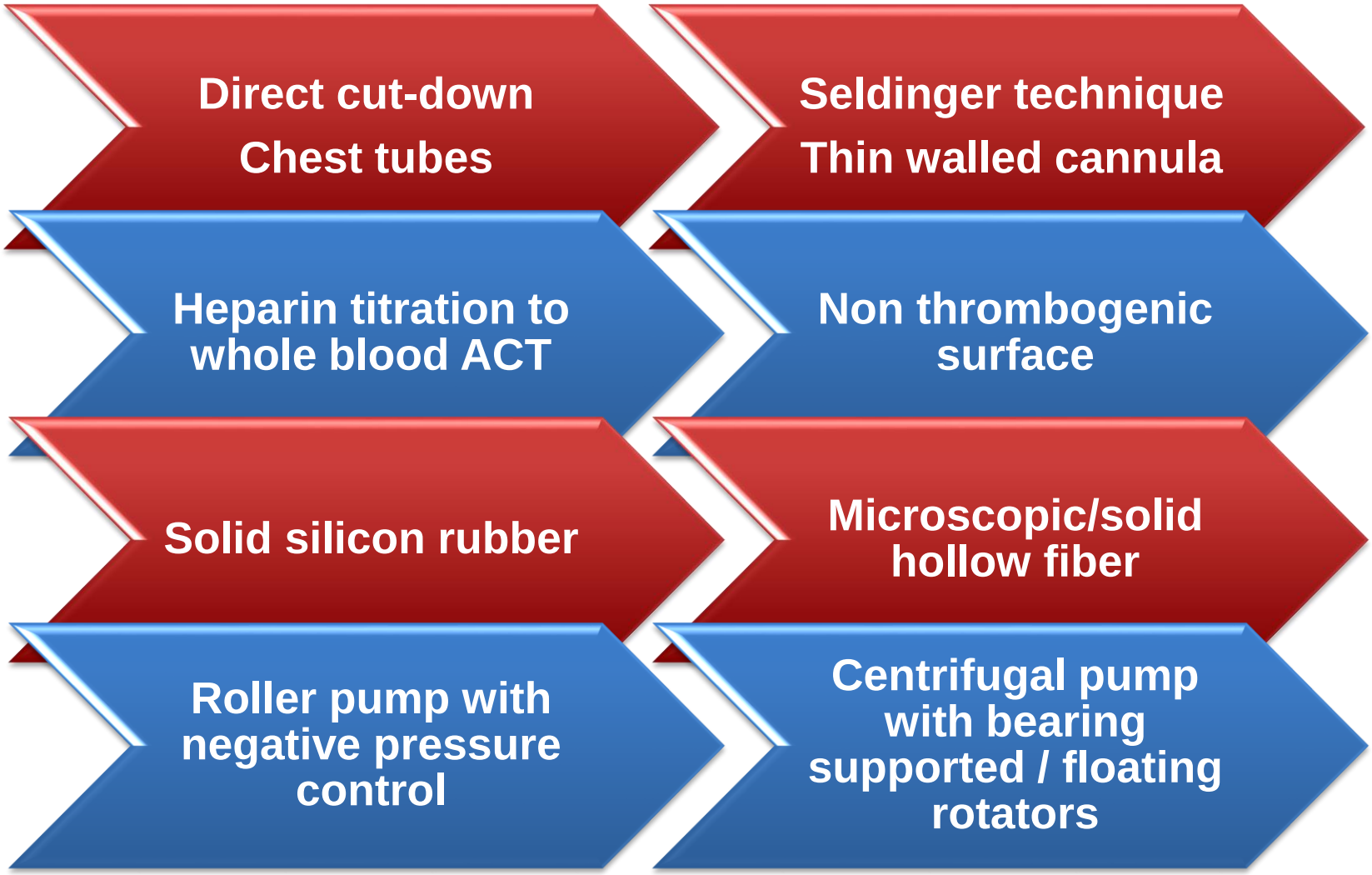
- OC Kwon KJTC Surg 2000;33:385-90

- 1st Percutaneous cardiopulmonary support clinical study
  - N= 22 (2003~05 mean age 63 ±14yrs)
  - Mean support duration 48.5 ±29.0min
  - Weaning 13 (59.0%) - Alive 9 (41.3%)

-KI Sung Ann Thorac Surg 2006;82:651– 6

- 1st Extracorporeal Life Support machine
  - Twin pulse life support (T-PLS®, New heart bio.BHK, Seoul, Korea)

ECMO Equipment I



- **Capiox EBS (Terumo com.)**

- **Quick, Compact and Simple (have the minimum number of necessary functions).**

- **Quadrox PLS® oxygenator**
  - **durability silicon membrane**
  - **approval for 14 days**
  - **Rota flow RF 32 pump**
  - **minimal priming volume**
  - **minimal hemolysis**

- **Lifebridge B2T®**
  - **Priming volume 1400ml**
  - **Auto priming 5min**
  - **Hollow fiber oxygenator**
  - **Internal battery 120min**
  - **18kg**
- **MAQUET Cardiohelp®**
  - **Flow 7L/min**
  - **Bioline coating**
  - **Internal battery 90min**
  - **10Kg**
  - **Approved for up to 30 days**
- **Affinity® Closed Chest Extracorporeal Support System**
  - **Rapid setup & prime**
  - **Heparin coated**
  - **With Bio pump**

ECMO Equipment II

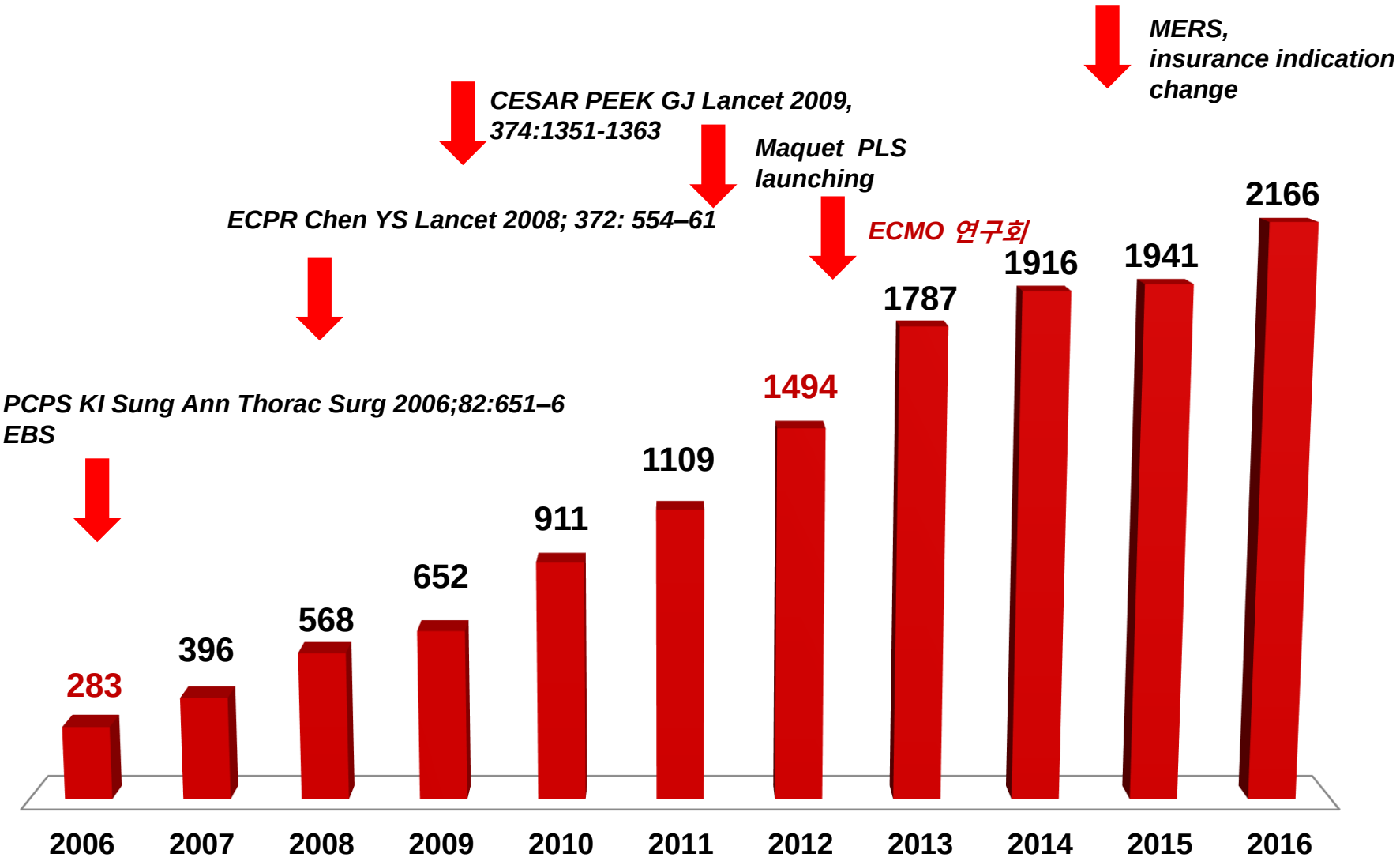
EBS; 66.7%

Emergency Bypass?

PLS: 18.2%

Permanent life support ?

ECMO in Korea



Korean Health Insurance Review

Asia-Pacific ELSO Conference 2017

12-14 October 2017 Gold Coast, Queensland

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Future of ECMO I

[in터뷰] "저수가 정책과 돈벌이 눈 먼 기업이 심장병 환아를 죽음...

2017.05.15 | 라포르시안

정지됐을 때 체내에 산소를 기계적으로 공급하면서 생명을 유지시켜주는 장치인 **에크모**(ECMO)는 삼성 이건희 회장과 **메르스** 사태로 인해 대중들에게 널리 알려졌다. 그런데...

메르스 에크모 삽입 권고안 및 **에크모** 핫라인 운영 2015.06.24 | 쿠키뉴스 | 다음뉴스

조민규 기자] 최근 **메르스** 관련해 **에크모** 삽입환자의 상태 호전이 보고 되는 등 사회적 관심이 증대되고 있다. 이러한 가운데 대한흉부외과(이사장 이정렬) 산하 **에크모**...

'**메르스-에크모** 권고 사항' 나와 2015.06.23 | 헬스조선 | 다음뉴스

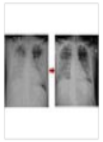
대한흉부외과 산하 **에크모** 연구회가 **메르스** 환자의 적절한 **에크모** 치료를 위해 '**메르스-에크모** 권고 사항'을 발간했다고 밝혔다. **에크모**는 인공심폐기로 환자의 정맥혈에...

- **에크모** 가이드라인으로 '**메르스-에크모** 권고사항 2... 2015.06.23 | 의사신문
- **에크모**연구회, **메르스** 사태 중 **에크모** 권고사항 발간 2015.06.23 | 메디포뉴스

[**메르스**] 백신 없는 **메르스**..**에크모**에 마지막 기대 2015.06.21 | MBN | 다음뉴스

혈액에 산소를 공급하는 **에크모** 치료를 하고 있습니다. **에크모** 덕분에 2명의 상태가...기자가 알아봤습니다. 【기자】 **메르스** 백신이 없는 상태에서 급성호흡부전 환자에...

관련뉴스 1건 전체보기 >



메르스 에크모 치료 효과있나..사우디선 생존율 38.5% 2015.06.21 | 뉴스1 | 다음뉴스

안암병원 흉부외과 정재승 교수는 21일 보건복지부에서 열린 **메르스** 정례브리핑에서 이 같은 '**메르스-에크모** 치료 현황'을 발표했다. 정 교수에 따르면 지난 20일 기준으로...

- **메르스 에크모** 치료 효과있나…사우디선 생존율 38.5% 2015.06.21 | 뉴스1

메르스 '**에크모**' 치료, 위독 환자 2명 살렸다 2015.06.21 | 한국일보 | 다음뉴스

35번 환자(38)는 **에크모**를 착용한 채 치료 받고 있다. 정재승 교수는 "**메르스**에 대한 **에크모** 치료가 학문적으로 효과성이 증명되진 않았지만 같은 호흡기 질환인 신종플루...

- 국내 **메르스**로 **에크모** 치료 8명..3명 사망·2명 호전 2015.06.21 | YTN | 다음뉴스
- **메르스** 환자 **에크모** 적용 8건..3명 사망·2명 상태... 2015.06.21 | 파이낸셜뉴스 | 다음뉴스

보건복지부 고시 제2016 - 58호

나. 금기증

합리적인 요양급여 인정을 위하여 시작시점이 아래의 금기증에 해당되는지 여부를 판단한 후 시술할 것을 권고함.

1) 회복이 불가능한 심장질환으로, 이식 또는 심실보조장치를 시행할 수 없는 경우
2) 충분한 조직관류(adequate tissue perfusion)없이 60분을 초과하여 심폐소생술을 시행하는 경우
3) 심폐소생술을 거부한 경우
4) 의학적으로 심폐소생술이 필요한 심정지가 목격되지 아니하여, 심정지 시간과 심폐소생술이 적시에 시행되었음을 확인할 수 없는 경우
5) 호흡부전환자에서 FiO2>90% 이거나 Pplat>30cmH2O의 높은 설정의 인공호흡기를 7일 이상 유지하는 경우
6) 지혈이 불가능한 출혈부위가 있어서 항응고요법의 절대적 금기증에 해당하는 경우
7) 최근(recent) 뇌출혈이 있거나 출혈이 증가하는 경우
8) 이미 진행된 다발성장기부전 등으로 회복가능성이 없는 경우
9) 진행성 혈액암, 골수이식 실패, 무과립구증, 절대호중구수(ANC)<400/mm3 등 심한 면역기능저하상태인 경우
10) 회복 불가능한 뇌손상, 비가역적 중추신경계 장애가 있는 경우
11) 말기암, 회복가능성이 없는 폐, 간, 신장 등의 만성중증장기부전
12) 동 시술이 의의가 없는 고령 환자의 경우

Future of ECMO II

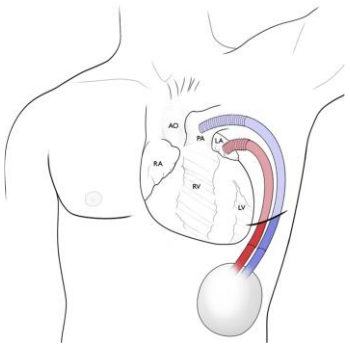
- **Hard/softwear**

ECMO I, 1980-2008	ECMO II, 2009-2017	ECMO III, 2018- 20??
Sedation, paralysis	Awake, spontaneous breathing	Awake, ambulatory
Intubated	Tracheostomy, extubate	Extubated
Rest vent settings	CPAP	Off vent
Specialist 24-7	ICU Nurse, ECMO team support	Conventional care, weeks Home, months
Lung recruitment	Watch and wait	Spontaneous breathing
Bleeding:major	Bleeding : minor	No anticoagulation

New Indication & Aim

- Patients transfer with ECMO
- OHCA ECMO
- Rehabilitation + Awake ECMO)
- ECMO for organ donation (after cardiac death)
- Bridge to TPL
- Bridge to Bridge
- Artificial lung
- Sepsis and others
- Standardization!
- The wind of change

is blowing powerfully!



Extracorporeal Support for Organ Donation after Cardiac Death Effectively Expands the Donor Pool

Joseph F. Magliocca, MD, John C. Magee, MD, Stephen A. Rowe, MD, Mark T. Gravel, RN, Richard H. Chenault II, Robert M. Merion, MD, Jeffrey D. Punch, MD, Robert H. Bartlett, MD, and Mark R. Hemmila, MD

Background: We sought to evaluate the effect on short-term outcomes of normothermic, extracorporeal perfusion (ECMO) for donation of abdominal organs for transplantation after cardiac death (DCD). Study parameters included increase in number of donors and organs, types of organs procured, and viability of kidneys transplanted.

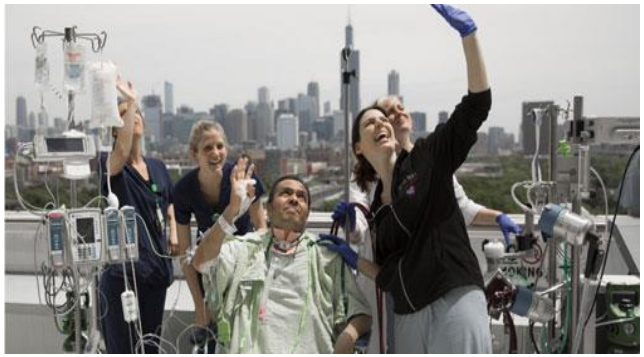
Methods: We retrospectively reviewed medical record data for all patients enrolled in our ECMO-supported DCD donor protocol between October 1, 2000, and February 2, 2004. We also reviewed the records for all patients undergoing organ donation after brain-death (DBD) during the study period at our institution. Recipient data were obtained and analyzed for all kidneys procured from both groups.

Results: Twenty patients were enrolled in our DCD protocol and underwent attempted organ donation. Fifteen patients completed the protocol; 3 maintained cardiac function throughout the prescribed 60 minutes after withdrawal of life support, and two patients' organs were deemed unsuitable for transplantation. Fourteen (70%) of the DCD donor patients originated on the trauma service and six (30%) were from other clinical services. The DCD program increased the potential donor pool by 33% (61 versus 81 patients) and the number of kidneys transplanted by 24% (100 versus 124). A total of 24 kidney, 5 liver, and 1 pancreas transplants were performed with these organs. Two of 24 (8.3%) DCD kidneys had delayed graft function. There were no perioperative rejection episodes or deaths.

Conclusion: The implementation of a DCD protocol using extracorporeal perfusion increased the potential organ donor pool at our institution by 33%. This was accomplished without short term adverse effect on organ function compared with kidneys transplanted from DBD donors.

Key Words: Organ donation extracorporeal perfusion ECMO, cardiopulmonary bypass, cardiac death, transplant

J Trauma. 2005;58:1095–1102.



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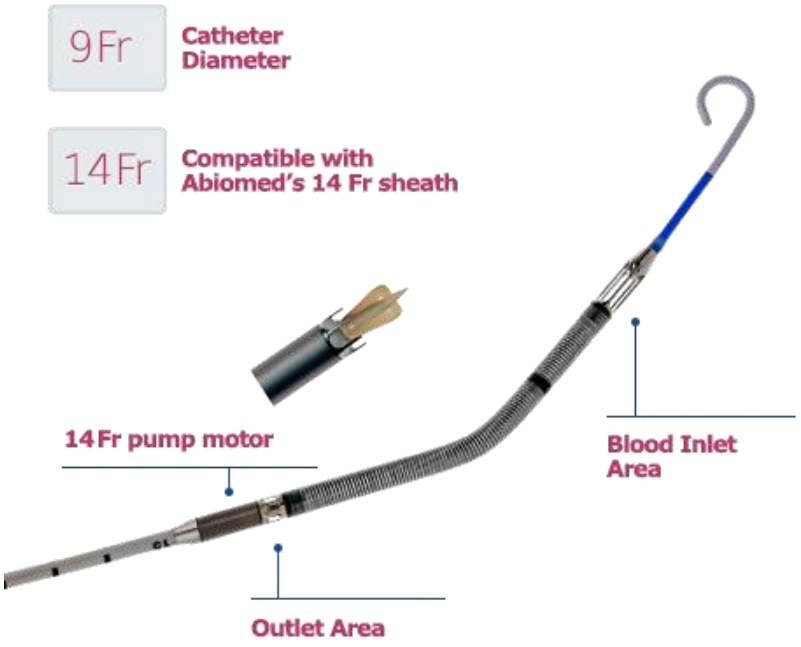
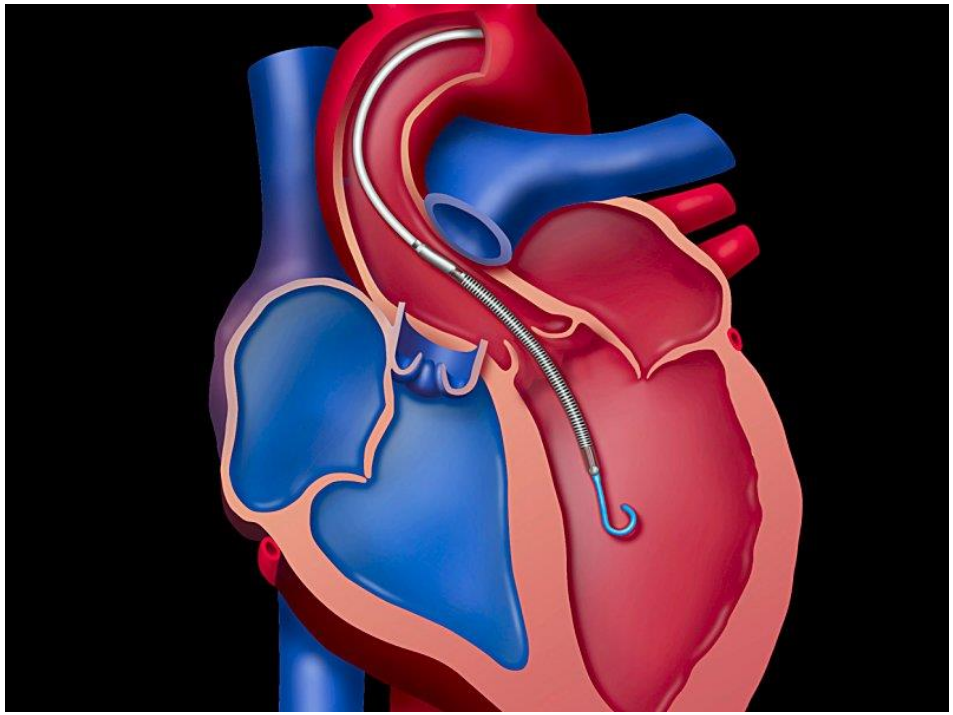
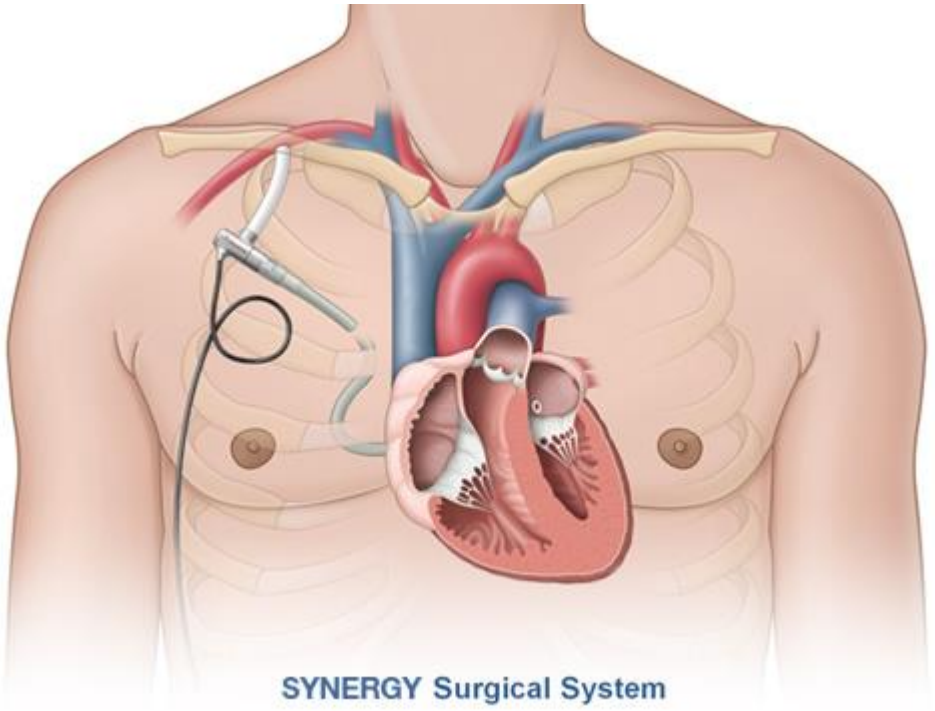
New Mechanical Device

- **Impella 5.0 L/min of forward blood flow from the left ventricle**





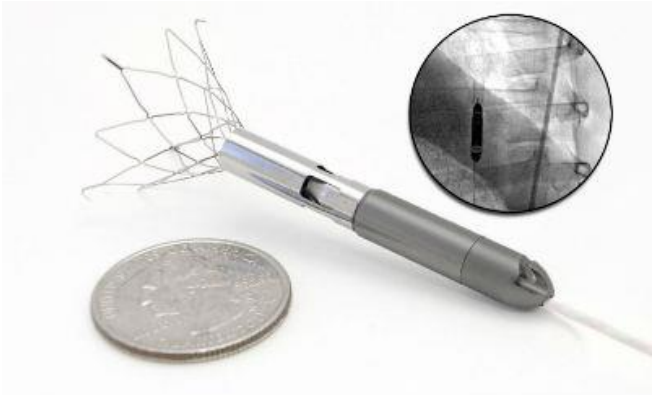
September 2012, received FDA 510(k) clearance

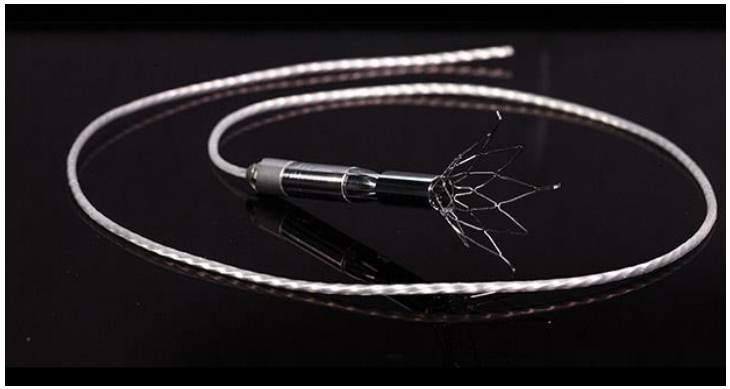


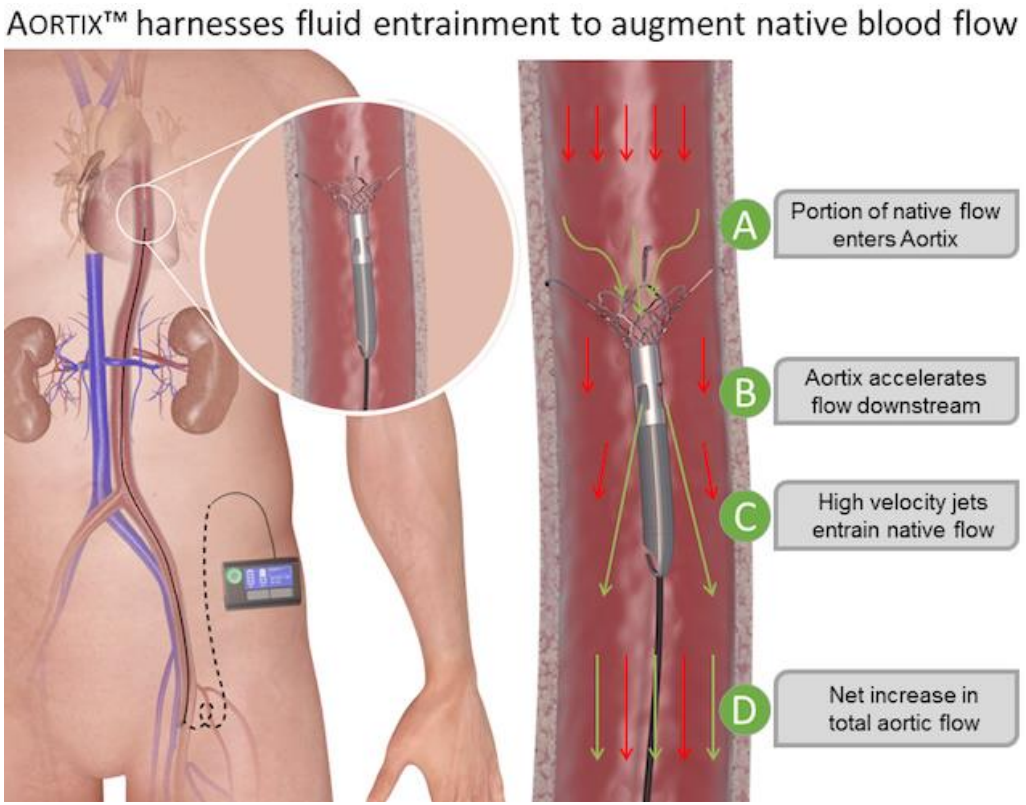
- **SYNERGY Circulatory Support System**

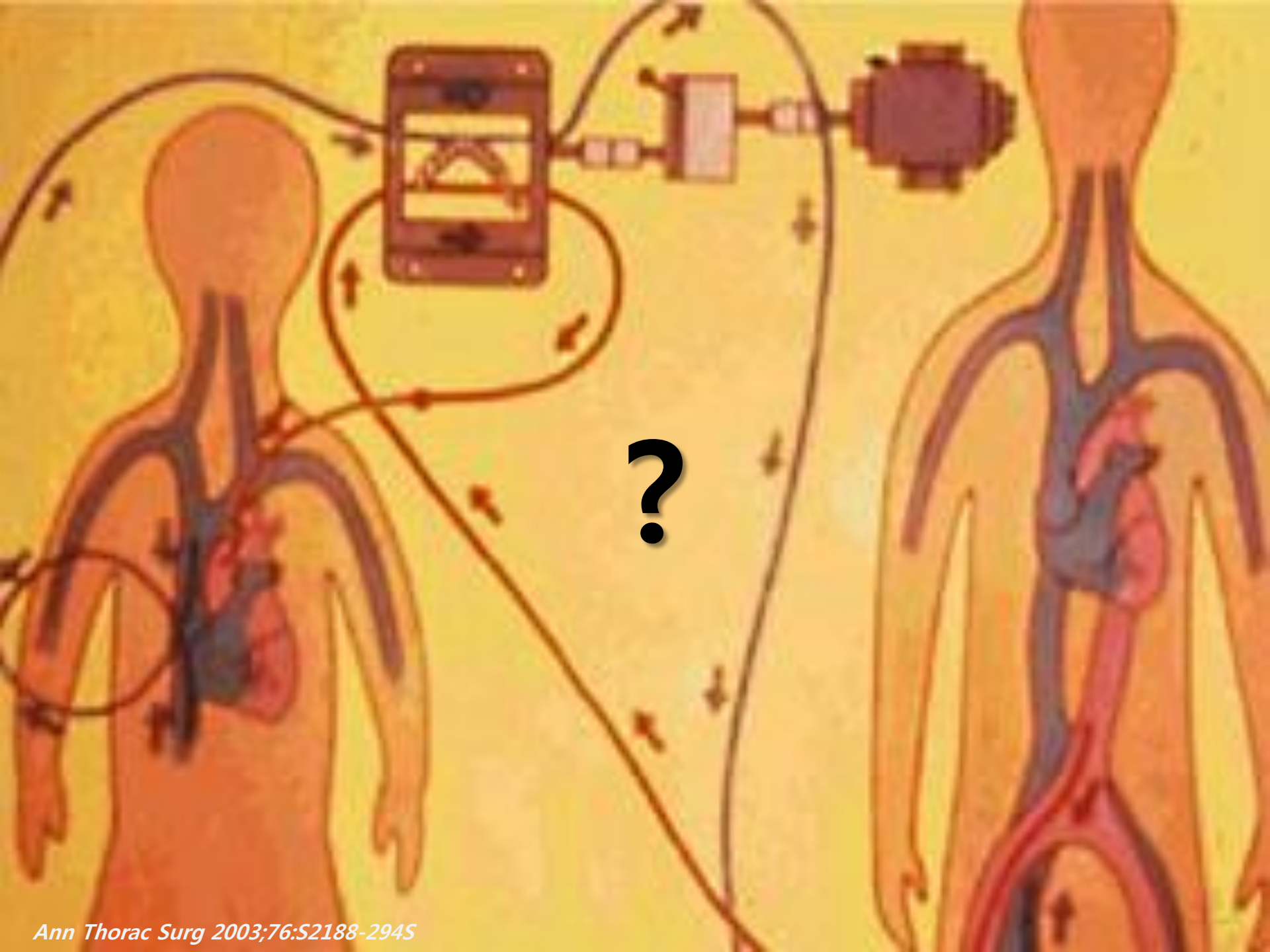
Blood is drawn from the Left Atrium via the Inflow Cannula that is connected to the micro-pump which pumps the blood back to the body via the Outflow Graft to the Subclavian artery.

- **Aortix 0.6*6.5cm, Aortix reduces the heart's energy consumption by 39 percent.**









Ann Thorac Surg 2003;76:S2188-294S

Take Home Massage

- **Past**
  - **History of Extracorporeal Membrane Oxygenation(ECMO) I**
  - **History of ECMO II (Korea)**
- **Present**
  - **2017 ELSO data**
  - **ECMO current status in Korea**
  - **Clinical study**
  - **Equipment**
- **Future**

Take Home Massage

- 1930년대 부터 태동하기 시작한 에크모는 많은 선각자들의 노력에 의해 2000년대가 되면서 전 세계적으로 시행되기 시작하였고, 80년대에 태동되었던 국내의 에크모 현황도 90년대를 기점으로 발달하기 시작하여 2015년 메르스 사태 등을 거치면서 흉부외과 특히 에크모 연구회를 중심으로 활발히 시행되고 있다.
- 국내 에크모 현황은 심장보조, ECPR이 상대적으로 폐 보조 보다 많은 특징을 가지고 있으며 최근 폐 보조를 의한 에크모도 크게 증가하고 있으며 현재 에크모의 결과는 ELSO의 결과 비교하여 낮은 수준을 보여주나 빠른 속도로 발전하고 있다.
- 국내 에크모 건수는 빠르게 증가하여 연간 2000례를 넘고 있으며 심평원의 적응증 조절이 있었다. 레지스트리도 현재 활발하게 진행되고 있다.
- 향후 에크모는 장비 발달, 시스템의 표준화 등으로 좀더 확대 될 것으로 보이며 새로운 장비들이 개발 되며 현재의 한계 등을 극복하게 될 것으로 판단되어 이에 대한 준비가 필요할 것으로 생각된다.
- 향후에도 운용의 표준화, 새로운 장비의 도입, 연구 등에 흉부외과에서 더욱 노력 해야 할 것으로 보인다.